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ABSTRACT

For this discussion, new technologies are defined as specially designed training systems based on microcomputers that incorporate high resolution color displays, special input devices for responses, laser videodiscs for storage of stimulus materials, and hard disk storage for programs and responses. Such systems have several advantages over existing training options in business and industry--e.g., reduced time needed for training--and more effective, individualized instruction results from utilizing computer based training. In addition, the computer can track, analyze, and present results quickly and meaningfully. Computer simulations provide the opportunity to present trainees with experiences that go beyond those available through textbook materials and classroom settings. However, three major issues should be considered when introducing new technologies into industrial training programs: the needs of those who will be using the system, the attitudes and reactions of trainees, and the attitudes and reactions of the trainer. A list of references completes the paper. (JB)

Use of the New Technologies
in Training in Business and Industry

Darlene F. Russ-Eft

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Education takes place in many more settings than the traditional school. Indeed, as the Carnegie Foundation for the Advancement of Teaching noted in their recent report called Corporate Classrooms: The Learning Business, there is a growing commitment by U.S. corporations to education for the workplace. The report states that U.S. companies are training and educating almost as many people as our four-year colleges and universities -- nearly 8 million people.

An important aspect of the training provided or supported by business and industry is that it be "relevant" to the job. Furthermore, the time spent in learning -- whether or not it is in the classroom -- is time that cannot be devoted to the job. So, businesses want training programs that can, in some reasonably short time-frame, produce some visible results.

Within this context, I would like to address some issues concerning the use of technology in training. First, I will define the new technologies for business training, and then identify some of their advantages. Finally, I will focus on three major issues: 1) what human factors considerations need to be accounted for, 2) the attitude and reaction of the trainee, and 3) the attitude and reaction of the trainer.

A Look at the New Technologies

Before discussing the advantages and issues, it may be useful to consider what is meant by the "new technologies". If the only capability desired in the system is to administer computer versions of standard classroom materials, then it is likely that systems incorporating existing commercially available microcomputers will be the norm. Such a system would probably consist of no more than an ordinary microcomputer with a keyboard for answer input, a cathode-ray-tube (CRT) screen for information display, and a large capacity disk storage device for holding the program.

If, however, more complex and innovative materials are to be presented, then it is likely that specially designed training systems, perhaps based on existing microcomputers, but certainly somewhat expanded in capacity, will be developed. These systems might incorporate high resolution color displays, special input devices for responses, laser videodiscs for storage of stimulus materials, and "hard" disk storage for program and response storage. Such systems, having the capability to display both graphics (including animation) and photographic quality (including motion sequences) images, will no doubt be integrated into stand-alone units.

It now appears unlikely that mainframe computers will form the basis for such computer mediated systems. The ability to control a large number of training stations from a single mainframe CPU tends to be more than offset by the lower costs of microcomputer systems, the reliability of not having the whole system go down at once, and the high costs associated with the hard wiring or telephone lines necessary to control remote training stations. Minicomputers located at each training site and controlling only the training stations at that site represent a possible compromise, but they have the disadvantages of moderately high costs and the problems associated with the entire system going down. Advantages that they do offer are that it is possible for them to collect and consolidate any training results for all trainees using these stations.

While cost and flexibility features tend to favor the use of stand-alone, microcomputer based systems, they do have the disadvantage that extra steps are necessary to consolidate any test results from each station. The most satisfactory method for overcoming this problem is probably to connect the several testing stations together in some form of network. Each station could function independently of all the other stations, but could be polled as necessary by the network so as to collect and consolidate the data on the trainees. With such a system, several extra training stations could be kept on site and used if one station failed. It is also likely that one of these extra stations could also serve as backup for the computer controlling the network, and thus it is unlikely that the entire system could go down.

Advantages of the New Technologies

Reduced Time Needed for Training. Various reports on computer-based training have indicated savings in trainee time (e.g., Barnes, 1984; Levine, 1984). For example, the Journal of Computer Technology in Medical Education and Assessment (1979) reported that "Savings in learner time to complete a course of study were shown in the great majority of the studies, with as much as 50-percent savings in training and testing time..."

