IDEA

Innovations Deserving Exploratory Analysis Programs

TRANSIT

New IDEAS for Transit

Annual Progress Report

JANUARY 2003

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TRANSPORTATION RESEARCH BOARD EXECUTIVE COMMITTEE

Further information on the IDEA Programs is available on the internet at *www.nationalacademies.org/trb/IDEA*.
For questions, contact the IDEA Programs office by phone (202-334-3310) or fax (202-334-3471).

Transportation Research Board publications may be ordered directly from the TRB Business Office, through the internet at *nationalacademies.org/trb*, or by annual subscription through organization or individual affiliation with TRB.

For further information on publications, contact the Transportation Research Board Business Office.
500 Fifth Street, NW, Washington, DC 20001, (telephone 202-334-3214; fax 202-334-2519; or email *TRBsales@nas.edu*).

NEW IDEAS FOR TRANSIT

An Annual Progress Report of the Transit IDEA Program

The Transit IDEA Program is part of the Transit Cooperative Research Program, a cooperative effort of the Federal Transit Administration, the Transportation Research Board, and the Transit Development Corporation, a nonprofit educational and research organization of the American Public Transportation Association. The program is funded by the FTA and is managed by TRB.

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

January 2003

Unedited Advance Copy

TRANSIT COOPERATIVE RESEARCH PROGRAM J-4 PANEL FOR THE TRANSIT IDEA PROGRAM

Eva Lerner-Lam, Chair
President, Palisades Consulting Group, Inc.

Fred M. Gilliam
President, Capital Metropolitan Transportation Authority, Austin, TX

Rolland D. King
Consultant

George Kovatch
Consultant

James P. Reichert
Reichert Management Services

Jack M. Reilly
Deputy Director,
Capital District Transportation Authority, Albany, NY

Katherine F. Turnbull
Associate Director,
Texas Transportation Institute

John P. Walsh
Chief Maintenance Officer, Department of Buses,
New York City Transit

Federal Transit Administration (FTA) Liaison

Walter K. Kulyk
Director, Office of Mobility Innovation

American Public Transportation Association (APTA) Liaison

Louis F. Sanders
Director, Research and Technology

USDOT Small Business Innovative Research (SBIR) Liaison

Joseph D. Henebury
Director, US DOT SBIR Program

TRB Liaison

Peter L. Shaw
Public Transportation Specialist

Transit Cooperative Research Program

Stephan A. Parker
TCRP Senior Program Officer

Transit IDEA Program

Harvey Berlin
Senior Program Officer

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board's varied activities annually engage more than 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

TABLE OF CONTENTS

INTRODUCTION

The Transit IDEA (Innovations Deserving Exploratory Analysis) Program supports development and testing of innovative concepts and methods for improving transit practice. The program fosters applied research and development of promising innovations to improve the efficiency, safety, security, maintenance, and ridership of transit systems. Two high-priority focus areas are transit security, and bus rapid transit.

This report describes the active and completed projects funded by the Transit IDEA program. It is a useful resource to transit agencies and others interested in innovations in transit practice. It also shows potential proposers the kinds of projects that have been funded by the program. The Transit IDEA projects in this report are organized by project number. Summaries are provided on the results and payoff potential of completed projects and descriptions of current active projects are included. A listing of completed Transit IDEA project final reports is also included in this report.

Proposals may be submitted by transit agencies, universities, private companies, and individuals. Proposers are encouraged to work with transit agencies in developing concepts and proposals, and to involve transit agencies in testing new and innovative products and prototypes.

The Transit IDEA Program is one of the four IDEA programs managed by the Transportation Research Board. The other three are the High-Speed Rail IDEA Program, the NCHRP Highway IDEA Program, and the Safety IDEA Program.

A number of successful products and results have emerged from Transit IDEA projects. One measure of success is if the results move into use by transit agencies. An example of this is the interactive multimedia CD-ROM training program, *Customers, Conflict, and You: A Transit Operator's Guide to Problem-Solving,* which has been obtained by 98 transit agencies. Another measure of success is if others fund follow-on work for further development, prototyping and testing, of concepts developed under the Transit IDEA program. Examples include the *Automated Rail Wheel-Gauge Inspection System* and the *Independent Transportation Network* for increasing the mobility of elderly persons.

Good examples of successful Transit IDEA projects that include participation by transit agencies in testing the product or prototype include:

- An interactive multimedia CD-ROM training program, *Customers, Conflict, and You: A Transit Operator's Guide to Problem-Solving*, to train bus drivers on violence prevention, was developed and tested by transit agencies, and has been obtained by 98 transit agencies (Transit IDEA-11);
- An *Automated Rail Wheel-Gauge Inspection System,* a low-cost system for automatic inspection of rail wheel flanges, was designed to improve rail track safety (Transit IDEA-17);
- An innovative method to remove graffiti scratches (scratchiti) from windows of rail transit vehicles was developed and tested for potential use in subway cars (Transit IDEA-28);
- The *Fare Machine Tactile/Audio Instruction System* project is developing and demonstrating a practical and cost-effective device to make transit fare vending machines fully usable by persons with vision impairments (Transit IDEA-29);
- The project for *Community Visualization in Design of Light Rail Transit Oriented Developments* is developing and testing innovative applications of technologies for dynamic com-

munity visualization in the planning and design transit oriented development around proposed light rail transit stations (Transit IDEA-33).

Guidelines for submitting IDEA proposals are provided in the IDEA Program Announcement, which is available on the Internet on the IDEA web site at <www.nationalacademies.org/trb/idea>. Questions about submitting IDEA proposals can be addressed by calling the IDEA Programs office at (202) 334-3310.

COMPLETED TRANSIT IDEA PROJECT FINAL REPORTS

The following Transit IDEA projects have been completed. The following project final reports are available. Reports may be ordered from the TRB Business Office, as indicated on the inside front cover of this report. Those reports with an NTIS number noted are also available from the National Technical Information Service (NTIS):

Transit-IDEA 1: *Customer Satisfaction Index for the Mass Transit Industry,* Tri-County Metropolitan Transportation District of Oregon, Kathy Coffell, Principal Investigator (NTIS # PB97-137541).

Transit-IDEA 2: *Adaptive Diagnostic System Project*, BART, Steven Mullerheim, Principal Investigator (NTIS # PB99-113201).

Transit-IDEA 3: *Automatic Wheel Inspection Station,* International, Electronic Machines Corporation, Zahid Mian, Principal Investigator (NTIS # PB97-141865).

Transit-IDEA 4: *Management Information Benefits of On-Board Integration of Electronic Fareboxes*, Northeastern University, Peter Furth, Principal Investigator (NTIS # PB97-137509).

Transit-IDEA 5: *Improved Passenger Counter and Classification System for Transit Applications*, Greneker and Associates, Inc., E. F. Greneker, Principal Investigator (NTIS # PB97-153563).

Transit-IDEA 7: *Wheelchair Restraint System*, Baylor College of Medicine, Thomas Krouskop, Principal Investigator (NTIS # PB97-137517).

Transit-IDEA 8: *Real-Time Transit Data Broadcast*, Transcom International Ltd., Edward Burgener, Principal Investigator (NTIS # PB97-137525).

Transit-IDEA 9: *The Independent Transportation Network: Alternative Transportation for the Elderly*, Southern Maine Area Agency on Aging, Katherine Freund, Principal Investigator (NTIS # PB97-171540).

Transit-IDEA 10: *Automatic Data Collection on Transit Users via Radio Frequency Identification*, University of Virginia, Manuel Rosetti, Principal Investigator (NTIS # PB97-137533).

Transit-IDEA 11: *Customers, Conflicts, and You: A Transit Operator's Guide to Problem Solving*, CD-ROM, Video, and Instructor Guidebook, San Francisco Municipal Railway, Debi Horen, Principle Investigator (Available from National Transit Institute)

Transit-IDEA 13: *Self Paced PC-Based Track Safety Training System,* TransTech Management, Daniel B. Mesnick, Principal Investigator (NTIS # PB99-113193).

Transit-IDEA 14: *Market Study and Operational Test Results for the Instant Rent-A-Car (IRAC) Station Field Tests,* CF International, John Chisholm, Principal Investigator (NTIS # PB99-113243).

Transit-IDEA 15: *Internet Information Sharing for Transit Maintenance,* Kiernan Transit Associates, Victor D. Kiernan, Principal Investigator (NTIS # PB99-113227).

Transit IDEA 16: *Transit Restraint System for Wheel Chairs,* Cleveland Clinic Foundation, Steven Reger, Principal Investigator

Transit-IDEA 17: *Operational Evaluation of a Rail-Based Wheel Gauge Inspection System,* International Electronic Machines Corp., Zack Mian, Principal Investigator (NTIS # PB99-113250).

Transit IDEA 18: *Pilot Testing Innovative Payment Operations for Independent Transportation Network (ITN)*, Independent Transportation for the Elderly, Katherine Freund, Principal Investigator

Transit-IDEA 19: *Field Testing and Evaluation of the Transit Integrated Monitoring System,* University of Virginia, Manuel D. Rosetti, Principal Investigator (NTIS # PB99-113268).

Transit-IDEA 20: *Non-Contact Sensor for Passenger Counting and Classification*, Greneker and Associates, Inc., Gene Greneker, Principal Investigator (NTIS # PB2002-106314)

Transit IDEA 21: *Smart Parking Lot with Just-in-Time Bus Service*, Oregon State University, Chris A. Bell, Principal Investigator

Transit-IDEA 22: *Sleeved Column System for Crashworthiness of Light Rail Vehicles*, Ronald Mayville, Principal Investigator (NTIS # PB 2002-106313)

Transit-IDEA 24: *Operational Testing of Intelligent Rail Lubrication System,* Tranergy Corp., Sudhir Kumar, Principal Investigator (NTIS #PB99-113219).

