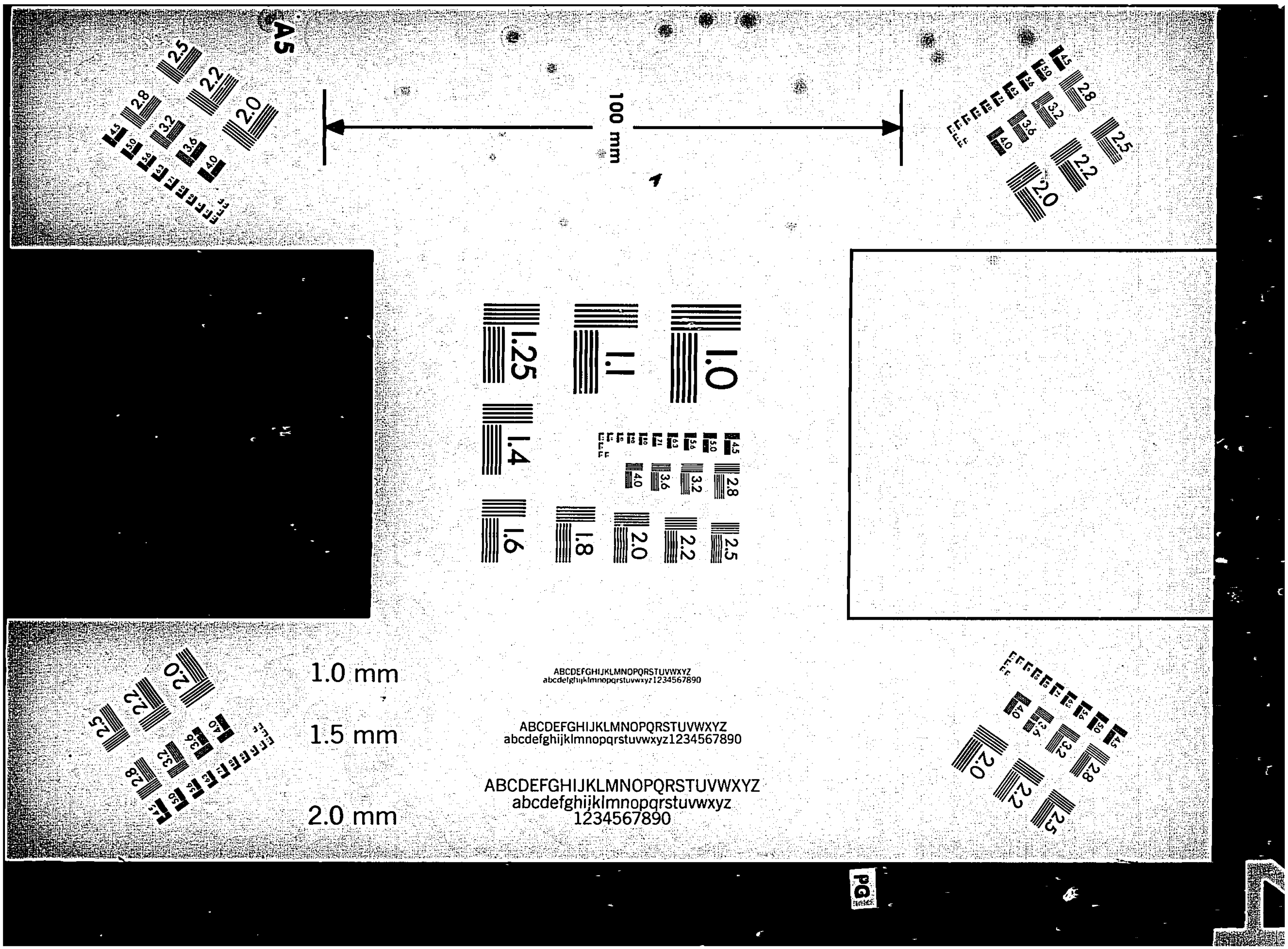
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ABSTRACT

