Computerized Interactive Videodisc Railroad-Worker Training in Houston, Texas

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ABSTRACT

In May 1983 computerized interactive videodisc (CIV) training was offered to 50 railroad workers on the Port Terminal Railroad Association (PTRA) in Houston, Texas. CIV combines the control capabilities of a microcomputer with the sound and video strengths of a videodisc. This project was cooperatively funded by the PTRA and the Office of Safety, Federal Railroad Administration (FRA). Its purpose was to test (a) railroad employee response to this type of training, and (b) CIV equipment capability in a live railroad training exercise. Six different CIV courses were developed and implemented. The courses were presented using a microcomputer, keyboard, a videodisc player, and a color monitor. Course material was contained on floppy disks and a videodisc. From comments supplied by employees and the on-site monitor from the company that developed the CIV, a number of conclusions were drawn, including: (a) railroad employees respond favorably to this type of on-site training; the amount of classroom training could decrease significantly if supplemented by CIV; (b) the ideal location for on-site training is one with little disturbance and yet that is not isolated; (c) hard disks are preferred over floppy disks and videodiscs; (d) railroad workers consider refresher training, such as CIV, an effective tool in increasing safety awareness; (e) the keyboard was cumbersome to a few employees; an alternative may be desirable; (f) employees prefer simple, direct, and concise features of course design, and employee enthusiasm decreases as degree of difficulty increases; (g) there appears to be direct correlation between interest of management and enthusiasm of employees.

Computerized interactive videodisc (CIV) training has been offered to railroad workers on the Port Terminal Railroad Association (PTRA) in Houston, Texas, since May 1983. CIV combines the control capabilities of a microcomputer with the sound and video strengths of a videodisc. This effort is cooperatively funded by the PTRA and the Office of Safety, Federal Railroad Administration. The results of an initial evaluation conducted with 50 railroad workers to determine their receptivity to this type of training and to establish guidelines for future direction of the course are summarized in this paper.

COURSE MATERIAL

Course material focused on railroad operating rules and safety procedures and was contained on floppy disks and a videodisc. Courses were presented by using a microcomputer, keyboard, videodisc player, and color monitor. Six different CIV courses were developed and implemented:

1. Train Yard Safety: a general training exercise designed to reinforce train-yard safety habits. This course is applicable to all craftsmen and managers working in a train yard.
2. Blue Signal: a course designed to teach proper blue-signal placement and recognition. This course is designed primarily for teaching mechanical craftsmen. It also is a practical method by which to familiarize operating craftsmen (train and enginemen and yard masters) with the purpose of blue-signal display.
3. Air and Hand Brake: a course designed to describe safe practices when working with hand and air brakes. Both operating craftsmen and mechanical craftsmen will benefit from the exercises contained in this course.
4. Hazardous Material Handling: a course designed to teach engine service and ground crews their responsibilities in situations in which they are confronted with hazardous material, such as leaking cars, derailments, hazardous material accidents, and so forth. The PTRA serves the Houston petrochemical complex.
5. Coupler Safety: a course used as an example of how CIV training can be used to teach safety and operating rules. Employees witness other employees, through scenes on the videodisc, in obvious violation of rules relating to coupler operation. The employee is asked to identify the rules being violated. This course is primarily designed for operating craftsmen.
6. Employee Injuries: a generic course designed to describe predominant employee injuries. Statistics and video sequences are used to stress importance of constant alertness when working in a train yard, particularly around moving equipment. Clerks, workers in operating crafts, maintenance of way, mechanical departments, and management can all benefit from this course.

Each of the preceding courses was designed with various combinations of digital displays and audio-video sequences. The audio-video sequences were contained on a videodisc that was produced from videotapes supplied by the PTRA. The Author Learning System controlled interaction between the equipment and the student. Courses were selected and developed with the assistance of the PTRA Director of Safety.

The Houston Labor/Management Project provided technical guidance and coordination with rail labor and local management.

Based on the results of this initial test, a more intensive program has been initiated. The PTRA has been joined in the current effort by the Southern Pacific Transportation Company; they are now the two principal carriers evaluating CIV courses.

A total of 14 modules will be available when the project is completed. The new courses also focus on railroad operating rules and safety procedures, but are more intensive than the original courses and include the full spectrum of rail operations. The courses will run on a computerized work station that consists of an IBM personal computer, a Pioneer LDV-1000 videodisc player, an Amdek color monitor, a printer, and headsets.