Transit-IDEA 28: *Transit Scrathitti Removal by Controlled fire Polishing,* Columbia University, Shane Y. Ilong, Principal Investigator

Customer Satisfaction Index for the Mass Transit Industry Transit-IDEA Project 1

Kathryn A. Coffel[1], Tri-County Metropolitan Transportation District of Oregon

This IDEA project developed and tested a customer satisfaction index (CSI) methodology in five transit districts to determine customer satisfaction with mass transit operations. The project was modeled after similar studies by the automobile and airline industries that were designed to improve and track customer satisfaction over time. This CSI application was the first systematic, non-biased and technically credible measure for comparing customer satisfaction between districts. This verified CSI approach is now available for transit agencies to analyze their performance, compare themselves directly to a total sample average, learn from other transit districts, and understand key factors for improving customer satisfaction and ridership.

The uniform guidelines were applied for the construction and interpretation of the CSI data derived from the investigation. The feasibility of the CSI concept was tested for the three transit modes of bus, light rail, and heavy rail in the following five transit districts:

1. Tri-County Metropolitan Transportation District, Portland, Oregon (TRI-MET);
2. Metro Regional Transit Authority, Akron, Ohio (MRTA);
3. Regional Transportation Authority through the Chicago Transit Authority, Chicago, Illinois (CTA);
4. Metropolitan Council Transit Operations, Minneapolis, Minnesota (MCTO); and
5. Southeastern Pennsylvania Transportation Authority, Philadelphia, Pennsylvania (SEPTA).

The IDEA investigation produced the following results:

- Identified the key attributes and factors reflecting transit customer satisfaction in the five transit districts;
- Developed and tested a uniform method of comparing the performance of each transit district;
- Identified specific priorities for improving customer satisfaction; and
- Developed guidelines for application of the CSI methodology by all transit agencies.

The project identified key attributes that affect customer satisfaction. A uniform method of comparing the performance of each transit district with those of other districts was also developed. In addition, specific priorities for improving customer satisfaction in transit districts were also identified.

The successful conclusion of this study marked the first step the transit industry has taken to establish customer satisfaction benchmarks. Additional data was collected to increase the predictive power of the CSI model from local to national levels. The investigators worked with other transit districts to expand CSI studies. The final report for this project was completed.

An expanded national research application of CSI results occurred under the Transit Cooperative Research Program with TCRP Project B-11: "Customer-Defined Transit Service Quality," which provided answers to several of the specific issues identified in the IDEA project and

[1] Market Analysis & Information Resources Department, 4012 SE 17th Avenue, Portland, OR 97202. Telephone: (503) 238-5860. NTIS # PB97-137541

broadened the application of the CSI index to a national level. A report on that follow-on project was published in 1999 as TCRP Report 47. Fourteen transit districts are currently employing CSI methodology. For example, the Chicago Transit Authority (CTA) elected to do an initial local survey. The results of the expanded survey were so informative that a new updating survey was completed by the CTA.

Adaptive Diagnostic System Transit-IDEA 2

Steve Mullerheim[1], San Francisco Bay Area Rapid Transit District

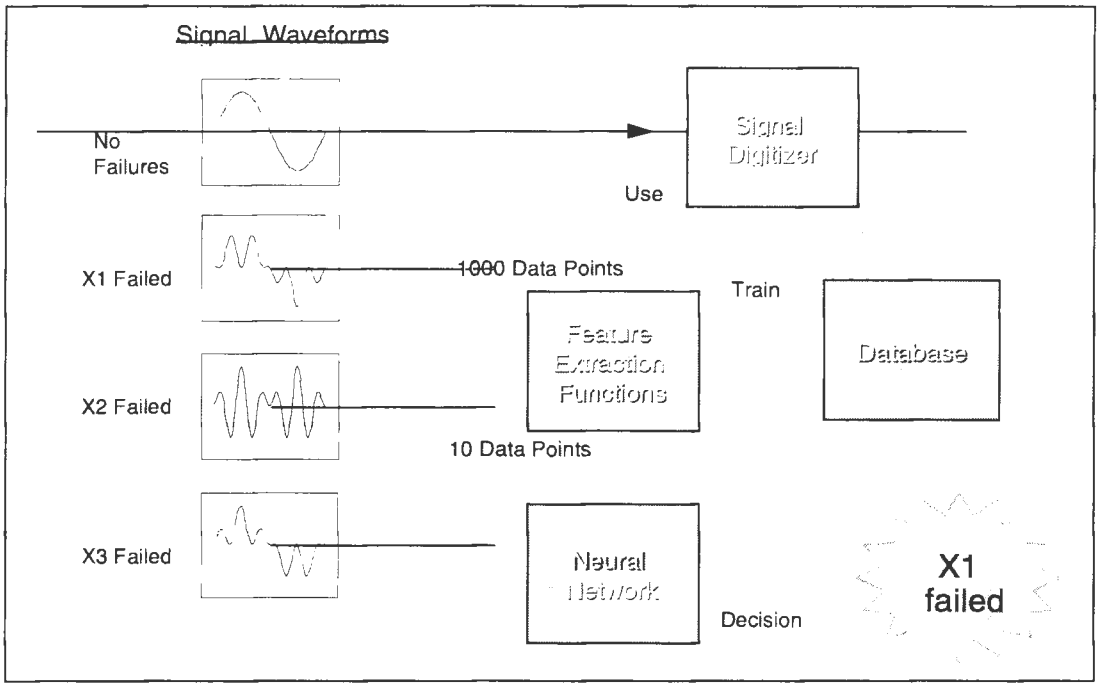
This IDEA project developed an automated general-purpose tester with artificial intelligence capabilities that can be adapted to the testing of a variety of transit equipment electronic units.

The artificial intelligence software incorporated in the automated programmable general-purpose test equipment consists primarily of neural networks that have the capability of being "trained" to recognize certain failures from specific waveform patterns as depicted in the figure. The programmable card-based instruments are under the control of a personal computer (PC) with a graphical user interface (GUI). Several graphically based off-the-shelf software systems from National Instruments greatly simplified the encoding of the needed control and display software. Diagnosis is accomplished quickly, and often quite accurately, without the need for time-consuming probing and circuit analysis procedures.

The project has demonstrated the productivity gains possible in the transit environment with PC-controlled programmable test equipment, which employs flexible software architecture and a graphically based programming language. With such a system, even technical personnel not proficient in computer programming can configure the equipment. The automated general-purpose tester incorporates software of programmable artificial intelligence tools such as neural networks and inference generators to assist in diagnosing circuit failures. Automated programmable general-purpose test equipment greatly enhances testing efficiency while reducing overall test equipment costs.

The Bay Area Rapid Transit (BART) used the product to test and repair other transit equipment and make appropriate modifications for troubleshooting electronic operational devices. This product has not experienced much application for transit equipment maintenance.

[1] 800 Madison Street, P.O. Box 12688, Oakland, CA 94607. Telephone: (510)464-6000. NTIS # PB99-113201. NTIS # PB97-141865



Neural analysis of signal input.

Management Information Benefits of Integrating Electronic Fareboxes With Other On-Board Equipment Transit IDEA Project 4

Peter G. Furth[1], Northeastern University, Boston, MA

Idea Concept and Product

This project investigated integrating fareboxes with other on-vehicle devices for estimating passenger loads and passenger miles. The farebox has great potential as a source of passenger data because nearly every bus has electronic fareboxes and nearly all boardings are registered by fareboxes. By integrating fareboxes with other on-board equipment, the value of the farebox with the vehicle's digital odometer makes it possible to stamp farebox records with the odometer reading for verification of trip length. Likewise, integration with additional devices makes it possible to use the fareboxes as a means of counting boardings by stop, providing valuable information for planning and marketing, and opening up the possibility for estimating passenger loads and passenger miles.

Modifications to the Society of Automotive Engineers (SAE) standards for on-vehicle communication established an industry standard for vehicle area networks (VAN). Those standards better accommodate fareboxes and related data. Developments in the industry toward VAN are generally related to automatic radio vehicle location and enunciator systems. In both cases, the computer that supports that system also serves as a platform for the vehicle logic unit (VLU), which is the brain that manages the VAN. In this IDEA project, the fareboxes are used as the brain for such a network.

The project identified various configurations for enhancing farebox data. By connecting the fareboxes to the headsign the operator may change route information without dealing with the headsign. Mating the odometer to the farebox to register odometer readings traces route changes. Also, an odometer stamp may be made with every record and is triggered from a door sensor. With the odometer stamp on each record, passenger boardings and miles can be estimated. By incorporating a VAN, all data are shared instead of compiled in each bus. An open standard for communication in a VAN, which includes descriptions of standard messages and message formats, has now been established by SAE.

This IDEA project also developed a method for estimating passenger miles from boarding counts that are odometer stamped. This method was verified on six bus routes provided by Los Angeles Metro. On all six routes, the tests proved that the reliability and accuracy of the method was within 1.5 percent.

Project Results

The open standards developed in this Transit IDEA project for dedicated communication provide information that would be useful in developing specifications for integrating farebox data with other data by transit operators.

---

[1] Department of Civil Engineering, Room 431 Snell Engineering Center, 360 Huntington Avenue, Boston, MA 02115. (617) 373-4419. NTIS # PB97-137509

Wheelchair Restraint System Transit-IDEA 7

Thomas A. Krouskop[1], Baylor College of Medicine

This IDEA project produced an innovative modular wheelchair restraint system that uses pneumatically driven resilient bristles that engage the wheels and frame of a wheelchair. The system stabilizes movements during acceleration and braking, thereby reducing the risk of injury in collisions. By engaging the bristles with the wheelchair frame and wheels, it is feasible to hold a variety of wheelchair geometries without subjecting the wheelchair to significant sideward loading. The bristles are actuated by a compressor on the vehicle. There is also a vacuum line to accelerate disengagement of the bristles from the chair. The restraint also stows itself with minimum space requirement. The pneumatic operation permits quick release and evacuation in case of a power failure after a collision. The restraint design incorporates sensors that detect when the resilient bristles contact the side of the chair and acts to limit the subsequent travel of the bristles so the chair will not collapse or bend.

