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IDEA

*Innovations Deserving
Exploratory Analysis Project*

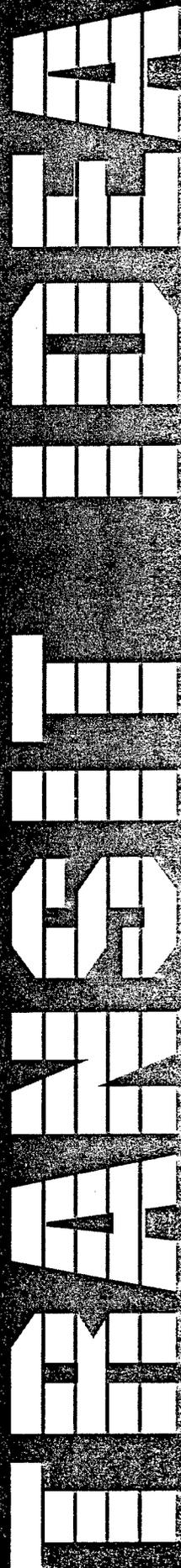
TRANSIT COOPERATIVE RESEARCH PROGRAM

**SELF-PACED PC-BASED TRACK
SAFETY TRAINING SYSTEM**

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Report of Investigation

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**INNOVATIONS DESERVING EXPLORATORY ANALYSIS (IDEA) PROGRAMS MANAGED BY THE
TRANSPORTATION RESEARCH BOARD (TRB)**

This investigation was completed as part of the TRANSIT-IDEA Project, which is one of four IDEA programs managed by the Transportation Research Board (TRB) to foster innovations in surface transportation. It focuses on products and results for transit practice in support of the Transit Cooperative Research Program (TCRP). The other three IDEA program areas are: ITS-IDEA, which focuses on products and results for the development and deployment of intelligent transportation systems (ITS), in support of the U.S. Department of Transportation's national ITS program plan; NCHRP-IDEA, which focuses on products and results for highway construction, operation, and maintenance in support of the National Cooperative Highway Research Program (NCHRP); and HSR-IDEA, which focuses on products and results for high speed railroads in support of the Federal Railroad Administration. The four IDEA program areas are integrated to achieve the development and testing of nontraditional and innovative concepts, methods, and technologies, including conversion technologies from the defense, aerospace, computer, and communication sectors that are new to highway, transit, intelligent, and intermodal surface transportation systems.

The publication of this report does not necessarily indicate approval or endorsement of the findings, technical opinions, conclusions, or recommendations, either inferred or specifically expressed therein, by the National Academy of Sciences or the sponsors of the IDEA program from the United States Government or from the American Association of State Highway and Transportation Officials or its member states.

INTERACTIVE PC-BASED TRACK SAFTEY TRAINING
TRANSIT-IDEA Project 13¹
*Daniel B. Mesnick*²

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IDEA PRODUCT

An interactive PC-based training (PCBT) pilot course module was developed for track maintenance, construction and engineering personnel at LRT, heavy rail and commuter properties. Historically, track maintainers are exposed to on-the-job training eventually acquiring a level of proficiency to supervise others. Some transit properties certify their track personnel to perform certain safety-critical maintenance tasks such as *in-situ* rail welding. Typically, staff are sent directly out in the field to work in gangs and/or sent to training courses which may not be tailored to a properties' specific track design and maintenance practices.

TransTech developed two separate multi-media training programs provide self-paced track inspection training through this pilot program. First, an Internet website (See Appendix 1) was developed which gives the generic basis for transit track design, maintenance and terminology with an emphasis on track-structure design, drainage and Right of Way maintenance. The second product is a multi-media based set of mini training modules to demonstrate what a track inspectors should look for in the field and what actions to take in the event a defect is detected.

¹The IDEA PROJECT started in May 1996 and was completed in July 1997. The IDEA project advisor was Mr. Mark O'Hara, Senior Project Manager of Right of Way, Engineering and Maintenance Department, Massachusetts Bay Transportation Authority.