CHARACTERISTICS OF A CIV

Description of a CIV

CIV represents a merger of two technologies: computer-assisted instruction (CAI) and videodisc. Equipped with a computer, an interface to control the videodisc player, and a monitor, the user is provided the high visual impact and graphic capability of video and the responsiveness, flexibility, and power of the computer.

CIV incorporates all of the recognized advantages of CAI: self-paced individualized instruction, complex branching, feedback, testing, and record keeping. CIV's major advantage, however, is that it permits the user to randomly access or branch to specific visual images that are stored on a videodisc.

A videodisc is a mass storage medium, generally the size of an LP record. It contains analog, digital information, or both, that represent text, audio, video, and computer programming. A noncontact or optical disc can store 54,000 frames of information, which is recorded as microscopic pits that vary in length and density on each side.

The videodisc is read by using a low power laser; information contained in the microscopic pits is converted to visuals (pictures), audio (voice, music, or other sounds), text, or program logic. Each track contains information for a separate video image, giving a per-side equivalent of 675 carousel slide trays of pictures, or one-half hour of motion. Because the videodisc is read by a laser beam, there is no physical contact with the disc; therefore each image can be read over and over without causing wear and tear to the disc. This makes it possible to use the freeze- or still-frame feature as well as slow motion. Users can directly access any track in 2 to 6 seconds, depending on the player used.

Two audio channels are available. They can be used in bilingual programs, to provide multiple strategies for instruction, or to produce stereo. For example, in the current effort under way in Houston, the Maintenance of Way course will be in both English and Spanish to accommodate the Spanish-speaking railroad population.

With a computer, interactive instructional programs may be implemented. This interaction allows branching to visual motion, visual still, audio, or computer text graphics, on the basis of student response. Learner control as well as system control is possible. Tracking performance allows evaluation of the student as well as the program. Motion sequences can be shown in slow motion or still frame to observe critical details. Overlaying computer text and graphics on top of projected videodisc images allows highlighting, cueing, and other visual techniques. There is also the possibility of using a given visual image for multiple purposes and captioning for non-English speaking persons or the hearing impaired. Thus, CIV offers unlimited possibilities for use in education and training.

Effectiveness of Computer-Assisted Instruction

CAI has been evaluated in a number of different settings and its efficacy as an instructional delivery system has been determined. Results of research in the military, where most of this type of training is under way, show that CAI is an effective instructional method. Specifically, it reduces learning time, increases achievement, and produces favorable attitudes toward learning.

Most studies of military technical training courses demonstrate that CAI saves a significant amount of time needed by trainees to complete courses. Although the median value of time savings is 30 percent, the value varies with the type of course. For example, trainees in courses on electronics and electricity saved up to 60 percent in learning time when using CAI methods compared with learning time when using conventional instruction. Reducing learning time, however, did not reduce achievement. In the military studies, in almost all situations, trainee achievement when using CAI was the same or better than when using conventional instruction.

Data evaluating the effectiveness of CIV are not yet available from railroad companies. However, the following conclusions can be drawn from this initial test on the PTRA:

1. CIV reduced from days to hours the amount of time railroad workers required for taking refresher courses on operating rules.
2. As part of an overall management plan, CIV contributed to the complete reversal of the accident and injury record. That is, among railroads within the same classification, the PTRA went from having the worst safety record in 1980 to having the best safety record in 1983. The PTRA received the 1983 Gold Harriman Award for being the safest railroad in its class of service.

The followup effort will be statistically evaluated to determine its effectiveness relative to the results of the initial test. It will also include cost comparisons with more traditional forms of training. Further information will be available from PTRA in 1985.

DETAILS OF PILOT TEST

Scheduling and Personnel

For five full days, beginning on Monday, May 23, 1983, PTRA employees were exposed to the six different courses. On the first day the system was set up in the employee lunchroom of the PTRA North Yard main office. For one day a large concentration of PTRA's operating craftsmen and mechanical craftsmen were given an opportunity to inspect the equipment. Word spread quickly throughout PTRA that such a system was in place. This led to other employees coming to see firsthand the type of training being offered. This was a good step in acquainting employees with the new system.

On the second day and for the rest of the week the equipment was set up in the PTRA North Yard rip track office. This was a better location because it was smaller, more accessible by mechanical and operating forces, had fewer distractions than the lunch

room, and the equipment could be left overnight without security problems.