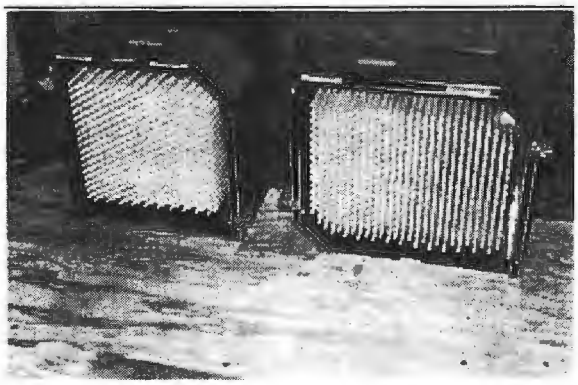


FIGURE 1

Bristle sections

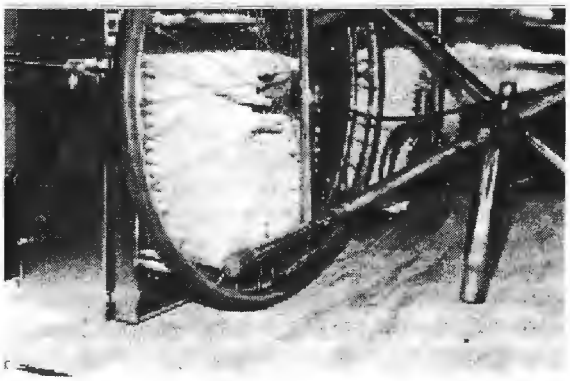


FIGURE 2

Engaging the wheelchair

The restraint protocol uses a double-staged activation to engage the bristles with the wheelchair. The first stage of activation extends the bristles in preparation for contact with the wheelchair frame, and the second stage of activation moves each section of the resilient bristles forward to engage the chair. During the second stage of activation, the bristles slide and flex freely when engaging the wheelchair frame and wheels. Any bristle placing a sideward force on the chair is retracted while other bristles continue to advance and further engage the chair. Essentially, the bristles restrain the wheelchair by making a custom mold of the frame that maximizes the area available to restrain the chair, as shown in figures 1 and 2. In this way, stresses on the wheelchair are kept as low as possible. The excursion of the wheelchair is designed to be limited to less than 1.5 cm (0.59 in.) when loaded to the design load of 26,700 N (6,000 lbs). This design criterion conforms to standards of comfort and safety for wheelchair users.

[1] TIRR-REC, 1333 Moursund Avenue, Houston, TX 77030. Telephone: (713)495-6838. NTIS # PB97-137517

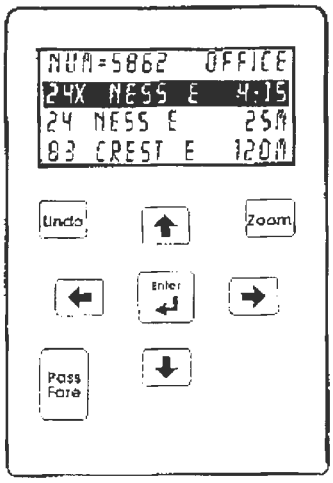
The wheelchair restraint prototype has been constructed, and preliminary contacts have been made with manufacturers of wheelchairs and wheelchair restraints to identify partners in the commercialization of the product. In addition to increased safety for the wheelchair user, the design of the restraint system reduces ingress and egress times for wheelchairs, resulting in considerable time savings for all passengers. The engagement operation is fully automatic. Dynamic operational testing will be needed to develop a preproduction design for marketing the product.

Real-Time Transit Data Broadcast Transit-IDEA 8

Edward C. Burgener and Norm Goertzen[1], Transcom International, Ltd.

This IDEA project developed transit broadcast software for a personal portable receiver that provides real time-to-arrival information to transit passengers at any selected bus stop. The innovative software system transmits bus location to the personal portable receivers by one-way broadcast. The system operates in conjunction with an automatic vehicle location and control (AVL/C) system to locate each operating transit vehicle. Transit location data are then broadcast in a format compatible with the software installed in the portable receivers. These remote receivers convert the locational data into real time-to-arrival information for passengers consonant with input station stop location numbers the users put into their receiver/processors. The actual broadcast method can be any one-way transmission system, such as an FM subcarrier, a pager network, or the Internet.

This product was tested on the bus system of Winnipeg, Manitoba, Canada, as a sample city of 62 routes, 500 buses, 650,000 in population, 128 patterns, and 4600 stops. The model developed required a file size within the original estimate of less than 30 Kbytes. As a follow-up, real-time data was collected from Hull Transit in Ottawa, Canada, and the model accurately predicted arrival within less than a 15-sec variance. Application has been made to the Canadian Federal Transportation Development Center for funding of a commercial product that would allow persons with disabilities to determine which buses are wheelchair accessible. Funding is also being sought from interested transit authorities. The funding would be used to (a) enhance the design of a current AVL/C software package being designed for a signpost AVL system in Halifax, (b) modify the standard paging protocol to be compatible with the proposed personal portable receivers, and (c) implement the design to a standard display pager system. Having this transit information system as a pager feature could provide an incentive to the established pager industry.



Transporter.

Transcom worked with NextBus of Emeryville, California on a preproduction system for the transit market.

[1] 55 Gibraltar Bay, Winnipeg, Manitoba, Canada R2Y 1J4. Telephone: (204)889-6754. NTIS # 137525

Violence Prevention Training CD-ROM Transit IDEA Project 11

Debi Horen, San Francisco Municipal Railway, San Francisco, California
Renee Haider1, National Transit Institute

This project developed an interactive multi-media CD-ROM training program, to improve transit bus drivers' ability to handle incidents of violence and aggression and potential problem situations.

This training program was developed by the San Francisco Municipal Railway (MUNI) in cooperation with six other transit agencies, in Transit IDEA project 11, and was tested by those transit agencies, in cooperation with the National Transit Institute (NTI).

Critical data on bus operator demographics, incidents, and existing training programs was collected from the seven participating transit agencies. Focus groups at each agency collected qualitative data on positive solutions to violent and potentially violent situations. An analysis of these data was provided to an expert panel work group that included 10 experts from transit, law enforcement, mental health, and public health agencies. Feedback from this expert panel suggested control techniques that can be used by the transit operator. These recommendations formed the foundation of the program that was developed and used in the interactive training program. The CD-ROM format includes video of bus drivers, computer-generated art, animation, music, narration, voice recordings, and stills, edited and digitized for use on a personal computer.

The training program is being marketed and distributed by NTI of Rutgers University. This interactive multimedia training program, called *Customers, Conflicts, and You: A Transit Operator's Guide to Problem Solving*, has been obtained by 98 transit agencies. The training package includes the interactive CD-ROM, a video, and an instructor guidebook, for a day-long training session for bus drivers. The complete training package is available from NTI for $199, plus $6.95 for shipping and handling. For further information on this training program, contact the person listed below.

[1] Renee Haider, National Transit Institute, 120 Albany Street, Suite 705 New Brunswick, NJ 08901. Telephone: (732) 932-1700, ext. 23. Fax: (732) 932-1707. E-mail: rhaider@nti.rutgers.edu

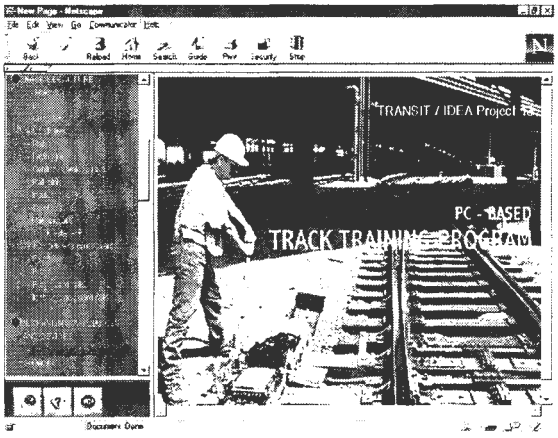
PC-Based Track Safety Training Transit-IDEA Project 13

Daniel Mesnick[1], TransTech Management

The IDEA project developed multimedia tools for communication over the Internet to improve the education and training of transit track staff responsible for the day-to-day maintenance of track safety. Illustrated below is the Internet home page, which is presented in full color. The training program uses multimedia integrated with text, drawings, schematics, and blueprints that guide track foremen in theory, design, standards, procedures, and maintenance methods to identify and correct track defects. Specific contents of this pilot training software include

1. An instruction scope covering transit track roadway design, drainage, geometry, special work maintenance and component renewal/replacement, inspection for defects and in turnouts and frog welding and rebuilding.
2. Course modules that are self-paced and self-directed.
3. Voice and text integration providing the track worker with visuals, text, and audio guidance on how, when, and where to perform track maintenance action in the field.

The consortium of transit agencies participating in this course development effort include the Massachusetts Bay Transit Authority (MBTA), New York City Transit Authority/Staten Island Transit Authority (NYCTA/SIRTOA), Port Authority Transit Corporation (PATCO), Southeastern Pennsylvania Transit Authority (SEPTA), and the Metropolitan Atlanta Rapid Transit Authority (MARTA). The MBTA will test the product before finalizing the software to confirm that voice, standards, and media will be effective. The American Railway Engineering Association (now AREMA) has supported this effort by allowing the use of elements of the AREA Manual and Portfolio of Trackwork Plans, and AREMA will receive a web-site link, assuring its continued participation in the implementation of this learning tool. Interest in this technology has been expressed by the MBTA, SEPTA, Washington Metropolitan Area Transit Authority (WMATA), NYCTA, AREMA, a few regional and short lines, the Polish State Railways (PKP) and several other railways internationally.



Maintenance home page on the Internet.

The investigator plans to promote and demonstrate the pilot version to managers responsible for improving track safety and maintenance.