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This application is specific to Track Inspection and Maintenance Procedures (Appendix 2) at the Massachusetts Bay Transportation Authority (MBTA).

We expect the program to provide users with immediate benefits through this stand-alone self-paced training tool. During subsequent commercialization at the close of the pilot program, we plan to enhance the scope of our program by incorporating all safety-critical elements of track inspection training.

The pilot training module was produced for the MBTA with representatives of MARTA, PATCO and NYCTA/SIRTOA participating in this product development cycle. During our Stage 1 needs assessment, a series of track training needs were ranked and prioritized. Based on the needs assessment, it was determined that the pilot would concentrate on special work theory, design installation and maintenance practices with the option to incorporate some training on track geometry inspection and rail wear measurement. *Switches and special work account for approximately 5 percent of the track system, but require about 40% of the maintenance budget.*

The pilot laid out a program for the most difficult and complex aspects of track maintenance which can be expanded with relative ease. The commercial product will incorporate a more robust scope of track areas following initial development, implementation test and acceptance of the pilot program. The multi-media advantage is intended to minimize the difficulty and complexity of learning what is now considered, in the words of one pre-eminent supplier of special work devices, "a big black hole".

The first product has been developed on TransTech's Internet Web site. Access is proprietary and can be obtained by contacting TransTech.

The second product is a proprietary training program developed using Microsoft's Power Point presentation software (Version 4.0 for Windows 95 or higher). Power Point allows the user to look at the drawings or digital photographs in any scale. For example, the user can look at the precise check gage at switch frog by scrolling to that image, clicking on it, and increasing its size or blowing up a rail section to make the checks on a rail defect more visible much like using a microscope would in the laboratory. The training files are self contained and stored on 100 megabyte Zip files because of their large size. Yet storage is cheap and Zip files highly reliable. At a later date, the product will be made available on CD-ROM for ease of use and maximum accessibility.

In addition, several Quicktime Virtual Reality clips were shot under this program, one of which gives the user the ability to turn a Pandrol clip in three dimensions. This capability gives the trainee to "look" at a rail component from any angle to see how a defect grows.

This set of capabilities and products allow the project different possible applications depending on the user's needs as well as added flexibility that will be helpful in responding to a quickly changing industry.

INVESTIGATION

Stage One: Needs and Technology Assessment

The first task was to collect and evaluate the content and efficacy of a sample set of potentially applicable transit track training and maintenance documents. Information was reviewed from Atlanta (MARTA), Baltimore (MTA), Calgary (LRT), New York (NYCTA and SIRTOA) Philadelphia (SEPTA and PATCO), San Diego (MTDB) Toronto (TTC).

This review resulted in a "long list" of possible training needs consisting of:

- rail welding and adjusting continuously welded rail
- rail wear inspection and condemnation limits
- track geometry inspection and standards
- track fastener inspection and renewal
- switch and special work maintenance
- frog rebuilding and welding
- repair of rail insulated joints
- bolt torquing
- ballast tamping and renewal
- maintaining track on bridge decks and in transition zones and viaducts

This list of areas was used to make a preliminary assessment of the possible scope and coverage for our training course.

Differences and Similarities Between and Amongst Properties

There were major differences between and amongst the various transit properties' switch maintenance practices and policies. Some of these differences relate to the operating environment, others relate to differences in design and maintenance philosophies of the Chief Engineer, and still other differences revolve around whether the property is operating LRV, rapid transit and/or commuter rail services. For example, the older properties were more likely to lay out the alignment first and follow with custom built switches to fit the specific clearance envelope. On most of the older properties, this leads to many one of a kind turnout angles and designs which must be custom fabricated, while the newer properties generally follow standard alignments and switch designs.

The second task consisted of conducting a series of interviews with the transit property participants to rank and prioritize the "long listed" track training needs. Through this needs assessment, it was determined that the pilot program would concentrate on special work theory, design installation and maintenance practices with the option to incorporate some training on track geometry inspection and rail wear measurement.