Fifty railroad employees participated in the pilot test. The sequence was as follows: Day 1, 9 employees; Day 2, 10 employees; Day 3, 14 employees; Day 4, 8 employees; Day 5, 9 employees; total, 50 employees. The employees represented the following crafts: management, 9; car men or machinists, 26; maintenance-of-way workers, 4; clerks, 1; operating craftsmen (train and enginemen), 10; total, 50.

Management representatives took all six courses. Car men and machinists completed the four courses dealing with train yard safety, blue signal, air brake, and employee injuries. Operating craftsmen completed the four courses on train yard safety, hazardous material, coupler safety, and employee injuries. Maintenance-of-way representatives concentrated on two courses: train yard safety and employee injuries.

Course Design and Variation

A procedural document about the course was prepared. The course procedure was explained to each employee before he began. PTRA's Director of Safety was also briefed on the system and conducted start-up sessions.

Each course required approximately 20 minutes, depending on the knowledge of each trainee. No pressure was exerted to hurry the trainees; they were permitted to progress at their own pace. The courses were not designed as tests that an employee could pass or fail. They were designed as refresher learning exercises on operating rules and safety procedures.

The six courses were prepared with different combinations of audio-video scenes and questions. In one design set, audio-video scenes were used to generate questions. Employees were asked to respond to questions on audiovisual material they had just reviewed. In another design set, trainees were presented with continuous digital questions. If each of these was answered correctly, the student progressed to the next question. If the question was answered incorrectly, video scenes were used to present the correct procedure.

In another design set, a series of questions was presented sequentially. Following the series of questions, regardless of how well or how poorly the student performed, important reminder audio-video scenes were presented as reinforcing mechanisms.

Three levels of branching were used throughout all the courses in this pilot program. If the student failed to respond correctly on the second tier of branching, he was told in the third branching mode to see his safety director for assistance on that particular subject matter. After discussions with the safety director, the student was required to repeat the course. Flow charts of the two prevalent course designs are shown in Figures 1 and 2.

EVALUATION

Evaluation Criteria

On completion of the training session, each employee was asked to fill out a short questionnaire. Forty-six evaluation forms were completed. The numbers of representatives of different positions who filled out the questionnaires were as follows: management, 8; nonoperating union workers, 29; and operating craftsmen, 9. ("Nonoperating" positions include (clerks, shop people, car men, mechanics, and track-