While disputing the exaggerated claims for computerized teaching symbolized by Time Magazine's choice of a computer for its 1982 "man of the year," this paper argues that since the technology is omnipresent, and that since it can facilitate learning under certain conditions, teachers should be as informed about it as possible. A discussion of computer use for second language instruction examines the features to look for in a computer system, the types of installations available, and considerations in selecting courseware. The computer features discussed include memory, speed, processing power, the adaptability of the language used to interact with the machine, screen display capacity and clarity, availability of diacritics and various alphabets (e.g., Cyrillic), screen color, keyboard design, touch panels, interface with external audio and video devices, and potential radiation exposure. The types of installation discussed include central systems and individual microcomputers and the requirements of each. Courseware considerations include the potential for making copies, programming language, match with the computer's display capacity, usefulness with a variety of texts, program design quality, and availability of audiovisual components. (MSE)

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COMPUTER-AIDED INSTRUCTION: LANGUAGE TEACHERS AND THE MAN OF THE YEAR[1]

FERNAND MARTY[2]

[1]For those who have already forgotten and those who neve knew, *Time's* Man of the Year for 1982 was the computer.

[2]Fernand Marty is Professor of French and Computer-based Education at the University of Illinois at Urbana-Champaign.

I have been teaching French in the United States since 1946; in my efforts to improve my teaching, I have depended on applied linguistics, educational psychology, and--to some extent--on technology. I began using tape recorders at Middlebury College in 1948 and, in the workshops and NDEA institutes in which I participated in the 1950's and early 1960's, I emphasized that tape recorders were only devices that could provide out-of-class practice with audio materials (just as books provide practice with written materials). In situations where high accuracy in the spoken language was one of the objectives, the students who, for their "homework," have access[3] to audio equipment were *obviously* able to reach higher levels of performance than those who did not have any equipment--provided, of course, that the exercises were properly designed to fit the objectives of the course and provided that the students did want to attain those objectives.

I now have about 15 years of experience with the PLATO computer system at the University of Illinois.[4] In this brief article, I would like to discuss some of the problems that language teachers face when they consider using computers for language instruction.

I will not try to "prove" that computers can facilitate the process of learning a language. It is obvious that students who *want to learn* will learn faster or reach higher levels of accuracy when they have access to a computer which provides immediate feedback and detailed error analysis, which stores information about their performance, and which--on the basis of that data--supplies them with individualized exercises.[5] I believe that the gains made by such students using such exercises are worth the expense. [Of course, I do not take into consideration the computerized language lessons which are now commercially available for use on microcomputers and which, generally, are hardly any better than a pack of index cards or a programmed textbook.]

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[3]Access to technology can also take place at home; students whose parents can afford tape machines, shortwave radio receivers, dish antennas to receive foreign television programs, computers, etc., have a marked advantage over students whose access to instructional technology is limited to the school. It can be argued that technology, at present, is helping mostly the students already lucky enough to have educated parents who can devote their own time and money to the education of their children, who can afford to pay for private lessons, for trips abroad, etc. Our rapidly deteriorating school system can no longer offset that growing imbalance in educational opportunities.

[4]The PLATO system was conceived at the University of Illinois (Urbana-Champaign) and began to function in 1960; it has been under constant development and improvement since that time. Control Data Corporation, by virtue of an agreement with the University, has installed PLATO systems in Minnesota, Delaware, Florida, California, Maryland, and several foreign countries (Canada, England, France, Belgium, Korea, Australia, South Africa, etc.).

[5]For a discussion of language lessons, see Marty 1981, 1982.

As was the case some 20 years ago with language laboratories, much of what magazines now write about the use of computers for instruction is nonsense.[6] Research in the instructional uses of computers has been going on for over 20 years and there is no solid indication that we are about to witness a revolution in our educational system. However, since there is evidence that computers, under certain conditions, can facilitate the learning process, language teachers should know as much as possible about the available equipment and the results that can be expected today.

