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Autor: Schneider, Randall W.
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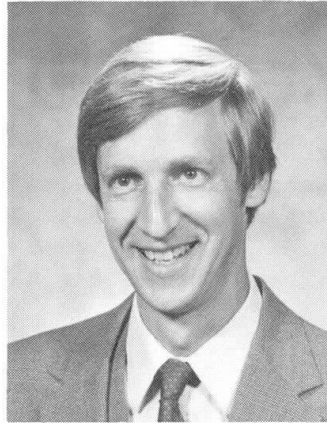
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Using the Computer to Teach

Utilisation de l'ordinateur dans l'enseignement

Ausbildung mit dem Computer

Randall W. SCHNEIDER
Ph. D.
McDonnell Automation Co.
St. Louis, MO, USA



Randall W. Schneider, born 1941, earned his graduate degrees from Southern Illinois University and St. Louis University. He taught mathematics at the high school level for seventeen years and has recently joined MCAUTO with responsibilities in computer based training.

SUMMARY

Industrial trainers have only recently discovered a new training medium – the computer. As compared to existing training methods, computer based training has the functional capabilities to fulfill most instructional needs. Engineers and engineering firms can use the computer based training approach in some conventional and some unconventional ways.

RESUME

Les maîtres d'apprentissage de l'industrie ont découvert récemment un nouveau moyen de formation: l'ordinateur. Comparé aux méthodes existantes, l'enseignement assisté par ordinateur remplit la majorité des fonctions nécessaires. Les ingénieurs et les entreprises peuvent faire usage de l'ordinateur comme support d'un enseignement traditionnel ou suivre des voies nouvelles.

ZUSAMMENFASSUNG

Ausbildner in der Industrie haben neuerdings den Computer als Ausbildungsmittel entdeckt. Mit existierenden Ausbildungsmethoden verglichen, hat eine auf Computer gestützte Ausbildung die zweckmässigen Fähigkeiten, die meisten Unterrichtsanforderungen zu erfüllen. Ingenieure und Ingenieurunternehmen können die auf dem Computer basierende Ausbildung auf verschiedene konventionelle und unkonventionelle Arten einsetzen.



1. INTRODUCTION

This is the age of Future Shock! The veritable wealth of new knowledge which inundates the civilized world daily is truly staggering. Even more difficult to comprehend is the technical nature of these new developments. It is said that the early nineteenth century German mathematician, Karl Frederick Gauss, was the last person to understand all mathematics. No mathematician in the last 150 years, no matter how great, can equal this accomplishment. Today, we are in the age of specialization. The true authority is one who thoroughly knows but one small area. With each succeeding year, that small area becomes smaller and smaller.

One of the most exciting aspects of any technical-base industry like structural engineering or computer science is its dynamism. The application of computer assisted design to the structural engineering environment, the added analysis capabilities of the high speed main frame, and the increased availability of terminals brought about by declining hardware costs have but whetted the appetite for what could be. Industrial trainers view these developments with awe. They have increased responsibility for providing training on these new developments.

2. THE INDUSTRIAL TRAINING DILEMMA

2.1 A Perspective

One of the characteristics of research methodology when confronted with a new problem is to step back and look at the problem in perspective. Has anything been done in the past which could help in the solution? Into what larger arena does the new problem fit? With the advent of the wide spread use of computer based training, it is valid to look at training in general and computer based training specifically.

2.2 The Dilemma - Part 1

The duty of the industrial trainer is becoming more and more difficult to fulfill. Management has put both time and monetary constraints on the training process. The research and development community through its work continually adds new material to be taught. Therefore, to answer the questions, "How should this new discipline be taught?" and "What new techniques are available to use to teach?", it is reasonable to do a brief analysis of present instructional methodology.

2.3 The Dilemma - Part 2

The cost of training is becoming expensive. Each hour that an employee is off a job or project costs the company. Therefore, it is most important that the time involved in training be kept to a minimum. Consequently, training time must be used efficiently. No time should be wasted on what is already known or on "nice to know" topics. Training should involve a carefully designed and directed set of learning activities for the express purpose of assisting a specific set of people to learn to do a specific task. The college classroom or the conference paper is the vehicle for educating, but not for training. Training is very task-oriented. Time is money! Trainers should not waste it.

3. TRAINING METHODS

3.1 The Tutorial

A variety of training methods have been used during the past few thousand years. Research has shown, time and time again, that the tutorial method--one teacher and one student--produces subject matter mastery at the highest level. It is a very common method for training entry level personnel. "You sit next to me and watch what I do. If you have any questions, just ask!" Unfortunately, this method is not very cost-effective. The efficiency of the trainer is decreased by this interruption in his daily work and the trainee does not "produce" during this period. The tutorial method is also 'occurrence oriented'. "When the invoice includes

these products, do this." "When the word processor acts this way, the problem is . . ." Once the training period is concluded, it is hoped that everything has happened that could happen. The flaws in this assumption are apparent. Contrary to these objections the tutorial method has the advantage of one teacher for one student and the valuable teacher-student interaction.