[1] 74 Sycamore Road, Wayland, MA 01778-4051. Telephone: (508)655-0387. NTIS # PB99-113193

Instant Rent-a-Car Technology Applied to Transit Station Car Practice
Transit-IDEA Project 14

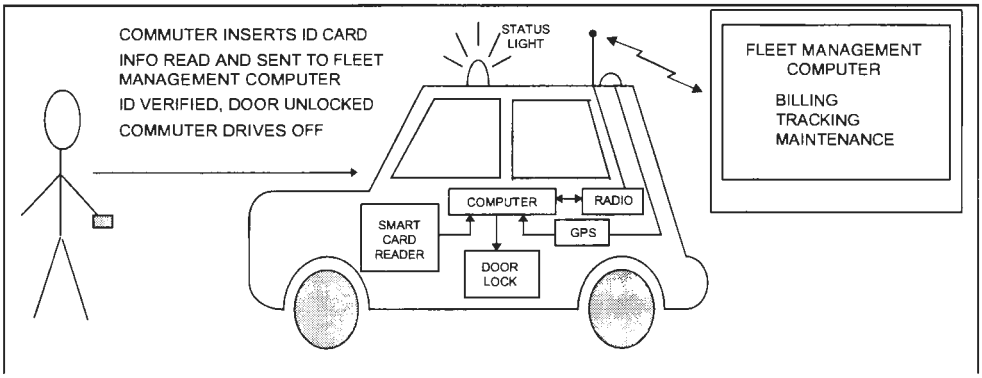
John Chisholm[1], C.F. International

This IDEA project employed ITS technology for short-term rentals of electric or compact vehicles to and from transit stations for increasing transit ridership, and was cost-shared with the ITS-IDEA program. As illustrated below, the Instant Rent-a-Car (IRAC) fleet management technology uses radio communications between the rental vehicle and a central processor to trace the status of a fleet vehicle. Rental transactions are possible by personal computer reservation or through a "walk-in" process. The user can then drive the vehicle and leave it parked on the street when finished. After the user exits the vehicle, the door is locked and a message is sent to the central processor containing billing data, rental availability, and other fleet management information, which may be used by other potential vehicle renters.

The project focused on integrating IRAC into transit practice by feeding rail rapid transit stations. The IDEA project included a limited-scale operational pilot project using up to 10 IRAC electric vehicles in a Bay Area Rapid Transit (BART) station to confirm predicted usage and ridership projections and patterns. Preliminary projections show that in a transit operation such as BART, ridership can be doubled with IRAC use by increasing the ridership on currently underused trains. IRACs are equally applicable to express buses and car pools and could provide a new market for the auto rental industry.

A large-scale operational test and evaluation using IRAC-configured vehicles was done as a follow-up after this Transit IDEA project to establish the viability for a national implementation of the IRAC technology. BART has subsequently undertaken a large-scale demonstration of a similar system. To achieve a low-cost IRAC system operation, a low-cost wireless communication device between the vehicle and the central processor must be developed in cooperation with transit agencies and suppliers of in-vehicle electronics.

The project cost was shared between the Transit-IDEA and ITS-IDEA programs, under ITS-IDEA projects 3 and 48, and Transit IDEA project 14.



IRAC technology.

[1] P.O. Box 9120, University Station, Reno, NV 89507-9120. Telephone: (702) 345-6577. NTIS # PPB99-113243

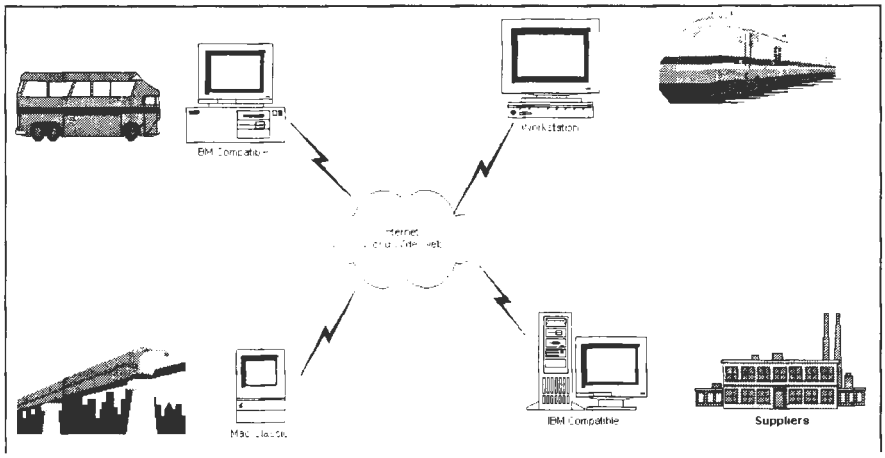
Internet Information Sharing for Transit Maintenance Transit-IDEA Project 15

Victor Kiernan[1], Kiernan Transit Associates

Transit maintenance data and information may be shared by public and private ground transportation agencies through the Internet. By sharing this information, cost savings are achieved in joint purchases, trading spare parts, and disseminating information related to transit maintenance, safety, and contracts. This IDEA project supported the Internet transit-maintenance information study in cooperation with major public transit agencies in the San Francisco Bay area. The study results show that transit agencies could achieve time and cost savings through Internet sharing of maintenance information.

The transit information maintenance system communicates through the World Wide Web. Some of the potential benefits of the IDEA project for transit maintenance include

- Reducing the costs of purchase ordering by an estimated 80 percent by using electronic ordering rather than the current paper-based systems.
- Transmitting competitive bidding and pricing on requests for spare parts among participating vendors and agencies.
- Increasing supplier discounts for coordinated joint spare-part purchases.
- Reducing inventory costs due to just-in-time ordering by sharing of the estimated more than $400 million in reserve spare parts currently held in transit agency warehouses.
- Facilitating sales of surplus parts through a single announcement capability on the Web site.
- Optimizing periods between routine maintenance by the comparison of maintenance information between agencies that specifies tasks, work performance, and personnel requirements.
- Sharing maintenance and life expectancy records of parts, which results in more dependable and efficiently run systems for improved safety and convenience for passengers.



Information through the Internet.

Using the Internet for sharing information provides the potential for reducing parts inventory costs of transit systems. Two journal articles by the California Transit Association in its *Transit California* magazine describe the possible benefits of a compendium of transit maintenance information. Following this Transit IDEA project, a large-scale demonstration project of a similar system started in 2000 under a demonstration project funded by the Federal Transit Administration to the Metropolitan Atlanta Rapid Transit Authority.

[1] 3234 Gloria Terrace, Lafayette, CA 94549. Telephone: (510)939-3577. NTIS # PB99-113227

Transit Restraint System for Wheelchair Users Transit-IDEA Project 16

Steven Reger[1], The Cleveland Clinic Foundation, Cleveland, Ohio

IDEA Concept and Product

This project developed several restraint design concepts and tested one that brings the anchor location into proximity with the wheelchair seat. The unique design of this restraint system eliminated the disadvantages of the existing seat belt systems anchored on the vehicle floor and routed around the pelvis of the person seated in the wheelchair. The prototype was designed to offer an easier and faster operation, often eliminating the need for assistance by the bus operator. When the restraint is not in use, the adjustable rails are rotated into a stored position clear of interference with passenger seating and ambulation. The lap belt is also stored on a small retracting spool to remain clean when not in use.

Project Results

Traveler protection during transit and vehicle impact is the primary objective of occupant restraint design including occupant restraints of wheelchair-using travelers in transit vehicles. The objective of this project was to develop and evaluate new occupant restraint design concepts with focus on minimizing the efforts to operate the system while maintaining the crash protection of the wheelchair traveler.

The investigation started with the formation of the design criteria based on multiple inputs from a resource panel of experts, wheelchair users, transit administrators, vehicle operators, human factors testing of wheelchair-using travelers and an experienced public transit vehicle designer.

Survey

A survey was developed and disseminated to administrators at 12 transit authorities throughout the country and vehicle operators involved with transportation of wheelchair users. Overall, the surveys indicated conflicting information on priorities of safety, lack of use of lap and shoulder belts, fastening time between fixed route and paratransit application, and the need for alternatives to the existing occupant restraint designs. New design criteria were indicated for restraints to be used independently and rapidly by many wheelchair users with reduction of stop dwell time and driver involvement.

Human factors testing

The human factors testing established anthropometric envelopes of wheelchair seated posture, reach, hand strength, and functional ability to position the wheelchair by the occupants.

The design criteria from all these inputs were finalized and tabulated. The criteria established specifications for activation time, user independence, durability, component locations, operating hand function requirement, body size accommodations, and crash safety in terms of load and deflection parameters.

Prototype designs

Using the design criteria, three conceptual models of wheelchair occupant restraint systems were developed and investigated. The early concepts of stanchion-mount and wall-mount designs were evaluated but not implemented because of obtrusive bulkiness for the first and incompatibility with vehicle structural design for the second. In previous sled impact testing (30 mph, 20-g and 5-g lateral impact) the stanchion-mount design performed well and appeared to be superior to the 3-point belt restraints.

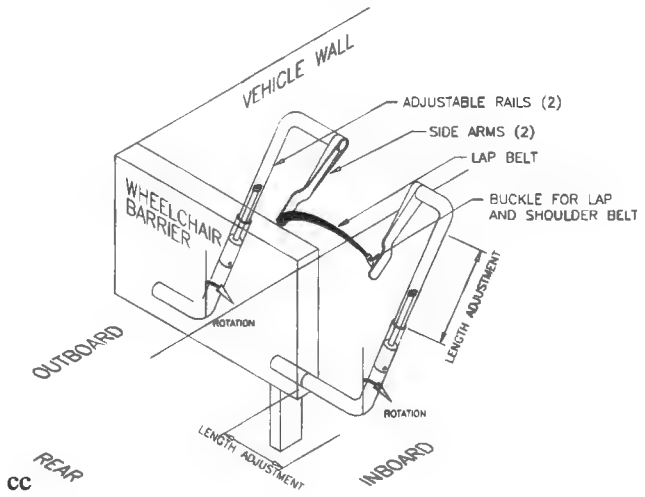


Figure 1.