This reduction in learning time may be the result of greater individualization of instruction. Through diagnostic sequences, a computer can identify an individual trainee's particular needs and skills. Thus, a trainee will be able to go to the computer and take a short test to determine the skills that are lacking. The computer could determine, for example, that one individual needed to learn the key steps in preparing for a meeting while another needed to learn about some techniques for encouraging active participation from others in a meeting setting. The computer could then present the appropriate instructional sequences for each of these people, permitting more individualized and self-paced instruction fitting their specific needs. The trainees can work at their own pace and participate in training at times that fit their work schedule.

The reduced time needed for training may also result from the greater interactivity that can be incorporated into training (Mahoney & Lyday, 1984). Effective training requires the active involvement of the learner.

Computer-based training can facilitate such active involvement by including hands-on exercises. Furthermore, the computer can track, analyze, and present resent results quickly and meaningfully.

New Types of Materials. Computer simulations provide the opportunity to present trainees with experiences that go beyond those available through textbook materials and classroom settings. For example, Stevens, Roberts, and Stead developed a computer simulation of a Navy steam propulsion system. The student can manipulate the simulated steam plant by pointing at the displayed objects; causing stop valves to open or shut, pumps to turn on or off, and throttle valves to gradually open or close. Changes in the component's state are indicated by changes in its color or by changes in displayed gauges, thermometers, and digital readouts. This system allows students to explore, inspect, and operate a propulsion plant.

Similar examples exist of simulations involving human interactions. For example, Skakun, Taylor, Wilson, Taylor, Grace, and Fincham (1979) described the use of computer simulations of patient management problems. A typical problem began with an introductory block of information describing the setting of a medical problem, the patient's ailments, and the physician's task. Several options were then presented to the physician, such as to obtain additional case history, to conduct a physical exam, and to admit the patient to the hospital. These problems were designed to test the ability to gather and organize information and to make appropriate diagnoses and treatment prescriptions (for use in the final certifying process of pediatricians by the Royal College of Physicians and Surgeons of Canada). Such simulations could, however, be used for training, and indeed computer simulations have been used in training diagnostic skills in learning disability specialists (Lerner & Reichhardt, 1977; Lerner & Schuyler, 1974) or in training school administration skills (Main, 1972).

Management training in business and industry relies increasingly upon behavior modeling methodology (e.g., Bandura, 1971, 1977a,b; Goldstein & Sorcher, 1974; Zenger, 1980). It is currently implemented through the use of videotapes of models performing the desired behaviors. Interactive video can potentially improve the delivery of this training. Through interactive video, the trainee can become a participant in the situation by supplying responses for the model. For example, one could imagine an interactive video providing a simulation/model of a supervisor dealing with an employee about a performance problem. At critical points in the discussion, the trainee would provide the supervisor's responses. Then, depending upon those responses, the video could branch along different paths to show the employee's reactions. If the trainee chose an "incorrect" response, the video could present both the negative reaction of the employee, as well as tutorial information indicating the correct response.

Individual Recordkeeping. A final advantage in using computers in training is the improved ability to gather and record information about the trainees. The computer can easily record and store responses to test items. These can then be used to develop national or corporate norms and to use those norms in interpreting the trainee's responses.

In addition to recording answers to test items, the computer can also record data on how items are completed -- response patterns and changes in response latencies for certain items. [See Betz (1975), Horn (1979), and Hunt (1982).] For example, the computer can enable the gathering of information on problem-solving tasks by allowing branching sequences. Rather than determining merely that the person solved the problem, this approach would enable measurement of the amount and type of information needed to solve the problem. In addition, the computer can facilitate the gathering of reaction time data. Such information can reveal much about the strategy a person is using on a particular problem. Several studies have found that good problem-solvers take time to deal with the information defining the problem and then proceed to the solution, while poor problem-solvers scan the initial information quickly in order to spend more time examining the alternative answers available (Bloom & Broder, 1950; Dillon & Stevenson-Hicks, 1981; Sternberg, 1979). The computer can also monitor response consistency and inconsistency. Such measures would indicate the presence of such things as guessing, partial knowledge, lack of motivation, or training/test anxiety. Another type of information facilitated by computer use is that of obtaining confidence weightings for certain items.