3.2 The Classroom

A very popular approach to training is the traditional classroom. Using this method, a planned presentation by one teacher is given to many students simultaneously. The trainer's time is used more efficiently in that the trainer is reaching many students rather than only one. Rather than the material based on "happenstance", it is normally well-organized. However, the individualized approach benefit of a tutor is greatly diminished. The students are forced into a mold called a class, where the fast learners are held back, and the slow learners learn very little. In addition, the students enter the class with diverse backgrounds. For some, the instruction will be a review and for others it will be too advanced. The trainer can compensate for this by altering the instructional plans. This causes problems with the class schedule as only a given amount of time is usually available for a course. Normally, certain topics are neglected in favor of others. Thus, each class does not receive the same material and the students are not fully prepared to meet all on-the-job problems. One other concern with the traditional classroom approach is the absence of a number of people from their jobs for an extended period. Few jobs enable a worker to be away for such a long time.

3.3 The Multi-media Approach

Another very common training method is called the multi-media approach. The subject matter is relayed to the student through any of a variety of instructional materials--books, audio-tapes, video-tapes. A major advantage is that a subject matter expert, not a trainer, is presenting the material. Often, these materials are written by the pre-eminent authority in the field. (This is much akin to the one-to-one of the tutorial method.) Also, the student can learn at his own pace. Students can reread a book or see a video tape a second or third time. Remember, the term "slow learner" implies that learning occurs at a slower rate, not that it doesn't happen at all. However, this method does have a few drawbacks. Even with the self-paced approach, some of the material could be of the time-wasting review type or some could be too advanced for the learner. In either case, a minimum of learning takes place. A major fault is the lack of student-trainer interaction. Much learning takes place through questions and answers.

3.4 Conclusion

In summary, the traditional training methods of the tutor, the classroom, and the book or movie, each have advantages but also glaring disadvantages. What is needed is a training scheme which possesses the one-teacher-one-student technique of the tutorial, the planned organized presentation and student-teacher interaction of the classroom, and the authority-written self-paced mode of the multi-media approach. A classic quote in education and in training is:

"Those of us in training/education are teaching people who are going to spend most of their working lives in the 21st century. We are training them in the 20th century. And most of the time we are using 17th century methods!"

4. COMPUTER BASED TRAINING

4.1 Definitions

A truly 21st century mode of training is Computer Based Training. CBT, CAI, CAL,

and CMI are just some of the acronyms used in discussing this training method. CAI (Computer Assisted Instruction) and CAL (Computer Assisted Learning) refer to the actual teaching and learning process. CMI (Computer Managed Instruction) normally pertains to the administrative function. A good CMI system will register students, keep track of student course completions (both passing and failures), store data regarding which students completed which courses, and update student personnel records. CBT (computer Based Training) is an inclusive term which encompasses CAI and CMI. As a point of information, it is possible to have a CAI system without CMI, and likewise a CMI system without CAI.

4.2 A Description of CAI

A typical CAI session would be initiated by the student logging on a terminal. The CMI system would then send the proper course to the terminal; that is, the course for which the student was registered. Most CAI courses are designed to determine, first of all, the baseline knowledge of the student. This is accomplished through a series of questions. The student is then branched to the course material which he needs to learn. Following the instruction, a number of questions will be asked to determine subject mastery. If the student shows mastery, he is then presented with the next segment of material. However, if too many questions are answered incorrectly, the student will be presented with more instruction on the same material. This could be a re-presentation of already seen instruction or it could be the same course material, but presented in a different way. Following this review, questions would again be asked to determine mastery. This sequence of pre-test, course material, post-test, review if needed, post-test, is repeated as the student proceeds through the course.

4.3 The Advantages of CAI

4.3.1 CAI and the Tutorial

CAI has the one-teacher-one-student aspect of the tutorial method. The instruction is individualized, meeting each student's needs. Ten students could go through a course. Each could receive a different order and amount of material. Each would attain subject matter mastery. And each would proceed at his own pace finishing in a different amount of time. For the slower student, it must be remembered that the computer has infinite patience.

4.3.2 CAI and the Classroom

CAI has the student interaction found in many classrooms. Students are forced to take an active part in the learning process. They cannot "sit in front of the CRT and sleep." Student responses to questions receive immediate feedback. Correct answers are given positive reinforcement and incorrect answers receive hints which lead to the correct answers.

4.4 A CBT System

4.4.1 CAI Course Authoring

CAI courses can be and should be written by subject matter experts just like a book or a video-tape. These courses come from two sources: outside commercial suppliers and in-house written training materials. While many good commercial CAI courses exist, many organizations find they need training materials for their own unique situation. Commercially written materials are probably not available to meet these specific needs. An alternative to having training materials specifically created by a vendor is to create the desired material within the organization.