Three aspects need to be considered: (1) the computer features which we need, (2) the types of installation which are available, and (3) the courseware (lessons) which we need. [The following comments apply only to language teaching; our colleagues in mathematics, physics, chemistry, etc. have different requirements and, indeed, their requirements may be less demanding than ours; thus, if a computer laboratory is to be installed in a school, the language teachers should make sure their voices are heard.]

FEATURES TO LOOK FOR IN A COMPUTER SYSTEM

1. Good language lessons require substantial amounts of computer memory. A typical 20-sentence exercise with several levels of feedback, a good error analysis, and a complete set of grammar statements which can be used for review requires about 3 million bits of information or, in computer talk, 375 kilobytes (a byte equals 8 bits); 375 kilobytes is usually written as 375K.

   In a computerized lesson, speed is of the essence. The basic justification for using computers in education is that a given set of objectives can be attained and retained in substantially less time than without computers; this goal, obviously, will not be reached if the machine needs several seconds to decide whether the student's response is acceptable, several seconds to find the appropriate feedback, several seconds to display the next question, etc.

   In a central (time-sharing) system, a large number of terminals can be attached to a computer; the speed depends on the processing power of the computer and the number of terminals active at a particular time. On the Illinois PLATO system, even when the maximum number of terminals are active (600), the speed of execution is less than one second and can be considered excellent.

   In stand-alone microcomputers (APPLE, TRS, IBM PC, etc.), the speed depends on the amount of memory required by the lesson itself *and* the amount

[6]For example, *Time* magazine (February 20, 1978) writes: "The computers provide an intensely visual, multisensory learning experience that can take a youngster in a matter of a few months to a level he might never reach in less than many, many years of study by conventional methods." and "...these magical beasts," as they have been called, are revivifying soporific students, dangling and delivering challenges beyond the ken of most educators."

of internal memory that the computer has. When the student uses a microcomputer, he must have a floppy disk (or diskette) which contains the language lesson he wants to use.[7] He must place this disk into the disk drive of the microcomputer. There are several kinds of disks (single-sided or double-sided, single density or double density, 3-inch disks, 3.5-inch disks, 5.25-inch disks, etc.); thus, the amount of information that can be stored on a disk can vary considerably and you will find that not all disks can store a language lesson that requires 375K of memory. After the student has placed the disk into the disk drive, the computer copies from the disk into the computer's internal memory as much information as possible.

Let's suppose that you have a 48K microcomputer; this means that the internal memory of your machine can store only 48,000 bytes of information at a time; keep in mind also that part of that memory (the ROM or Read Only Memory) is permanently loaded in the computer; without that permanent memory, the computer could not run. What is left over (RAM or Random Access Memory) can be used to store your lesson.[8] If your lesson requires only about 30K, all of it will be stored in the internal memory and the speed of execution will be very fast (salesmen of microcomputers tend to demonstrate only that kind of lesson). But, if you have a lesson requiring 375K, most of it will be left on the disk and the computer will have to go to the disk drive to copy the information necessary to judge the student's response, then to provide feedback, then to display the error analysis, etc. That constant exchange of information between the computer and the disk drive slows down the execution of the lesson to such an extent, in my opinion, microcomputers with less than 512 K of internal memory are unacceptable for effective language teaching.[9]

2. The computer language (the language that the programmer uses to communicate with the computer) should be so structured that a linguistic analysis of the student's answers is relatively easy; we need to be able to separate affixes from roots, judge the word order, distinguish lexical errors from spelling errors, etc.

3. The screen should be able to display at least 1920 characters (e.g., 24 lines of 80 characters each). This is necessary because, in a language exercise, the instructions, the stimulus, the student's answer, the error analysis and review, etc., will require that many characters. In

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[7]The program can also be on a cassette and loaded into the computer's memory with a cassette player. This takes more time and is used only with programs short enough to fit entirely into the computer's memory.