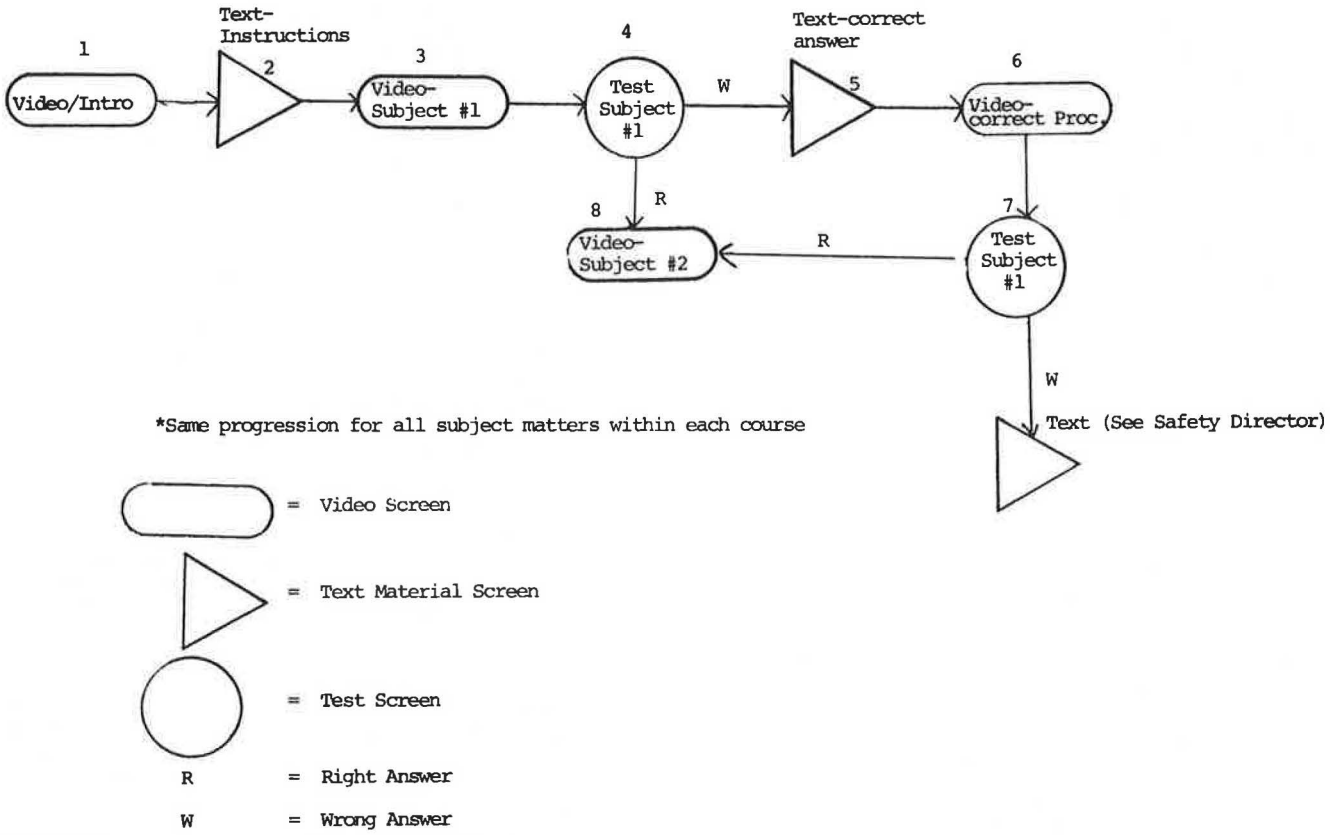

FIGURE 1 Flowchart of one of two CAI course designs.

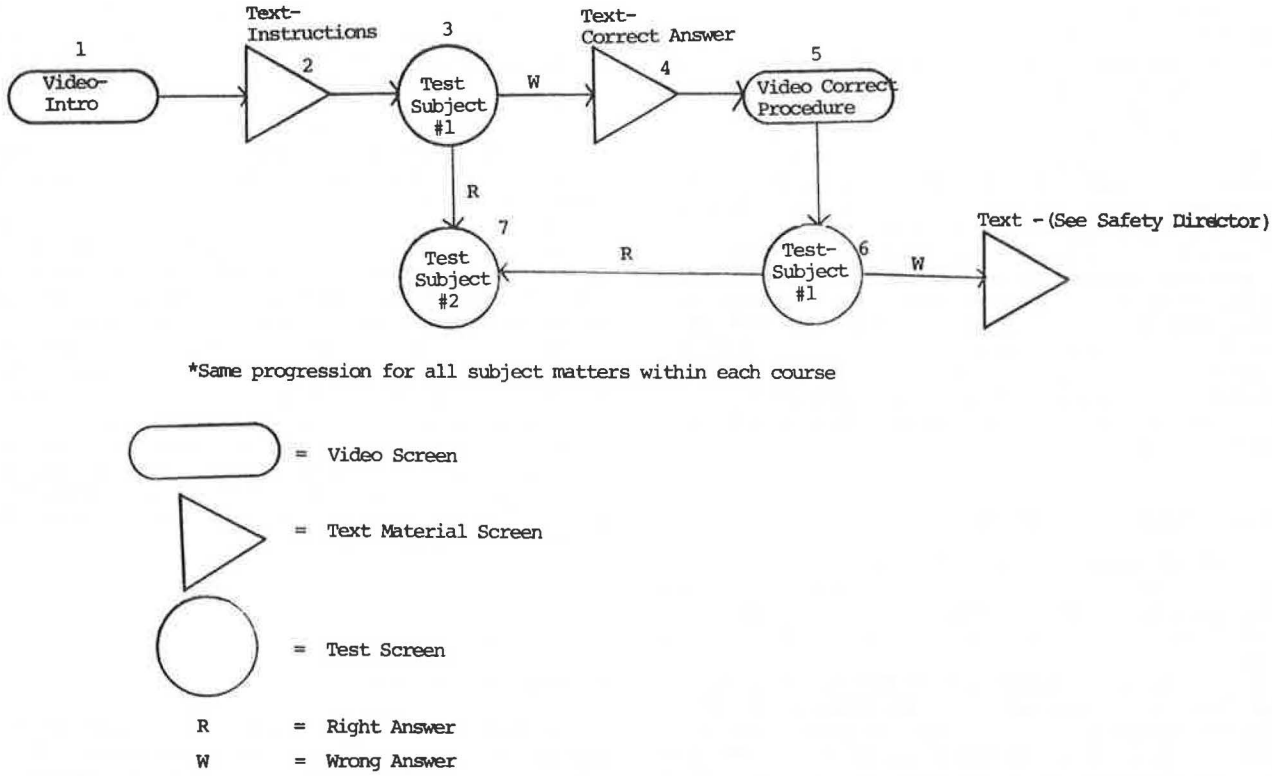

FIGURE 2 Flowchart of the second CAI course design.

men. "Operating" positions include train and enginemen and yard masters.)