Such a system should include an authoring approach which is easy to learn. Course writers should be able to write in their native tongue and not some programming language. Engineers, chemists business executives, or scientists should

be able to write CAI courses and in the vernacular. The authoring system should be easy to use so that modifications can be made without too much difficulty.

Also included should be multi-colored text and graphic capabilities. The use of color can enhance displays and can direct the student's attention to the salient points. Graphics can be very useful in explanations. Remember, "a picture is worth a thousand words."

A necessary feature is text and graphic displays based on student input. A key feature of CAI is individualized learning. CAI is not a programmed text. It is closer to an interactive slide presentation. This feature is vital.

Course evaluation becomes easier with data collection facilities. The author should have at his disposal the ability to collect data such as student responses to questions, the amount of time spent per screen display, and the number of students who decided to take a particular branch. This data will aid the author as he revises his course.

4.4.2 Summary

Thus, CAI possesses the positive attributes of the tutorial, the traditional classroom, and the written presentation. In addition, and of utmost importance, CAI fits the needs of the industrial training environment. A student can take a course at his convenience. He is not tied to a classroom schedule. Courses can be taken during the work day, after work, or on weekends. The computer doesn't mind working overtime. Students may not have to leave their work area to take a course. Many can learn at their own desks. As a course is taken, the CMI system will record student performance. Supervisors can easily learn who took which courses and how long it took (an excellent evaluation tool). Psychologically, CAI is a very personal form of learning. The computer will not laugh at wrong answers or ridicule incorrect responses. CAI will consistently deliver a high quality presentation designed to meet the individual students' learning needs. It has been shown to reduce training time by up to 40 per cent over other methods and with a higher level of subject mastery.

5. CBT AND ENGINEERING

5.1 Engineer Training

Hardware and software developers can train engineers in the latest technological enhancements. Training by developers is normally done in two ways: 1-developers come to engineers, 2-engineers come to developers. In many instances, either involves being away from the job for an extended period of time. CAI can remedy this problem. Developers can produce CAI lessons, put them on magnetic tape or disks, and send them to the engineers. Engineers can then, at their leisure, take the training without the extended absence.

5.2 Employee Training

Within a company, employees can be trained in new developments, techniques, and procedures with CBT. When the new accounting procedure is inaugurated or when that program has been company enhanced and the changes need to be disseminated, CAI will do the job in less time and with greater mastery. Also, employee skills can be upgraded. CAI courses are available in improving writing techniques, spelling, management topics, programming languages, system procedures, and many others.

5.3 Client Training

One of the newest areas in which CBT has been used is in client training. A standardized CAI presentation can serve as an introduction to the products and services of a particular company. A well-written CAI course on each product and



service can be taken by the client at his leisure and at his own pace. If such a presentation is well done, it can save many employee hours.

5.4 Problem Simulation

5.4.1 Problem Solving

What do engineers do? The two words that in the most general sense describe the field of engineering are "problem solving". The major tasks of building bridges, sending men into space, of finding a better bonding agent are really problems to be solved. Some tasks involve more problems than others. Some tasks require more problem solvers than others. But, in its most basic unit, engineering is one-man-one-problem.

5.4.2 CBT and Problem Solving

Computer Based Training though still in its infancy has reached such a high level that it can simulate problem solving situations. The problem solver can practice his art in a realistic but non-threatening situation. What can be simulated? It is possible to simulate almost anything that can be described and displayed in words and pictures. The operation of the Inertial Navigation System of a DC-10 from start-up to shut-down and the engine start-up procedures for an F-18 have been simulated. A problem-solving situation can be displayed, the student can be given an option as to how to solve the problem, and the results of that decision can be displayed. All displays are in both text and pictures. This concept of a simulation definition editor is less than six-months old, and thus, its prospects are still in the developmental stage.

6. CONCLUSION

If one were to study the literature or look at conference agendas, one would see that computer based training is the one concept that is discussed above all others. Then look at the past history of new ideas as written in the literature or discussed at conferences. Within the next ten years, if the usual pattern is followed, CBT will be the preeminent training method. It offers to the industrial training environment the best of all worlds. It has the one-teacher-one-student interaction of the tutorial, the planned presentation advantage of the classroom, and the authority-written self-paced mode of the multi-media approach. Management likes it because it saves them training time and money. Computer Based Training will become the training method of the 1980's.

Post Script:

Your attention is directed to the last sentence of the conclusion and to the second paragraph of the introduction. Those who work on the development side of Computer Based Training and its technology are already looking into the 1990's and beyond. At present, the staggering implications of the interactive video disk with text, video, and audio capabilities are moving from the day-dreaming stage to the drawing board. The imagination is considering the micro-processor and the miniaturization of television receiver. The 1990's will bring an improved cost effective, time efficient, and advanced instructional device for industrial training. The name of this new mode of instruction will be discussed at some conference or in some professional journal in the late 1980's.