[8]Some advertisements state the amount of Random Access Memory (e.g., 64K RAM or 64K User Memory); the buyer then knows how much memory is really available for his programs.

[9]Few microcomputers today have 512K of internal memory, but more are becoming available.

civilization lessons, you will require detailed maps and various other graphic displays which require a high resolution screen.[10]

4. Diacritics (accents, cedilla, etc.), italics, all alphabets (e.g., Cyrillic) should be available. It should also be possible to type from right to left.

5. The characters on the screen should be as clearly legible as in a textbook; they should be sharply defined and should not flicker.[11]

6. Color is desirable. If color is available, the displays should be as sharp as in black and white mode.

7. The keyboard should be easy to use. The alphanumeric keys (a through z and 0 through 9) should be arrayed in the same order as on a regular typewriter; the function keys (those providing editing facilities, feedback, help pages, etc.) should be grouped separately and be clearly labeled. The keys, when pressed, should feel "solid" (not "mushy") so that the students will be able to type as rapidly as they can. The keys should not "bounce," that is, type two characters when the student feels he has pressed the key only once.

8. An edit key is essential; the student must be able to make corrections in any part of his answer without having to retype the whole sentence.

9. Alphanumeric characters and graphic displays should plot and erase rapidly. An alphanumeric statement should plot at a speed of, at least 500 characters per second; erasing a line or a group of lines should be instantaneous. Fast plot and erase of drawings allows animation (for example, a person crossing a street).

10. It should be possible to communicate with the computer by touching the display screen; this can be useful, for example, in word order exercises.[12]

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[10]The PLATO system uses a square display panel consisting of 262,144 (512 x 512) dots which can be turned on or off individually.

[11]Most computer terminals use cathode-ray tubes (like television). The terminals used at the University of Illinois have a plasma panel; plasma panels display orange dots on a black background; they have no flicker at all and cause much less eye fatigue than CRT's. Unfortunately, the manufacturers of microcomputers have shown little interest in plasma panels and, since the demand has been so small, the cost has remained high. At present, plasma panels do not have color.

[12]There are two types of touch panels. The cathode-ray tubes can be covered with a pressure-senitive film which determines which area of the screen is touched by the student. On the terminals equipped with a plasma panel, there are--around the screen--light-emitting diodes (LED's) which generate vertical and horizontal infrared light beams; when the student touches the screen, two light beams are interrupted and the location is determined.

11. It should be possible to activate external devices such as slide selectors, tape recorders, video tape players, etc.

12. The students should not be exposed to dangerous radiation levels even if they sit very close to the screen.

TYPES OF INSTALLATION

As of February 1983, there are two basic types of installation:

1. A star or central system: In this installation a powerful computer (mainframe) serves several hundred terminals (time-sharing system). The terminals are usually connected to the main computer with phone lines and can be thousands of miles away from the building where the computer is located.[13] However, since the communication costs depend on the distance, most schools can afford this type of installation only when the central computer is on their campus.

2. Individual microcomputers: In this type of installation, a school has a number of microcomputers in a room and these machines can be used by students in various disciplines; each machine is independent of all the others. This kind of installation may be acceptable in a temporary, experimental situation, but it has so many drawbacks that, I believe, it should not be generalized. The most serious drawbacks are:

   a. You need to prepare as many diskettes of a lesson as you have students using the lesson at the same time. Thus, if you expect to have 20 students using lesson 10 simultaneously, you have to prepare 20 copies of that particular lesson. That takes much time and money.

   b. The diskettes require careful handling; they must be kept clean. You will need personnel to distribute the diskettes, to ensure they are properly inserted into the disk drives, and that they are returned undamaged.

   c. Maintenance is expensive. In this installation, each microcomputer must have a disk drive. Those mechanical disk drives are the most fragile parts of the installation; repairs can be slow and costly.

   d. The most serious drawback concerns the storage of each student's performance data ("restart" information so that the next study session will begin at the precise point where the previous session ended, lists of exercises which have been done, various scores, language areas which need to be reviewed, etc.). In a central system, that information is kept by the main computer and can be accessed by the student at any time from any of the terminals connected to the computer. With standalone microcomputers, that data could be stored on the lesson diskettes only if each student had his personal set of diskettes (a very expensive solution) and only if his performance data could be transferred from one

[13]Most of the terminals connected to the University of Illinois PLATO system are in Illinois, but there are terminals in Arizona, Hawaii, Connecticut, Florida, and some other states.