The form was designed to:

1. Extract information on employees' reactions to this training delivery system;
2. Identify system weaknesses;
3. Gain comments on the individual courses, paying particular attention to course design; and
4. Evaluate logistics such as training location and ease of use.

Evaluation Results

Nine questions were asked. The questions and the tabulated results are listed here.

QUESTION 1: Your overall reaction to this approach in training is:

Favorable	46
Unfavorable	-
Total	46

QUESTION 2: Did you find the system:

Hard to use	1
Easy to use	43
Between hard and easy	2
Total	46

Three employees noted some concern about start-up and operation in working with the system. According to comments received, this could have been due to their unfamiliarity with a typewriter keyboard, their inability to read (either because they forgot their glasses or because they cannot read), belief that the floppy disk was too delicate, or some combination of these. The majority of the employees found the system easy to use.

QUESTION 3: Do you believe you could learn more:

Through CIV than through safety classes	22
Through classroom and on-the-job training	7
Through some combination	17
Total	46

QUESTION 4: On the following list, please write a 1 beside the course you liked best, and a 2 beside the course you liked second best.

Course	No. of First-Choice Votes	No. of Second-Choice Votes	Total Votes
Employee Injuries	13	13	26
Blue Signal	17	4	21
Train Yard Safety	14	3	17
Air and Hand Brake	12	4	16
Hazardous Material	8	4	12
Coupler Safety	3	8	11

This question was designed to extract some employee reaction to the different combinations of presenting audio-video scenes and digital information. It also was structured to gain insight into employee reaction to the degree of difficulty of different courses.

On the first issue, it appears that railroad employees favor sequences in which audio-video scenes generate questions. The following four courses featured structured audio-video scenes in which railroad employees were shown properly or improperly performing tasks: Train Yard Safety, Blue Signal, Air and Hand Brake, and Employee Injuries. Following the scenes, employees were asked questions pertaining to

the material they had just received. Initially, the other two courses, in which digital information was presented without video material, were rated lower than these four courses.

Hazardous Material Handling and Coupler Safety--in their original design in which digital information was presented without video material--were the two most difficult courses. In these courses employees needed a good grasp of safety rules pertaining to the subject matter before they participated in the training. Of all six courses, these two received the fewest first-choice and second-choice votes. As the degree of difficulty increases, employees' favorable reaction appears to decrease slightly. Of the 50 taking the courses, only two employees (one from management and one car man) finished with a perfect score on all the courses. This indicates that all the courses were somewhat difficult.

QUESTION 5: What areas of railroad training lend themselves to this computerized approach?

Area	No. of Votes
Safety	36
Rules	24
Technical training	10
Clerical training	10
Management training	8
Other	6

Of the six votes cast for Other, five employees indicated that all training could benefit from a computerized approach, and one employee indicated that yardmaster training could benefit. The two areas Safety and Rules received the largest numbers of votes. This was probably influenced by the orientation of the six courses in the training exercise to these subjects. Employees appeared impressed with the effectiveness of the computerized approach as a learning mechanism for safety procedures and railroad rules. In addition, many employees considered this computerized approach suitable for use throughout the broad spectrum of railroad training.

QUESTION 6: Did you find it hard to set up the system and get started?

Response	No.
Yes	1
No	41
Total	42

Of those responding to this question, only one employee found the setup difficult. This employee's comment was that he was not accustomed to machines. In most instances, an on-site staff member of the agency that developed the CIV courses assisted each employee with the insertion of the floppy disk and the videodisc. However, those employees who were following the digital instructions without assistance mastered the technique rapidly.

QUESTION 7: Did you find the environment (re: on-site training) conducive to learning?

Response	No.
Yes	32
No	10
Total	42

Employees appeared to support on-site training. However, provisions need to be made to minimize disturbances and the number of onlookers. During most of the day, the rip-track location was an ideal spot for the training. Employees could totally concentrate on the course with few distractions. However, at lunch time or during a change of shift, it would be preferable not to train anyone at that location because of the commotion. An ideal situation would be one in which an employee does not feel isolated, the system is easily accessible, and the area is free from distractions.

QUESTION 8: Did you notice any problems in scheduling your session?