Stout (1981) examined the utility of computer interviewing and testing for providing new types of information, such as response latencies during interviewing sessions with patients from the inpatient and partial hospital services of Butler Hospital. The latencies for almost all subjects displayed a serial position effect, in which latencies are generally higher at the beginning of the interview than at the end. Some portions of the interview were associated with relatively long latencies, possibly because of item difficulty. Other portions of the interview displayed considerable variation in response latencies across subjects. Stout concluded by suggesting the use of response latencies to detect individual differences, gross "misbehavior" on the part of the interviewee, and the onset of interviewee fatigue.

Issues to be Addressed

Human Factor Considerations. Human factors research deals with factors affecting human performance in the context of human-machine systems. During the past decade, much human factors research has focused on human interaction with computer systems. Recently, however, attention has turned to "software psychology" (Schneiderman, 1980), which examines human performance associated with the design and use of software. Johnson, Godin, and Bloomquist (1981) reviewed human factors considerations in the design of mental health care delivery; Johnson and Johnson (1981) reviewed some psychological factors related to computerized testing; and Kearsley and Hillelsohn (1982) conducted such a review for computer-based training. Following is a brief summary of the findings from this research.

In any application of computers in training, it is important to consider the needs of those who will be using the system. The design of the interactive aspects of the system must depend on the users' experiences and abilities. Subjects with negative attitudes toward computers have been shown to perform more slowly and to make more errors (Walther & O'Neil, 1974). What is appropriate for an experienced user may not be appropriate for the naive user and vice versa. A system acceptable to all users is one that is powerful, flexible, and low in complexity (Ramsey & Atwood, 1979).

Acceptance of a system can be facilitated through a design that allows users to feel in control. Kearsley and Hillelsohn (1982) recommended that testing items be designed to allow trainees to change their answers either before proceeding to the next screen or by reviewing all questions and selections at the end of a test. Another option might be to allow trainees to skip questions and return to them later. A second important factor enabling users to feel in control involves the level of instruction and assistance provided by the system. Rouse (1977) suggests a system design in which the user determines the amount of instruction required. "Help commands" providing tutorial aid should always be available. A system should be capable of detecting user difficulties, such as consistent input errors, and be programmed to help the user learn the correct procedures. In particular, if errors do occur, the system should provide constructive messages about how to correct the error and eliminate similar errors in the future.

One major issue concerns timing factors, such as system downtime, system response time, and the length or duration of a session. Research has shown that system downtime must be kept at a low figure; reliability rates of at least 90% are needed for users to accept a system (Kearsley & Hillelsohn, 1982). Current microcomputers achieve this level of reliability. In terms of system response time, researchers (Carbonell, Elkind, & Nickerson, 1968; Wagner, Seidel, & Hillelsohn, 1978) have reported that extreme variability in response time bothers users more than the length of the system delay. Almost all users found a delay of 2 seconds or less to be acceptable.

No algorithms exist for determining the optimal or maximum acceptable duration for a training or testing session. Duration of a session is a function of the content and objectives of the test and of the examinee's motivation and attention span. Environmental and equipment factors do have an effect, however. Poor equipment design (e.g., screen glare, chair height) can produce physical fatigue (Duncan & Ferguson, 1974; Holtgren & Knave, 1974). In addition, individuals experience visual fatigue when watching a CRT for a few hours without a break (Mourant, Lakshmanan, & Chantadisai, 1981).

Good screen design can help to prevent eye fatigue. For example, Ramsey and Atwood (1974) suggested that designers should limit the number of elements to be displayed on a CRT at any one time. Increasing the number of display elements presented simultaneously results in greater amounts of time to respond, greater numbers of errors, and more rapid onset of fatigue.

Since the most common input device is the alphanumeric keyboard, extensive research has been done on keyboard design (e.g., Alden, Daniels, & Kanarick, 1972). Lack of typing skill has not proven to be a hindrance in using keyboards (Morrill, Goodwin, & Smith, 1968; Weeks, et al., 1974) in interactive situations. Nevertheless, system designers need to take account of the fact that errors will always be made. A simple error correction procedure, such as a "backup key" on the keyboard is one solution. One might consider designing alternative keyboard arrangements, such as the use of specially marked keys (by colors or names) to reduce input errors by persons unfamiliar with a keyboard. [See Schneiderman (1980) for a discussion of the use of alternative keyboards for various types of users.]