Thirdly, a detailed functional outline for development of the pilot training course module was drafted and reviewed with the MBTA. Generally, the pilot will focus on turnout theory and the

wheel-rail interface (10%), turnout design and fabrication (20-30%) and turnout maintenance and renewal practices (60-70%). Additional materials were also obtained from the MBTA on track design standards and maintenance procedures for the training program.

Concurrently, a program structure was designed which would enable a multi-media program designed to enable a module customized to the MBTA's specific switch training needs while providing a generic structure for any transit properties' design and maintenance policies and condemnation limits. As a result:

- PCBT software will be programmed in such a way as to allow some of the variables to be user definable while others will be hard coded where there is no difference amongst and between properties (by use of arrays).
- The training software will be flexible enough to enable a) future updates at the property level; and b) additions to the pilot training module will be enhanced and made commercially viable.
- Self-diagnostic test capabilities will be added subsequent to the pilot program.

In Task 4, scripting for the switch theory, design, and maintenance course content was initiated for multi-media programming and production in Stage 2. Concurrently (Task 5) over 400 photos and digital images were shot in the field of turnout designs, installation practices, rebuilding, and maintenance activities during seven separate sessions involving night and daytime movie and digital photography at MBTA, NYCTA, SIRTOA and SEPTA in the field. Additional maintenance planning materials, engineering drawings and manuals were also collected as training inputs. TransTech also obtained permission from the American Railway Engineering and Maintenance Association to use various materials in the training course. Several follow-up field and plant photo shoots were conducted during the Stage 2 productions process where gaps were identified.

Stage Two: Training Program Pilot Production and Implementation

During the process of multi-media production, the emphasis was on clearly identifying the MBTA's training needs as a property that has had substantial recent turnover in qualified track personnel, limited training in years past, and a set of standards and procedures which have not been updated over time.

The MBTA was very supportive throughout the course of the pilot activity. Engineering and Maintenance staff worked closely with us to facilitate this activity. As a result, we have been provided with a large set of media which adequately display the early range of requirements that a track inspector should learn. Photo shoots were conducted during the following activities, a large number of which took place during track closure periods of 12:30 AM to 5:00 A.M. when the General Order (GO) track forces' occupancy period expires:

MBTA Photo Shoots

- I. Track Geometry Car Runs (Green Line - Riverside).
- II. Stock Rail and Closure Rail Renewal on Special work (Blue Line - Orient Heights Station)
- III. Special Work Rail Replacement and Surfacing with Tamper Machine (Green Line)
- IV. Special Work Inspection - Standard 115 pound modified AREA turnouts with and without Sampson Points and Rail Bound Manganese frogs.
- V. Tongue and Mate Switches in-street at Cleveland Circle, Green Line and assorted Flange Bearing Frogs
- VI. Sullivan Rail Shops, Everett - frog rebuilding shop including rotary welding table, crack painting, cutting out of occlusions, grinding and skip welding to restore frog profile. Shots of rail bending machine and process were also captured. Rebuilt frog inventory in stores was also shown.
- VII. Direct Fixation Fastener Failures - shot in tunnel at various locations on Red Line Harvard Extension (Portec Double Spring Clip Failures).

In addition, a variety of digital photographs were shot at the following locations and properties:

- I. SIRTOA, St. George Yards, Staten Island, New York - Special Work Inspection Procedures including Switch Motor Adjustment (see TransTech website Home Page).
- II. NYCTA - Training Facilities at Public School 248, Brooklyn, New York. Rail Defect Cross-Sections.
- III. SEPTA, Philadelphia, PA -assorted shots.

The production process for scripting, layout and integration of drawings, images and text was conducted intensively during Stage 2. As in any media production process, a large number of images were assessed given the requirement to produce a basic but highly tailored pilot MBTA Track Inspection Training program.