Panel-mount design for wheelchair occupant restraint system

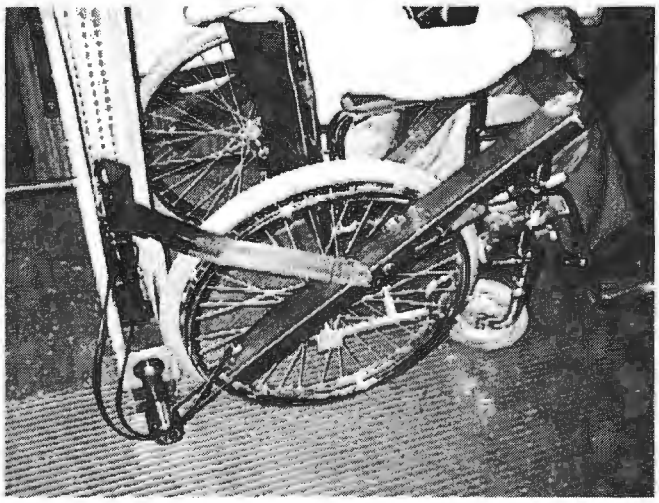


Figure 2.

Side view of the prototype restraint

The final panel-mount design was developed and refined and a full-scale prototype was built for limited user tests and strength evaluation. The concept is illustrated in Figure 1. To minimize costs and to enhance commercial appeal, an effort was made for a simple design with off-the-shelf components and cost-effective tolerances.

Field testing

The prototype was built and installed in a 44-foot bus in service at the Greater Cleveland Regional Transit Authority and was driven to wheelchair users for a hands-on trial (Figure 2). The limited field trial in the nonmoving vehicle by experienced wheelchair travelers pointed out a general acceptance of the principles of the prototype design, a dissatisfaction with the current lap belt system, and a need for further improvements in slimmer design and in the operation of the panel-mounted restraint design.

Pull testing

The final evaluation of the prototype restraint system was a static pull test to determine compliance with the Federal Motor Vehicle Safety Standard (FMVSS)-210 for seat belt anchorage. This test was performed at the NASA-John H. Glenn Research Center in Cleveland, Ohio. The test results indicated the ability of the restraint prototype to carry nearly half of the 5,000 lbs. of target load, displacement, and duration. Failure of the body block in the prototype restraint system occurred at approximately 2,200 lbs. in this test. The early failure did not occur in the design concept, but was due to faulty welding and the incorrect accommodation of the belt anchor to the commercial wheelchair.

Product Payoff Potential

The potential benefits to transit practice from this project arise from the surveys of transit administrators, fixed route and paratransit operators, which indicated conflicting understanding of crash safety and belt

restraint use. This information reinforces the need for a nationwide educational effort to inform providers of the importance of properly positioned lap and shoulder belts for wheelchair traveler crash safety. The project has also shown why it is important to reduce operator assistance and enhance rapid user application of restraint systems, which would reduce bus stop dwell time and improve operational efficiency.

Operational Evaluation of Automated Rail Wheel-Gauge Inspection System
Transit-IDEA Project 17

Zahid Mian[1], International Electronic Machines Corporation

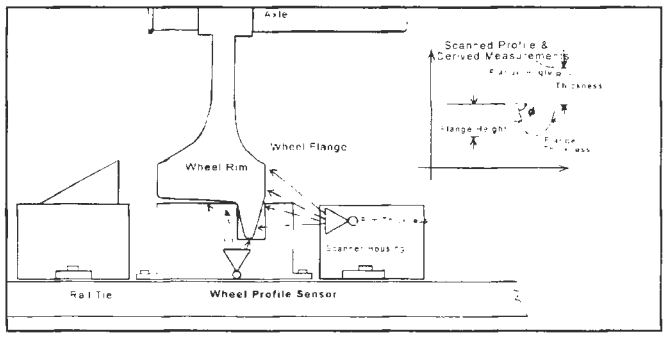
This IDEA project demonstrated a low-cost prototype of an automated rail wheel-gauge inspection concept, that had originally been developed under Transit-IDEA Project 3. The rail wheel gauge uses a series of laser scanners and cameras mounted at track side along with a series of ultrasonic sensors. These scan an entire cross-section of the wheel.

The measurement output is a digitized profile of the wheel that is processed by geometric algorithm software. A set of standard wheel measurement data compatible with existing measurements is derived from the digitized profile. Additional computations are incorporated into the algorithm to check for such critical specifications as wheel cracks, flange angle, wheel diameter, hollow tread, etc.

Transit operators and railroadsoften use time-consuming manual procedures to inspect and maintain railroad wheels. Current railroad wheel-inspection techniques lag behind the technological advances available for automated inspection. Existing hand-held measurement instruments lead to inefficient and non-uniform inspection operations.

The product provides a complete profile of a railroad wheel and inspects the wheel and flange wear.. The advanced wheel inspection method is particularly attractive to high-speed rail operations where issues of wheel/rail interaction are crucial to overall performance and safety. For example, since the high-speed rail link in the Northeast corridor calls for the wheels to be inspected at the end of each run, existing wheel inspection procedures would result in an unacceptable amount of downtime.

A conference convened during Transit-IDEA Project 3 confirmed that the automatic wheel-inspection system can meet rail transit requirements. The system was also field tested at the Amtrak Albany-Rennselaer Yard.



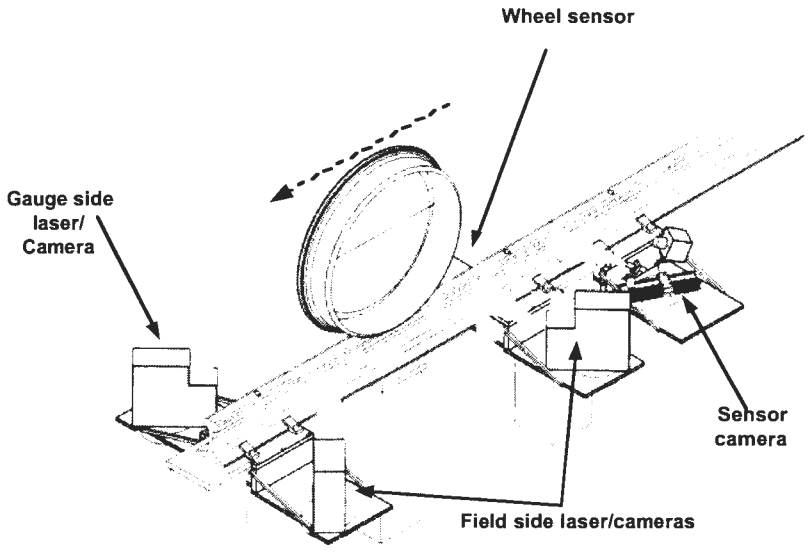
Wheel scanning system.

[1] 60 Fourth Avenue, Albany, NY 12202-1924. Telephone: (518)449-5504. E-mail: zack786@nycap.rr.com.
NTIS # PB99-113250

Following the Transit IDEA project, the investigator received a letter of interest from AMTRAK to purchase several test wheel inspection stations. Additional proposals are in preparation for other rail wheel inspection stations. The investigator has developed a booklet on wheel inspection stations.

Subsequently, the investigator was contracted to expand and continue the work, by the New York State Energy Research and Development Authority (NYSERDA), for approximately $500,000. Additional field tests revealed certain potential limitations of the original system, partly due to the physical design (which had necessitated the use of custom rail segments with a cut-out section) and partly due to some limitations of the hardware in real-world settings. The investigator determined to attack these challenges, leading to a vastly improved redesign involving added cameras, a faster and tremendously reliable wheel detection and capture system .(the detection and capture subsystem never failed to detect and trigger capture of a wheel in many months of trials) The refined system also has no special rail segments or footings for installation, and a fully 3-D laser imaging-based measuring system. The current system operates at higher speeds than the prior system, has the potential to measure wheels on trains moving at normal full transit speed, and determines all measurements by more accurate and robust means than the original design. A diagram of the current system layout follows. A patent for the system was approved in October 2002.

Several railway companies and organizations in the U. S. and in countries ranging from China to Brazil have made inquiries to the investigators about obtaining these systems for commercial use. The investigator has prepared technical specs and overviews of the systems' requirements, installation, and use for prospective customers.



Rail-Based Wheel Inspection System

Innovative Payment Options for Independent Transportation For The Elderly Transit IDEA Project 18

Katherine Freund[1], Independent Transportation Network

IDEA Concept and Product

This project (Transit IDEA Project-18) pilot tested two innovative payment operations for independent transportation for the elderly—adult child payment plans and merchant participation. It also investigated the use of geographic information system (GIS) technology for community-based transportation for seniors.

A previous Transit IDEA Project, *Independent Transportation Network: Alternative Transportation for the Elderly* (Transit IDEA Project-9), showed that seniors were willing to use a transportation service that models the comfort and convenience of the private automobile. (Freund, McKnight 1997) This Transit IDEA Project-18 research moves beyond that beginning to explore the economic sustainability of such a senior transportation service by examining several innovative sources of revenue and by developing efficiency through the application of information system technology.

Transit IDEA Project-18 demonstrated that businesses and adult children are willing to participate in the cost of transportation for seniors. Community willingness to voluntarily support senior transportation has important implications for the economic sustainability of present and future transit services seeking to meet the mobility needs of the growing older population. Transit IDEA Project-18 investigated innovative payment methods by looking outside the traditional public funding sources to private resources in the community.

Adult children whose parents use the transportation service and members of the business community whose customers and patients use the service were identified as groups who might be willing to help pay for rides. Geographic Information System (GIS) technology was selected as the information system application most likely to contribute to the efficiency of the senior transportation service.

Research was conducted at the Independent Transportation Network (ITN) in Portland, Maine. ITN uses automobiles and both paid and volunteer drivers to provide service seven days a week, 24 hours a day. Seniors who use the service become members of the non-profit organization and open pre-paid accounts which are debited to pay for their rides. No money changes hands in the vehicles; rather, members receive monthly statements, similar to a telephone bill, detailing their rides and charges.