Alternative input modes are inexpensive and may, in some instances, help to reduce errors. These include pointing devices (touch panels, light pens), mark-sense readers, cursor control devices (e.g., joysticks and mice), and graphics tablets; voice recognition is somewhat more expensive and at this point it is probably not technologically feasible or socially acceptable for large-scale training or testing programs. (Consider the potential confusion, for both trainees and response devices, that could exist in a situation where 20 trainees, all in one room, are speaking their answers into microphones.) Touch input is appropriate when the task being tested can accept an analog response. For example, the trainee can be told to touch the appropriate button (on a graphic of the device) or to touch (a picture of) the connection that should be soldered.

Attitudes and Reactions of Trainees. As computer mediated training and testing has been shown to be cost effective and technically feasible, the question of its acceptability to trainees assumes increased importance. Indeed, Lord (1975) made the following comments as a discussant at an American Psychological Association symposium on the efforts of the U.S. Civil Service Commission to solve the technical problems associated with computer adaptive testing. "Thus it seems apparent that computer-assisted testing as a wide-spread operational reality is only a matter of time. It is therefore appropriate to ask what kind of a reception computer-assisted testing is apt to get from those who will be most directly affected by it -- the individual examinees." Schmidt, Urry, and Gugel (1978) reported on an investigation of that particular point. Over a three month period, 163 examinees voluntarily took a computer adaptive verbal test. When asked to rate this experience, the examinees' responses to both Likert items and to sentence completion questions were overwhelmingly positive. Examinees most frequently liked the reduced time requirements, the clarity and simplicity of the method, the lack of time pressure, quick feedback of results, and administration at the examinee's convenience. The things liked least about the method were inability to review and change previous answers, difficulty of adjusting to the method, and difficulties in reading the CRT screen.

Anderson and Trollip (1982) studied the administration of a computer-based version of the FAA Private Plot Written Examination. The FAA designated examiner at the University of Illinois gave applicants the choice of taking the test conventionally or via the PLATO system. Approximately 45% of these applicants chose the PLATO system. Reactions of these examinees were that the instructions seemed clear, the system was sufficiently flexible, and they would advise others to take the computer-based version. Most responses to the open-ended request for good and bad points indicated appreciation for the immediate feedback and for the enjoyable, relaxing, and easy method. The only bad point mentioned by more than two people was that the system might confuse, scare, or strain other people.

In the field of clinical and counseling psychology, positive client response has been obtained to computer applications. Clients report positive experiences with computer-assisted testing (Byers, 1981; Calvert & Waterfall, 1982; Johnson & Johnson, 1981; Katz & Dalby, 1981b) and with computer-assisted structured interviewing (Byrnes & Johnson, 1981; Space, 1981; Stout, 1981). Indeed, for sensitive interview topics, Erdman, et al (1981) reported that clients found the computer option more appealing than the conventional face-to-face interview.

One major concern expressed by most researchers is that of the resistance of some people to using a computer for training or testing. Fears about and lack of experience with computers are not uncommon (L'Allier & Tennyson, 1980). Indeed, in the studies cited above, the participants were volunteers, with others refusing to take the computer version of the test or interview. It has been suggested that providing the trainee or examinee with an opportunity to "try out" the system might reduce or eliminate such resistance. This area needs further research, particularly when considering the use of computers for large-scale training or testing efforts.

Attitude and Reactions of Staff. The issue of staff resistance to the use of computers in training situations appears in the literature on the use of computers in education and in mental health care delivery. Russ-Eft and McLaughlin (1983), in their investigation of the needs and develoment opportunities for educational software, identified teacher resistance as a major barrier to the implementation of computers in education. This resistance stems from several different concerns about the technology.