TransTech captured about 400 digitized images in its library. Given specific training requirements for the pilot, only a small fraction of these have been used, to date, to illustrate each rail, tie, fastener and special work inspection procedure.

In each case, the objective was the same:

Provide the man in the field with actual drawings of track components which are well within their maintenance limits and those which are condemnable, as well as the basis (objective/quantifiable criteria) for condemnation. Actions for each defect or safety condition as recommended are shown at the bottom of each screen.

Note that in every case, this training program is intended to reinforce or augment existing standards and procedures for track inspection and maintenance at the MBTA. In lieu of a codified existing standard, recommended approaches are presented.

One of the most important experiences gained from conducting the pilot training module is as follows:

There is a balance between capturing the way things are done in the field today by existing field staff and Supervision versus recommending incremental improvements for tomorrow's needs. Too much reality merely reinforces practices which may be less than optimal today, while too much change will be summarily rejected by the end users.

Because this objective is critical, TransTech has and expects to continue to work closely and collaboratively with the MBTA to implement the training program. Ultimately, success is measured by the desire of management and field staff to use this product on a day to day basis.

Sample results of both the Web-based training program and the Training Inspection Procedure Screens are shown in Appendices One and Two, respectively.

RECOMMENDED MINIMUM COMPUTER SYSTEM REQUIREMENTS

Hardware & Software

- I. Pentium 100 or higher (today's low-end desktop standard is a P-266 processor)
- II. 640 x 480 SVGA Monitor with 65, 536 colors
- III. 2 button mouse
- IV. 8 x CD-ROM Drive (today's standard is a 24 x CD-ROM)
- V. 32 bit sound card
- VI. speakers
- VII. Internal or External Zip Drive which uses 100 megabyte cartridges (Iomega Corporation)
- VIII. 16 megabytes of RAM (32 bits will speed performance considerably and is today's desktop standard)
- IX. 200 megabytes of free hard disk space (today's standard low-end desktop for multi-media comes with 3-4 gigabytes of hard disk space)
- X. Microsoft Power Point Version 4.0 for Windows 95 or later (Note: the next release of this software will rely on Office 97).

For Website Training (optional)

- I. Netscape Navigator or Internet Explorer 3.0 or later
- II. Quicktime for Windows 3.0 or later
- III. Quicktime VR plugin for Netscape or Explorer
- IV. Local Internet Access through any Internet Service Provider (ISP)

Desktop machines that meet these minimum requirements are available for the Windows platform for \$2000 or less.

PLAN FOR IMPLEMENTATION

The pilot program is now complete and is being evaluated for further implementation at the MBTA. The action plan for the work training pilot was the "blueprint" for our production. During the upcoming period, TransTech will be demonstrating the product in North America.

Long term plans include development of a set of self-certifying self-diagnostic course modules designed to assist field and office staff from entry level to supervisory positions. Internet-resident training is also available but may be more suitable for the railroad operating environment. Railroad environments provide a compelling incentive to coordinate and integrate the system wide staff training function especially given the wave of recent Class I mergers where experienced staff are being downsized and territory increasing.

TransTech has received strong expressions of interest in gaining funding from other sources to proceed with further development of this product at a time when transit and rail track maintenance needs are increasing while well-trained staff are diminishing.

CONCLUSIONS

Interactive training using computers is a rapidly evolving field. Certainly the multi-media approach assures student input both aurally and visually. This IDEA TRANSIT Program developed an interactive training module applied to railroad track maintenance. However, any such system must be tested and improved just like any instructor improves by interacting with his students. As part of this Program, an association was required with several rail transit organizations who will test the current product, partially illustrated in the appendices, to obtain a next stage product which should have even greater marketability. The materialization of this training program is well timed to the advent of increased railroad development which will require new personnel using new technology while the old guard is disappearing rapidly into retirement. TransTech remains committed to a leading roll in computer based training modules for track maintenance protocol.

CONTACTING TRANSTECH

Please feel free to contact us for more information and consultation concerning your computer based transit and rail training needs:

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