Response	No.
Yes	1
No	42
Total	43

The one positive response was given as a criticism of the constant movement of people into and out of the rip-track office. All of the employees who participated in the exercise were being paid and were removed from their regular assignments. Employees were scheduled to take courses by either the Safety Director, the Assistant Superintendent, the car foreman, or the lead car man.

QUESTION 9: Do you believe you are a safer employee with a better understanding of certain rules as a result of this pilot program?

Response	No.
Yes	41
No	-
Total	41

CONCLUSIONS

A number of conclusions about the entire training exercise can be drawn from comments supplied by the employees and from observations by the technical teams. These conclusions are presented in the following paragraphs.

Railroad employees respond favorably to this type of on-site training. In general they favor it as a supplement to, not a replacement for, classroom training. However, the amount of classroom training could decrease significantly with a CIV backup.

The ideal location for on-site training is one that has little disturbance and yet is not isolated. Employees like to be seen taking the courses but not disturbed while they do.

The insertion of floppy disks and a videodisc is not a mechanical problem. Employees will do it. However, the floppy disks do not appear rugged enough for the industrial environment. The hard disk is the preferred alternative.

Railroad workers believe that refresher training, like CIV, is an effective tool in increasing safety awareness.

The keyboard was somewhat cumbersome to a few employees. These employees admitted that they were not familiar with typewriter keyboards. An alternative design may be desirable.

Railroad workers prefer a course design that features video scenes generating questions. As the degree of difficulty of a course increases, employees' enthusiasm decreases slightly. These workers believe that more in-depth handling of the subject matter would be preferable.

Some solutions to the problems of scheduling this type of training need to be found. This may be approached differently by each railroad and within each class and craft of employees.

Video sequences and digital material must be concise and to the point. Too much material confuses the employees. Some workers had trouble reading the material. Sentences shorter than those presented in the current design would facilitate understanding.

There appears to be a direct correlation between the interest of management and the enthusiasm of employees. Management needs to make a solid commitment to this type of training for it to be successful.

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Comparison of Freeway and Railroad Rights-of-Way for High-Speed Trains in the Texas Triangle

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ABSTRACT

Alternative rights-of-way for high-speed trains operating in the Texas Triangle, which connects Dallas-Fort Worth, Houston, and San Antonio, are described and compared in this paper. These alternatives include medians of Interstate highways and the former Rock Island right-of-way. It is concluded that cross-sectional geometry would allow construction of a high-speed rail line on the majority of the two types of rights-of-way. Two different microcomputer simulation programs were applied to the Texas Triangle to investigate different types of high-speed train technologies operating in Interstate highway medians and along the former Rock Island right-of-way. The simulation runs demonstrated that comfort and curvature limitations prevented full utilization of a 350-mph speed, and that lower speeds (150 to 200 mph) would appear more effective given the existing geometric constraints. In addition to operating characteristics, the Texas Railroad Company simulation provided estimates of energy requirements. The investigations demonstrated that 200-mph high-speed rail passenger service is technically feasible along existing rights-of-way in Texas.

Proposed routes for high-speed rail service generally use three types of right-of-way: (a) existing railroads, (b) existing highways, and (c) new alignments. Each provides a different set of benefits and problems.

Travel time, an important factor in attracting riders, is affected by the combination of physical route and performance characteristics of the trains. Human factors and mechanical limitations determine the maximum speeds at which a train can traverse curves and grades. Vertical and horizontal curves combine with train operation and performance characteristics to determine the time and distance necessary to accelerate and decelerate the train (1).

Use of computer simulations of train operation over proposed routes can yield information that is needed to make early policy decisions about appropriate technology and engineering designs, but multiple detailed mainframe computer simulations can be expensive. Microcomputers provide the ability to run low-cost, simplified simulations for sketch-planning purposes, which can help with comparisons of predicted performances of high-speed trains on various types of routes.

The studies described in this paper were directed toward assessing the physical practicality of implementing high-speed rail passenger service on existing highway and railroad rights-of-way in Texas. This paper does not include an investigation of market potential or a detailed analysis of the financial or legal feasibility of implementing and operating high-speed rail service in the Texas Triangle.

POSSIBLE HIGH-SPEED RAIL LOCATIONS IN TEXAS

One major U.S. corridor that has been considered for high-speed rail service is the 750-mile Texas Triangle, which connects Dallas-Fort Worth, San Antonio, and Houston (Figure 1). Investigations of potential routes for implementing high-speed rail passenger service in Texas have concentrated on using existing freeway and railroad rights-of-way. These routes were examined for physical and geometric