These include fear of mechanical problems, concerns about the costs of the equipment and software, concern about difficulties in learning new skills, and fear that expanding technology signifies progressive dehumanization (Holmes, 1982; Wilson, 1981). A similar situation arises in clinical settings. Byrnes and Johnson (1981) noted that, despite positive evaluation studies, computers have failed to gain wide acceptance and support. Space (1981, p. 602) concluded that professional acceptance is the "weakest link in the chain of elements" necessary for effective utilization of computers.

This literature does contain some suggestions for improving staff acceptance of such systems. Byrnes and Johnson (1981) reviewed the literature on change technology and suggested that there must be (1) organizational readiness for the change, (2) a planned strategy for change, and (3) an approach for overcoming staff resistance. Russ-Eft and McLaughlin (1983) made similar recommendations. There must be an organized program of staff training, geared to the needs of each individual.

This staff training must be coupled with software designed not only for the trainee, but also for the trainer. The system should not be more difficult to operate than the average tape recorder. According to Beaumont (1981), the test administrator should be required to do no more than insert a floppy disk or cassette, turn the power on, and then respond to an initial dialogue with the machine to select a test and then establish the parameters for a particular test session. The software should guard against possible input/ output errors, maintain control within the program, and instruct the administrator on actions to be undertaken in the event of errors being detected.

Summary

The introduction of the new technology into training offers exciting possibilities. As you may have noticed, I said "possibilities" rather than "realities". As stated in a recent article, only about 14 percent of training departments in U.S. companies are using computer-based training (Lewis, 1984). A recent survey of companies in the San Francisco Bay Area (and "Silicon Valley" in particular) revealed that "low technology" training remain the norm (Appleby, personal communication, February 1985). For widespread application of computers in training, greater attention needs to be directed toward the issues raised in this paper, particularly that of training staff acceptance.

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References

Alden, D. G., Daniels, R. W., & Kanarick, A. F. (1972). Keyboard design and operation: A review of the major issues. Human Factors, 14, 275-293.

Anderson, R. I., & Trollip, S. R. (1982). A computer-based private pilot (airplane) certification exam: A first step toward nation-wide computer-administration of FAA certification exams. Journal of Computer-Based Instruction, 8, 65-70.

Bandura, A. (1971). Psychological modeling: Confliction theories. Chicago: Aldine-Atherton.

Bandura, A. (1977a). Social learning theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1977b). Toward a unifying theory of behavioral change. Psychological Review, 54, 191-215.

Barnes, K. (1984, March 6). CBT gets good marks: Studies show retention is high. PC Week.

Beaumont, J. G. (1981). Microcomputer-aided assessment using standard psychometric procedures. Behavior Research Methods & Instrumentation, 13, 430-433.

Betz, N. E. (1975, August). Prospects: New types of information and psychological implications. In D. J. Weiss (Ed.). Computerized adaptive trait measurement: Problems and prospects. Symposium conducted at the Annual Convention of the American Psychological Association. (NTIS No. AD A018675)

Bloom, B., & Broder, L. (1950). The problem solving processes of college students. Chicago, IL: U. Chicago Press.

Byers, A. P. (1981). Psychological evaluation by means of an on-line computer. Behavior Research Methods & Instrumentation, 12, 585-587.

Byrnes, E., & Johnson, J. H. (1981). Change technology and the implementation of automation in mental health care setting. Behavior Research Methods & Instrumentation, 13, 573-580.

Calvert, E. J., & Waterfall, R. C. (1982). A comparison of conventional and automated administration of Raven's Standard Progressive Matrices. International Journal of Man-Machine Studies, 17, 305-310.

Dillon, R. F., & Stevenson-Hicks, R. (1981). Effects of item difficulty and method of test administration on eye scan patterns during analogical reasoning. (Tech. Rep. No. 1, Contract No. N66001-80-C0 57, Office of Naval Research). Department of Psychology, Southern Illinois University, 1981.

Duncan, J. & Ferguson, D. (1974). Keyboard operating posture and symptoms in operating. Ergonomics, 17, 651-662.

Goldstein, A. P., & Sorcher, M. (1974). Changing supervisor behavior. New York: Pergamon Press.

Holmes, G. (1982). Computer-assisted instruction: A discussion of some of the issues fcr would-be implementors. Educational Technology, 12(9), 7-13.