> diskette to another as he moved from lesson to lesson. Another solution is to provide each student with an individual diskette (to be inserted in a second disk drive); the computer would write the student's performance data on that second diskette. To avoid loss or damage, it would probably be necessary to keep those individual diskettes in the computer laboratory, which would further complicate the work of the laboratory personnel.

Neither of those installations is really satisfactory for school systems. Research is now being done, in various places, to develop cluster or network systems. The "cluster" system being developed at the University of Illinois uses a minicomputer with a high-speed disk drive; it can operate about 100 terminals all located in the same building. As in the central system, the students have only a terminal and a keyboard in front of them (NO diskettes to handle), but there are NO communication costs. In my opinion, this will be the most efficient and cheapest installation for a school.[14]

COURSEWARE

The term "hardware" designates the physical components of a computer; "software" designates the commands that can be understood by that computer. The term "courseware" is used for the set of instructional lessons that can operate on that particular type of computer. Good courseware requires a powerful computer and a software which includes all the commands necessary to perform an effective presentation of the lesson and execute a detailed analysis of the students' responses.

How good can computerized lessons be? This subject is difficult to discuss because there are so many people who believe in "magic" and see in computers the solution to all problems.[15] We cannot predict the state of technology 20 or

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[14]The current estimate is that a 40-terminal cluster system will cost $100,000: $20,000 for the minicomputer and $2,000 for each of the 40 color terminals.

[15]See, for example, Jean-Jacques Servan-Schreiber's "Le Défi mondial" (Fayard 1980), in which he claims that microcomputers can solve the problems of the Third World. For example, he writes (1980:373): "Le moment arrive, indique 'le mémoire', où nous n'aurons qu'à parler aux ordinateurs pour qu'ils enregistrent nos instructions, nos messages, ou l'expression de nos pensées, et où ils auront appris, par l'intermédiaire de la voix synthétique, à nous transmettre leur réponse, une fois leur travail accompli. Les échanges dan les deux sens se feront, et bien plus rapidement, par la parole."

"Ainsi l'abîme qui sépare encore les populations des continents industrialisés des populations illettrées est appelé à perdre son caractère d'obstacle infranchissable au développement du Tiers-Monde."

This passage shows a total lack of understanding of the difficulties posed by natural speech processing.

The search for "magical solutions" which require little or no intellectual effort is also apparent in an article published by *l'Express* (February 25, 1983). It is claimed, in the article, that--under hypnosis--one can learn to speak a foreign language in one month.

50 years from now, but there is no indication that artificial intelligence will even come close to duplicating all the functions of human intelligence. As far as language teachers are concerned, I do not see any possibility that we will ever have a computer program that, for example, would judge *free* written expression, would perform a phonemic analysis of a student's oral response, or would understand oral free expression and respond coherently.[16]

I am often asked why I do not make my computerized-language lessons as exciting as the computer games which in arcades fascinate people and keep them entranced for hours. It is obviously possible, for example, to design a game in which the alien invaders cannot be destroyed unless the player plans his strategy in French; the problem is that, under such conditions, the amount of learning per hour is so small that it would take much too long to reach satisfactory objectives. Furthermore the game approach is far more feasible with vocabulary and morphology than with syntax. I have yet to see a complete language course (e.g., a 4-semester college course) which is exciting, amusing, and efficient (in terms of time needed to reach its objectives).