[1] Independent Transportation Network, 90 Bridge Street, Westbrook, Maine 04092. Telephone: (207) 854-0505. E-mail: kfreund@itninc.org.

Project Results

A. *Innovative Payment Operations for Adult Children*

A catalogue that combined gifts and transportation certificates was tested with seniors and their adult children. The response rate from the target market, adult children of seniors, was approximately 10 percent. By comparison, the typical response rate of companies in the catalogue industry is only two percent. Most of the gift certificates purchased, however, were for transportation only, not transportation combined with a gift. This meant that the only opportunity to raise revenue was from fees charged for the certificates, a practice that was unpopular with consumers. The willingness of adult children and families to participate in and support the ITN senior transit service was then tested as a membership campaign, expanding the membership concept from the senior customers to families and the population as a whole. The membership program produced revenue immediately, with membership dues from adult children and siblings ranging from $35 to $1,000. Gift Certificates have been retained in the transit program as conveniences for customer service. Adult children liked them as a feature of the service and showed their appreciation for the ITN through contributions and membership dues. Likewise, credit cards as a payment method did not increase adult child participation in the program, but they did provide a good customer service.

B. *Innovative Merchant Program*

Merchant participation was tested with the Ride & Shop program. A control group and an experimental group tested the program for six months, collecting stickers from thirteen area merchants. The results indicated the Ride & Shop program was effective in increasing rides to participating stores. Each sticker collected was worth $1.50, with $1 going to the riding seniors, as an incentive to patronize that store, and $.50 going to the ITN to help cover the deficit incurred with every ride. The administrative cost of the Ride & Shop program exceeded the economic benefit until the program became "stickerless" as an electronic transfer of funds from the merchant's account to the accounts for the seniors and the ITN. Like the membership campaign described above, the electronic Ride & Shop program was implemented after the actual research project was completed. It is now a successful program at the ITN in Portland, Maine, and may be adapted by other transit services or by communities replicating the ITN model.

C. *Information System Technology*

A GIS program was designed to create shared rides among community dwelling seniors using windows of availability and dispatching to volunteer drivers. Available commercial GIS software applications for transit were found to be inappropriate and unaffordable for small community volunteer transit services that need to capture the detail necessary to properly dispatch volunteer drivers and their vehicles. Focus groups and a survey of seniors using the ITN service showed that 80 percent of seniors were willing to share rides in automobiles with other seniors in the service. The GIS software program could not be built with the resources available in the Transit IDEA Project, so a pilot test was not possible. However, a GIS software application that uses Transit IDEA research results was built with other resources. The program dispatches to both paid and volunteer drivers, creates shared rides as a consumer choice, incorporates revenue and data collection for the innovative payment operations (Ride & Shop, Healthy Miles and Ride Services), and maintains a database for membership.

By creating new sources of revenue through adult children of seniors and businesses in the community, and by using a GIS to create shared rides and efficiently dispatch volunteers, this project points the way to innovative payment methods for community-based transportation services for elderly people.

Field Testing and Evaluation of the Transit Integrated Monitoring System (TIMS) Transit IDEA Project-19

Manuel D. Rossetti[1]
University of Arkansas, Fayetteville, AR

IDEA Concept And Product

Transit IDEA Project-10 addressed the need for improved methods of data collection concerning transit users and vehicles by developing a prototype radio frequency identification (RF/ID) tag that acts as a bus pass. Passengers carrying the cards can be *uniquely* identified and tracked throughout the transit system. The Phase II demonstration project, Transit 19, improved on the prototype by field testing an integrated automatic passenger counting (APC) system and automatic vehicle location (AVL) system based on GPS and RF/ID smart cards.

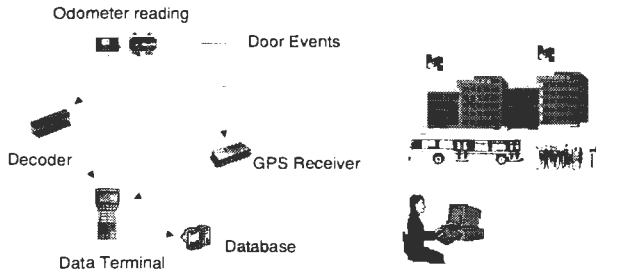


FIGURE 1

System Concept Diagram

Project Results

During the Transit IDEA Project-10, a prototype based entirely on RF/ID tagging technology was developed and tested on a University of Virginia bus route using student volunteers. In addition to providing tags to bus passengers, RF/ID tags were embedded at bus stops along a route to track the movement of buses. Preliminary data were collected in near real-time. The read rate of the embedded tags was less than 50 percent. The data captured included passenger and bus stop identifiers and event times (arrival and departure times of buses and boarding/alighting times of transit users). From these data, information such as origin-destination pairs, passenger transit times, and schedule adherence were derived. The data were organized into a database and example summary reports were formulated. Passenger acceptance of smart cards and tracking was analyzed via surveys.

[1]Department of Industrial Engineering, 4207 Bell Engineering Center, Fayetteville, AR, 72701, (479) 575-6756, rossetti@uark.edu

The results of the Transit IDEA-10 project indicated the potential of using radio frequency identification to integrate APC and AVL systems. The Transit-19 Phase II demonstration examined the integration of APC/AVL and other monitoring functions in the form of a Transit Integrated Monitoring System (TIMS). Objectives for Phase II included developing a demonstration system that: 1) improved the hardware components of the Transit-10 prototypes, 2) enhanced the software architecture and software subsystems, and 3) enabled a better understanding of the operational performance of TIMS under transit conditions. A route within the Charlottesville Transit System served as the demonstration's case study.

The hardware system was redesigned to utilize global positioning technology as the primary bus stop identification mechanism. In addition, the system concept was changed to allow fare collection on a portable data terminal mounted within the vehicle. The results include an object-oriented software architecture of the information content for the system, a set of use cases for the system, a design specification for the database, a design specification for the user interface, and the hardware requirements and specifications. The system was tested during a field trial of two weeks. The results of the testing yielded a 96.5 percent read reliability rate for the cards. In addition, if the cards are used as proximity devices a 100 percent rate was achieved. The final product associated with this project is the completed design and specifications of TIMS using the software industry standard Unified Modeling Language, the integrated hardware and software, and a demonstrated system.

Product Payoff Potential

The primary benefit of this project is the design of an integrated system that replaces the functionality of disjointed passenger counting, vehicle location, and fare collection systems at approximately the same cost. In addition, because the system can record passenger's fares automatically without the passenger having to remove the fare card from their purse or wallet approximately 1 to 2 seconds per boarding passenger can be saved. These time savings can be significant in large high-volume urban transit settings.

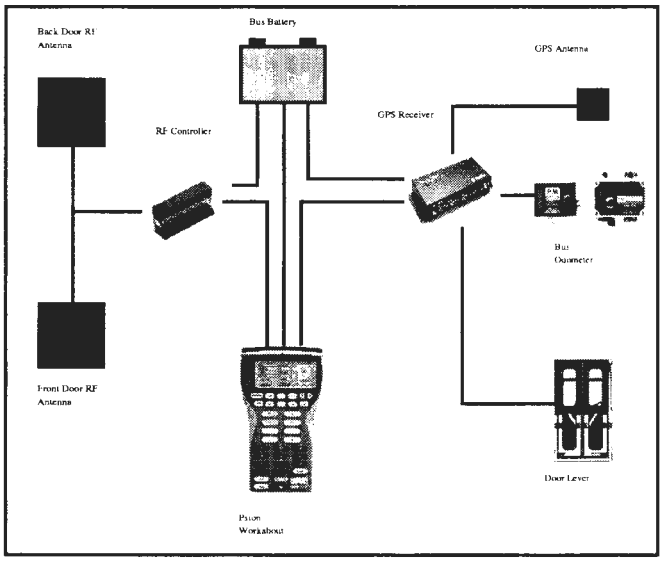


Figure 2:

Hardware Connections

For this demonstration, APC integration was achieved through the use of smart cards based on radio frequency technology; however, we emphasize that the hardware and software design specifications *do not* depend on the use of radio frequency based smart cards. The ultimate benefit of this project to practice depends on the acceptance of smart cards by the general population within the United States. Data from the Smart Card Forum suggests large gains in the smart card market within the next few years. For example, according to market researcher Dataquest (San Jose, Calif.), the microprocessor and memory based smart card market will grow from 544 million units in 1995 to 3.4 billion units by 2001. (Dataquest, 408-468-8206) Integrated systems such as TIMS must be available to take advantage of the growing use of smart cards.

Product Transfer

The steps taken to facilitate product transfer include:

1. *Partnerships with industry:* The project was a joint effort between academic researchers and a smart card company Axcess, Inc.
2. *Partnerships with transit providers:* Transit-10 was implemented on the University of Virginia transit system. Transit-19 was implemented on the Charlottesville Transit System.
3. *Monitoring by a Transit Users Forum:* The forum consisted of researchers and practitioners associated with the Virginia Department of Transportation, Charlottesville Transit System, and the Richmond Transit Authority.
4. *Publications:* Two journal articles, one conference paper, and one MS thesis.

Additional plans by the investigator as a follow-up to this project include:

- Seeking additional financing to enhance the system to include real-time DGPS, GIS, and web-based interfaces.

References

Rossetti, M. D. and Turitto, T. (1998) "Comparing Static and Dynamic Threshold Based Control Strategies", *Transportation Research Part A*, Vol. 32, No. 8, pp. 607-620.

Rossetti, M. D. and Turitto, T. (1997) "Design of an Integrated Transit Monitoring System based on RF/ID" to appear in *International Journal of Technology Management.*

Rossetti, M. D. (1999) *Field Testing and Evaluating the Transit Integrated Monitoring System*, Final Report, Transit IDEA-19, January.1999.

Rossetti, M.D. (2002) "Field Testing and Design of a Transit Integrated Monitoring System," 9th Annual World Congress on Intelligent Transportation Systems, Chicago, Ill.