Holtgren, G. V., & Knave, B. (1974). Discomfort glare and disturbances from light reflections in an office landscape with CRT display terminals. Applied Ergonomics, 5, 2-8.

Horn, J. L. (1979). Trends in the measurement of intelligence. Intelligence, 3, 229-240.

Hunt, E. (1982). Towards new ways of assessing intelligence. Intelligence, 6, 231-240.

Johnson, J. H., Godin, S. W., & Bloomquist, M. L. (1981). Human factors engineering in computerized mental health care delivery. Behavior Research Methods and Instrumentation, 13, 425-429.

Johnson, J. H., & Johnson, K. N. (1981). Psychological considerations related to the development of computerized testing stations. Behavior Research Methods & Instrumentation, 13, 421-424.

Katz, L., & Dalby, J. T. (1981b). Computer and manual administration of the Eysenck Personality Inventory. Journal of Clinical Psychology, 37, 586-588.

Kearsley, G. P., & Hillelsohn, M. J. (1982). Human factors considerations for computer-based training. Journal of Computer-Based Instruction, 8, 74-84.

L'Allier, J. J., & Tennyson, R. D. (1980). Principles of instructional design applied to an introductory course on educational computing. Journal of Computer-Based Instruction, 7, 26-32.

Lerner, J. W., & Reichhardt, R. W. (1977). Teaching clinical skills using interactive computer simulation. MICC User's Conference.

Lerner, J. W., & Schuyler, J. A. (1974). Computer simulation: A technique for training educational diagnosticians. Journal of Learning Disabiities, 7, 15-20.

Levine, J. B. (1984, July). Improve corporate management skills through computerized training. Data Management.

Lewis, M. (1984, October). Software that improves managers. Nation's Business.

Mahoney, F. X., & Lyday, N. L. (1984). Design is what counts in computer-based training. Training and Development Journal.

Main, D. B. (1972). Toward a future-oriented curriculum. American Psychologist, 72, 245-248.

Morrill, C. S., Goodwin, N. C., & Smith, S. I. (1968). User input mode and computer-aided instruction. Human Factors, 10(3), 225-232.

Mourant, R., Lakshmanan, R., & Chantadisai, R. (1981). Visual fatigue and cathode ray tube display terminals. Human Factors, 23(5), 529-540.

Ramsey, H. R., & Atwood, M. E. (1979, September). Human factors in computer systems: A review of the literature (Tech. Rep. No. SAI-79-111-DEN). Englewood, CO: Engineering Psychology Program, Office of Naval Research.

Russ-Eft, D. F., & McLaughlin, D. H. (1983). Ideas for reading and writing courseware: Needs and development opportunities for educational computer software--reading, writing, and communication skills (AIR/26500/FR/83). Palo Alto, CA: American Institutes for Research.

Schneidermann, B. (1980). Software psychology: Human factors in computer and information systems. Cambridge, MA: Winthrop.

Skakun, E. N., Taylor, W. C., Wilson, D. R., Taylor, T. R., Grace, M. & Fincham, S. M. (1979). A preliminary investigation of computerized patient management problems in relation to other examinations. Educational and Psychological Measurement, 39, 303-310.

Space, L. G. (1981). The computer as psychometrician. Behavior Research Methods & Instrumentation, 13, 595-606.

Sternberg, R. J. (1979). The nature of mental abilities. American Psychologist, 34, 214-230.

Stout, R. L. (1981). New approaches to the design of computerized interviewing and testing systems. Behavior Research Methods & Instrumentation, 13, 436-442.

Walther, G. H., & O'Neil, H. F. (1974). On-line user-computer interface: The effects of interface flexibility, terminal type, and experience on performance. Proceedings of the National Computer Conference, 43, 379-384.

Weeks, G. D., Kelley, M. J., & Chapanis, A. (1974). Studies in interactive communications: V. Cooperative problem solving by skilled and unskilled typists in a teletypewriter mode. Journal of Applied Psychology, 59, 665-674.

Wilson, K. G. (1981, September). English teachers: Keys to computer literacy. English Journal, 50-53.

Zenger, J. (1980). The painful turnabout in training. Training and Development Journal.