Computerized lessons can be easily copied on tape or disks and distributed to other systems (of the same type). Making those copies is inexpensive, but the cost of preparing the lesson itself can be very high if it is a lesson with precise cues, detailed error analysis, record keeping, remedial exercise, etc.[17]

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[16]Articles in journals or demonstrations in "computer fairs" tend to be deceiving. It is true that there are computer programs that judge free expression if the "writer" limits his "free expression" to a short list of syntactic constructions and a given vocabulary. It is true also that computers can understand human speech if the speaker uses the vocabulary and syntax already stored in the computer and if his voice (distribution of the formants, pitch, rate of delivery, etc.) matches the voice(s) which the computer has been trained to recognize. Understanding *totally free* oral and written expression is quite another matter.

[17]Other possible uses of the computer are: In culture and civilization courses, we could provide the students with simulation lessons. For example, in a course on contemporary France, the student could pretend he was born in France, he could choose his place of birth, his family and friends, could choose his profession, could get married, etc., and thus assume a "French" identity. Since he could enter the program as many times as he wanted and could make different choices, he would get to know contemporary France from many different angles: un O.S. chez Ranault, un instituteur dans un village de Lozère, un docteur dans le 16e arrondissement, etc.

Another powerful use of computers is to detect the weak points in a student's knowledge and to have the computer present the student with remedial work. For example, a student who wants to resume his study of French after a lapse of a few years would be given a general test. He would be told what his weak points are, and the computer would put together exercises which would bring the student to the desired level.

In literature, a student about to enter a course on the Renaissance could be told that he needs to take a computerized test designed to determine whether he has acquired the knowledge necessary to take the course with profit; if not, the computer program would provide the necessary remedial training.

In order to provide a student with about one hour of language work on the computer, a language teacher and a programmer may have to work for 50 or even 100 hours: determining the objectives of the exercise, writing the computer code to judge the students' answers and provide the error analysis, checking that the lesson operates properly and catches all the errors the students might make, etc. Thus, to develop a set of exercises for a two-year language course, it might be necessary to spend over $100,000 in salaries alone (not counting computer time, supplies, etc.). However, since the cost of duplicating the course is trivial, this amount--although large as an initial expense--would be quite reasonable if the course were to be used by 200 schools (about $500 per school). Since there are about 2,000 colleges and many thousands of secondary schools in the United States, finding 200 buyers does not seem unduly difficult. However, the following should be kept in mind:

1. There are several computer languages in use: BASIC, FORTRAN, PASCAL, LISP, COBOL, TUTOR, etc.; some of those languages (e.g., BASIC) exist in several forms ("dialects"). A program written in PASCAL will work only on machines which "understand" PASCAL. There are programs which convert lessons from one language into another, but--usually--the conversion is not complete and must be finished manually. A solution to this problem will probably be found, but meanwhile--in order to achieve maximum distribution--the author of a course would need to prepare as many versions of his course as there are computer languages in use.

2. Some terminals can display a maximum of 960 characters (24 lines of 40 characters each), some can display 2,048 characters (32 lines of 64 characters each), some can display 1,960 characters (24 lines of 80 characters each), etc. Thus, a language lesson written in BASIC and which requires a 64 x 32 screen will not run on machines that understand BASIC but have a 80 x 24 screen. The dissemination of computerize materials will remain difficult until a standard is adopted (possibly 24 lines of 80 characters).

3. The computerized materials will probably have to be of a general nature. There are too many different textbooks in use and each edition is used for too short a time to make it profitable to prepare a computerized version of the exercises of each edition of each textbook. At the University of Illinois, we have prepared a large number of exercises (about 700 in French, about 500 in Spanish); the number is large enough to allow the students to find exercises corresponding to their needs whatever textbook is used.

4. It is easy to examine textbooks and workbooks and decide which one is perferable for a particular class. It is far more time-consuming to examine a computerized course; in addition to evaluating the contents, one must ascertain that the computer program will not "bomb out" leaving, for example, the student with a blank screen and unable to proceed. It will probably be necessary to establish review boards composed of language teachers and students to "go through" the programs in order to evaluate them and verify that the code performs correctly.