Noncontact Sensor for Passenger Counting and Classification Transit IDEA Project 20

Gene Greneker[1]
Greneker and Associates, Inc., Marietta, Georgia

IDEA Concept and Product

A transit passenger counting system was developed to provide counts of multiple passengers, entering rail rapid transit vehicles through a wide-stream door. The direction of travel of each passenger can also be determined. This prototype system is called the Cyclops Passenger counter and was originally developed under Transit-IDEA Project 5. In addition, an experimental method was tested to determine if individual passengers can be tracked to determine origin and destination stations.

Three elements currently comprise the experimental Cyclops system: (1) a radar system; (2) a television camera; and (3) a wireless data link that transmits both radar and television images to an associated data recording system (not shown). The radar system was tested to determine if it could serve as a low-cost sensor/counter capable of detecting a passenger entering the radar beam, and determine if the detection is an entry or exit event. The television camera system was used for counting passengers and identifying the stop where a passenger boards and exits. In final form, a microprocessor controller could process the radar and television camera system data and provide that information as output to the transit vehicle's database, on-board recording and collection system, or radio linked data collection system.

Project Results

This project was conducted in two stages. The first stage tested the performance of the Cyclops experimental passenger counting system employing radar and television sensors and a wireless data transmission system. These tests were conducted in the laboratory to demonstrate the feasibility of using each type of sensor to count passengers entering and exiting a simulated wide-stream door located in the laboratory. Each of the two sensor systems (radar and television) were designed to sense passenger presence data independently.

During the second stage of research, radar and television image data were first collected from an operating out-of-service rail transit vehicle to determine if there are vibrational or electromagnetic interference issues that must be addressed and solved. This was followed by full-scale testing of the system on Metropolitan Atlanta Rapid Transit Authority (MARTA) rail transit cars during revenue service. Counting multiple passengers simultaneoulsy entering the wide stream door abreast of each other, shoulder to shoulder, is a challenge for the current radar system design. The Cyclops passenger counter system would need further development to overcome that obstacle before it could provide passenger counts on transit vehicles with wide-stream doors.

[1] Greneker and Associates, Inc., 184 Lake Somerset Drive, Marietta, Georgia 30064. Telephone: (678) 777-2979. E-mail: gene.greneker@gtri.gatech.edu

Summary of Testing Program

The data produced during testing were used to determine the vibration environment as well as the electromagnetic environment found on a moving rail transit vehicle. Following static testing, operational problem areas were identified and these problems were addressed before tests were conducted on a rail transit vehicle in revenue service.

Processing algorithms were developed in the laboratory after the recorded data were analyzed. The processing system provides the total number of entry and exit events through a wide-stream door at each stop, with a time tag.

Product Payoff Potential

The system, when fully developed, may offer transit systems an efficient method of obtaining ridership counts.

Product Transfer

A final report on the Transit IDEA project has been completed. If the passenger counting system can be further developed to overcome the obstacle of multiple passengers simultaneously entering wide stream doors, a commercial prototype system could be developed. This system could be provided to firms in the passenger counter industry for the purpose of testing to industry standards. Problem areas will need to be corrected during further development. The system design could then be licensed to the passenger counter industry for manufacture and sales to the transit industry.

Figure 1.

Passenger Counter being mounted on MARTA rail rapid transit vehicle

Smart Parking Lot with Just-in-Time Bus Service Transit-IDEA Project 21

Chris A. Bell[1], Oregon State University

IDEA Concept and Product

This project was aimed at developing and trial testing an adaptive software system and scheduling algorithm for a "smart" parking lot with just-in-time shuttle bus service to improve parking efficiency in large parking lots at intermodal and transit terminals. Based on the results, prototype input-output hardware and software systems were designed to prepare for deployment trials in a large parking lot at Portland International Airport (PDX).

Demonstration tests were performed at the PDX airport parking lot. The deployment testing process will be supported through external cooperative funding.

Project Results

The project involved four stages of research. The first stage involved collection of information on parking issues in large intermodal parking lots and the development of an appropriate system configuration for operating the "just-in-time" parking process. A beta version of the smart parking simulation software was developed and preliminary results for a hypothetical parking lot were evaluated and found satisfactory to proceed to simulation of the more complex situation of a real parking lot. A panel of regional experts convened to discuss stage 1 results and evaluate project plans and endorsed the development of the simulation to apply to the Economy parking lot at PDX airport.

Following refinement of the simulation, verification tests were performed in stage 2 using the PDX parking lot configuration. The simulation has a dumb and a smart mode, enabling comparison of operating characteristics before and after implementation of the smart system.

Stage 3 involved additional refinement of the simulator based on data collected at the PDX Economy parking lot. Various operating characteristics were evaluated, and, based on the results, the system was improved. Criteria for designing input-output hardware and software were developed by applying the results of the simulation. The regional panel of experts was convened again to discuss proposed improvements and advise on plans for the fourth and final stage.

Stage 4 completed the design of an automated parking system to prepare for a pilot system on the PDX parking lot.

[1] Oregon State University, College of Engineering, 101 Covell Hall, Corvallis OR 97331. Telephone: (541)737-1598.

Project Payoff

The market potential and benefits for this concept are significant. The concept relates to parking information systems and will improve efficiency of parking at any parking terminal (with an input routine to define the lot characteristics). Time savings can lead to cost savings. In addition to the application in public transportation practice, there are significant applications in the private sector, where parking lots for large industrial campuses deal with several thousand users on a daily basis.

Product Transfer

The project was undertaken with the collaboration of the parking contractor at the PDX airport. The Port of Portland is the airport owner and was also represented on the regional panel of experts, together with TRI-MET, the local transit agency in Portland, Oregon. A successful demonstration was performed at PDX with external funding, following completion of the Transit IDEA project. The final report for this project was completed.

The next step would be to complete refinements and a permanent implementation at the PDX parking lot. To date, a funding package for such an implementation has not been assembled. This would have applications for parking facilities for other airports or transit terminals or other large parking facilities.

Sleeved Column System for Crashworthiness of Light Rail Vehicles Transit-IDEA Project 22

Ronald A. Mayville [1]
(formerly with Arthur D. Little, Inc., Cambridge, Massachusetts)

IDEA Concept and Product

The concept and product that was tested is a novel, low cost, lightweight replaceable energy absorption system that can be incorporated into modern rail transit vehicles to provide substantial protection in collisions with other trains and with road vehicles at grade crossings. The system is based on the sleeved column technology, in which one or more small-diameter steel core rods carry load, compress and efficiently absorb energy within a sleeve made of mild steel or other material. The sleeve prevents buckling of the relatively slender core and can be an existing structural member in the rail vehicle underframe.

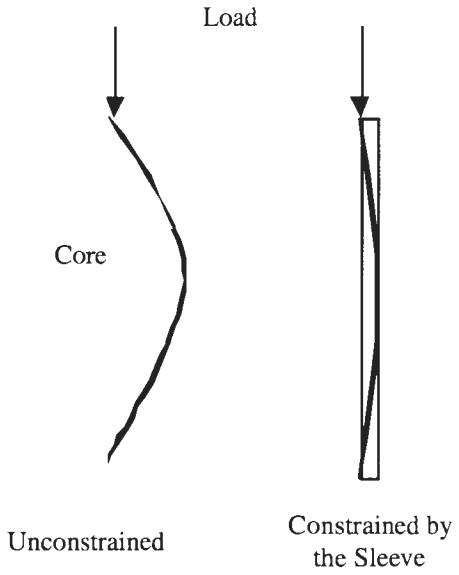


Figure 1:
Sleeved Column Concept

Project Results

A detailed design of a sleeved column energy absorber was developed and fabricated for dynamic testing. The sleeve is a rectangular, hollow, mild steel member with a length of nearly 8 ft. Rectangular structural members are more commonly used in rail vehicle construction than shapes with circular cross sections. A single core element was fabricated from a solid high-strength low-alloy steel piece.

Tests indicated that the design crush load is reached at the first stage of crush and then increases by a factor of two for the second stage crush, resulting in a desirable stepped load-crush response distributing energy absorption to other vehicles. Tests were performed and results reviewed by the project panel.

[1] Ronald A. Mayville, Telephone: (617) 527-7607

Product Transfer

While the primary objective of this project was to demonstrate the applicability of the sleeved column technology to transit rail vehicles, the investigators also explored the incorporation of the system into light rail vehicles through a collaborative effort with a leading manufacturer of transit vehicles for U.S. service.

This project included generation of a structural layout of the new energy absorbing elements in a representative light rail vehicle underframe and analytical evaluation of the performance of this system. This engineering work is available for potential use. The final report for this project was completed. It includes information needed by practitioners in the rail vehicle industry to design sleeved column energy absorbers.

Optimizing Travel Paths for People with Disabilities Transit-IDEA 23

W. Davis van Bakergem[1], Washington University

This IDEA project developed a method for people with various types of disabilities to review barriers to travel before embarking on a transit trip so they can plan their paths to more easily reach destinations surrounding transit stations.

The research analyzed typical travel barriers for the disabled around transit access points. A database of physical landscapes and barriers was developed and a prototype transit accessibility mapping system was demonstrated. The model is based on Metrolink light rail transit stops in the St. Louis, Missouri, region. The scope of this project was reduced to accommodate the FY'98 Transit-IDEA funding shortfall. The investigators only conducted Stage 1 of this project.