5. At present, language teachers can easily prepare materials to supplement their textbooks, but it is unlikely that they will have enough free time and/or training in computer programming to prepare their own computerized materials. It is even more unlikely that they will be able to modify/

improve the courses they might purchase. The code for good language lessons is so complex that even expert programmers hesitate to change programs written by other programmers.

6. Audio-visual components are desirable. It is fairly easy to add color slides to a computerized lesson since there are machines which can be connected to a terminal and which can access *any* picture (on a microfiche, a tray, or a carrousel) in less than one second. The problem is that we must prepare a number of slide sets or microfiches as large as the maximum number of students likely to use the lesson at a particular time. We also need personnel to check out the slides, make sure that they are used properly, returned undamaged, etc. The cost in time and money is very high.[18]

   It is also easy to connect an audio tape machine and/or a video tape player to a computer terminal and write a program which can access any part of the tape. The problem is that in a good, individualized lesson, the needed segments will not occur in a linear fashion; for example, a particular student might need segment 1, then segment 20, then segment 12, then segment 45, etc. The tape is wound or rewound automatically, but it takes far too much time. And, of course, we have the same problems as with color slides (number of copies, personnel, etc.).

   At present, the only way to obtain immediate random access to any part of an audio and/or video recording is to place the recording on a disk or a cylinder; for example, on the random access audio device developed at the University of Illinois, the disk and the playback/record head move jointly in such a way that any part of the disk can be accessed in less than half a second.[19] Some video disc machines can provide practically immediate access to any audio, slide, or moving picture segment, but the cost of manufacturing a video disc master is still very high and the number of potential users is not sufficient to bring the cost of the copies to an affordable price. In any case, the use of such audio or video devices suffers from the limitations already mentioned (number of copies to be made or bought, personnel, etc.).

   Another possibility is to convert the needed recordings into digital information and store it in the computer memory with the code for the lesson, but--because of restrictions in the available amount of memory and/or the transmission rate of information between the computer and the terminal--the speech needs to be compressed. This process of removing non-essential information keeps the speech intelligible to natives, but it is hardly satisfactory for language teaching.

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[18]I used microfiches with 256 color slides for my "culture" lessons (geography, etc.) for several years. I had to discontinue the use of those microfiches because of the cost of updating them and replacing them.

[19]The random access audio devices are manufactured by Education and Information Systems in Champaign, Illinois.

Another possibility is to use synthetic speech. Instead of recording the needed sentences, we can type phonemic strings with their pertinent prosodic features into the computer program for the lesson and a synthesizer (incorporated into the terminal used by the student) changes that information into speech. It is also possible to use a computer program to convert the graphemic strings into phonemic strings[20] which can be sent to the synthesizer; this presents the advantage of allowing the students to hear the sentences they have typed or of allowing audio feedback based on the student's response (Sherwood and Sherwood 1982). At present, the quality of the voice produced by such synthesizers is not good enough for language teaching, but progress is being made.

CONCLUSION

At the University of Illinois, I have had many students who have profited from the computer programs I have written and who have reached levels of accuracy they could not have attained without the programs; for those students, the expense of time and money was clearly justified. But my purpose in writing this article was not to convince you that all forward-looking language departments should use computerized lessons. It may well be that this world would be a better world, with happier people, if cars, television, computers, etc., had never been invented or if wisdom had governed their development and their use. But, for better or for worse, language teachers and their students are part of a society that has been deeply affected by technology, a technology which is omnipresent and cannot be ignored. Computers will not go away; their influence in our daily lives and education will continue to grow. It is up to us, in the Humanities, to understand that technology, to evaluate its potential (for good or for bad), and to be among those who decide how it will be used.

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[20]A grapheme-to-phoneme program for French is being developed at the University of Illinois by Fernand Marty and Robert Hart.