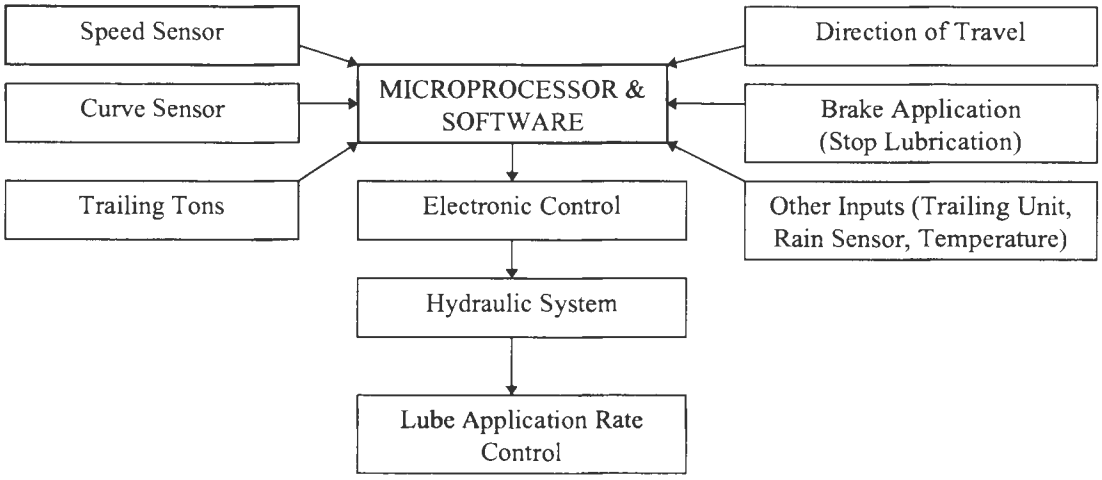
Intelligent Rail Lubrication System Transit-IDEA 24

Sudir Kumar[1], Tranergy Corporation

This project designed, built, and demonstrated an automated, computer-controlled onboard intelligent system for applying new environmentally safe and consumable lubricants for rail systems. The lubricant applied to the rail will reduce friction between the wheel and rail and is expected to provide significant benefits in maintenance, safety, and overall economic efficiency. A schematic diagram of the rail lubrication system for railroads is illustrated below.

Progressive development of a rail lubrication system for U.S. railroads and transit systems indicates potential benefits including reduction in wheel wear, rail wear, and track maintenance costs. The scope of the Transit IDEA project was reduced to accommodate the FY'98 Transit IDEA funding shortfall. A final report was prepared for this Transit IDEA project.

Tranergy continued the work on the system at its own costs after discontinuation of funding. In September 2000, a new joint venture called "Friction Management Services, LLC" was formed by Tranergy and Timken, a major international corporation. This joint venture has been continuing the work on the system and has installed many systems on locomotives of four Class I railroads in the US and Canada for checking performance improvements on trains in revenue service.



Schematic diagram of rail lubrication system.

[1] 726 Foster Avenue, Bensenville, IL 60106. Telephone: (630)238-9338. E-mail: sudkumar@tranergy.com.
NTIS # PB99-113219

Operating Policies for Improved Transit Productivity Transit-IDEA Project 25

Roy Lave, SYSTAN, Inc.

IDEA Concept and Product

This project proposes to develop a more efficient application of a computerized software package for scheduling and dispatching paratransit service to help transit managers make informed decisions on paratransit operational strategies. Using operational data from the transit agencies in two areas, San Mateo County, California and Winston-Salem, South Carolina, a parametric analysis of the operating policy in each of these cities is planned by the investigators.

For example, passengers with travel distances above a specified threshold could be assigned van or taxi service instead of transit, depending on system-wide impacts on travel time and cost. Such a scenario may be especially important in scheduling trips for passengers in sparsely populated rural areas. Some other operating policy decisions include:

- whether to purchase ITS-APTS equipment to permit real-time, demand response service;
- whether to assign subscription passengers to the same driver;
- whether to use broad or narrow pickup time "windows" to passengers; and
- how to balance passenger service versus system efficiency.

Given such operational questions, a transit manager could consult the guidelines and associated figures developed by this project, identify the local situation, and see the potential impacts on costs and passengers of different policies.

Planned Investigation

The investigation plans to begin with interviews of transit managers to determine appropriate operational scenarios and policy decisions to evaluate. Next, operational data, ride files, and client lists for two paratransit systems will be obtained. The data will form the basis for simulations to test alternative operational policies. The results of the simulations form graphical and narrative guidelines that could show tradeoffs between one policy and another.

Passenger convenience is a function of time, window size, and passenger ride time; operating efficiency is a function of vehicle mileage and number of vehicles. By holding fleet size constant and adjusting policy values of ride time, for example, the manager could find the simulated tradeoff values of ride time and vehicle miles that are directly related to passenger service and system costs. Other policies could be tested similarly. The value of such a concept is that it could allow the transit manager to experiment "on paper" rather than "on the street," thereby possibly reducing costs, passenger and staff frustrations, and the chances of making the wrong decision. It is expected that the investigators will only conduct Stage 1 of this project.

Product Transfer

The two transit operators who are providing operating data for the investigation are also partners in the investigation. They will suggest the policy issues that are significant to their operations.

Designing Transit Services for the Mode-Choice Market Transit-IDEA Project 26

Alan Hoffman[1]
The Mission Group, San Diego, California

IDEA Concept and Product

The project is aimed at developing new tools for market-focused transit planning to compete for riders who have a choice of modes. The approach, named "Stage III" to distinguish it from current mode-centered planning, directly builds on the two variables of greatest importance in designing competitive transit services: time and modal utility. The project will address the first variable through the elaboration of a new measure of regional mobility, the Mobility Index, which measures and maps automotive and transit mobility based on trip times to demand generators. The second variable will be addressed by intensive focus group research aimed at solving the problem of market positioning for transit services; this research will explicitly attempt to identify and weigh the characteristics that make one mode's utility higher than another.

Planned Investigation

The project involves two stages of research. The first stage focuses on the development of the Mobility Index and a set of associated maps for the San Diego metropolitan region. Each Transportation Analysis Zone (TAZ) in the region will be scored for its absolute (average time required to reach all regional demand generators, weighted by demand) and relative mobility (average time required to reach those demand generators actually demanded by the target TAZ) for both automobile and transit modes. These maps and measures will be produced for both a baseline case and for one or more alternative transit strategy cases. The research will be tied closely to the strategic planning effort being undertaken by the San Diego Metropolitan Transit Development Board (MTDB) and will help the Board and other regional decision makers understand the impact of different transportation scenarios on both automotive and transit mobility.

The second stage focuses on the question of designing transit services aimed at the mode choice, or discretionary, market. A weakness of transit system design has been the gap between what is designed, named, depicted, and promoted, and what key segments of the choice market would most respond to. The literature on service sector industries suggests an approach to product and service design based on careful market segmentation, intelligent market positioning, and careful attention to the design of the customer experience at every stage in the "service encounter." The focus group research will attempt to identify the "bellwether" segment(s) of the choice market and explore those elements that are crucial to designing and then positioning new transit services aimed at achieving significant penetration of the choice market.

[1] World Trade Center, Suite 214, 1250 Sixth Avenue, San Diego, CA 92101. Telephone: (619) 232-1776.

Product Payoff Potential

The project will have two kinds of payoffs. In the short term, it will inform and help guide a regional transit agency, MTDB, in its current strategic planning effort, and hence may directly help shape the future development of the San Diego metropolitan region. Beyond the local application, the Mobility Indices provide a tool that can aid both transit agencies and metropolitan planning organizations in other regions to better understand and identify opportunities for transit system improvements; weigh competing alternatives, even dissimilar ones (such as a change of land use in one area compared with increased bus frequencies in another), in terms of their impact on regional mobility; and provide elected officials and the public with explicit pictures and measures of the projected impacts of transportation investments.

The research into transit positioning systems should likewise benefit transit agencies, particularly those that are exploring the potential for new transit systems, such as Bus Rapid Transit or local shuttles, to achieve wider and quicker acceptance on the part of new transit markets.

Product Transfer

The project is being undertaken with the full collaboration and participation of both the Metropolitan Transit Development Board (MTDB), the major transit operating agency in the San Diego area, and the San Diego Association of Governments (SANDAG), the regional planning organization. The results of the study will be directly incorporated into MTDB's long-range strategic planning program, which aims to devise a new approach to regional transit development.

The project will also produce two documents, which will be of great use to transit agencies and planning organizations. The first will be a manual outlining the Mobility Index approach to measuring regional mobility and the uses to which such measurements may be put. The second will be a report outlining the results of the market research, which will address the key concerns of identifying "bellwether" segments of the mode choice markets and issues involved in designing and positioning transit services for these markets.

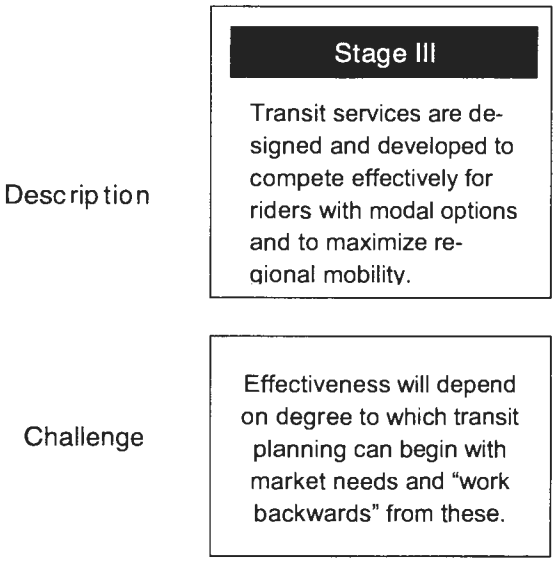


FIGURE 1

Stage III transit planning

Scratchitti Removal by Controlled Fire Polishing Transit-IDEA Project 28

Shane Y. Hong,[1] Columbia University, New York City, New York

IDEA Concept and Product

This project addressed the problem of vandalism on rail transit car windows. A type of graffiti vandalism that has emerged and prevails is the scratching or etching of polycarbonate and glass windows in subway cars, called "scratchitti." Unlike paint graffiti, the scratches cannot be removed or covered over, and they cause permanent damage.

New York City Transit supported this project from the time it was proposed, and has collaborated in providing samples of scratched glass subway windows to Columbia University to test and characterize.

To address the problem, this project used an innovative approach—controlled fire polishing, which incorporates a technique of localized softening and surface tension. Intensive heat is positioned near to the scratch marks on the glass panel. The heat melts a thin layer of glass into liquid, changing the glass's viscosity to a formable state. The glass is melted to a level close

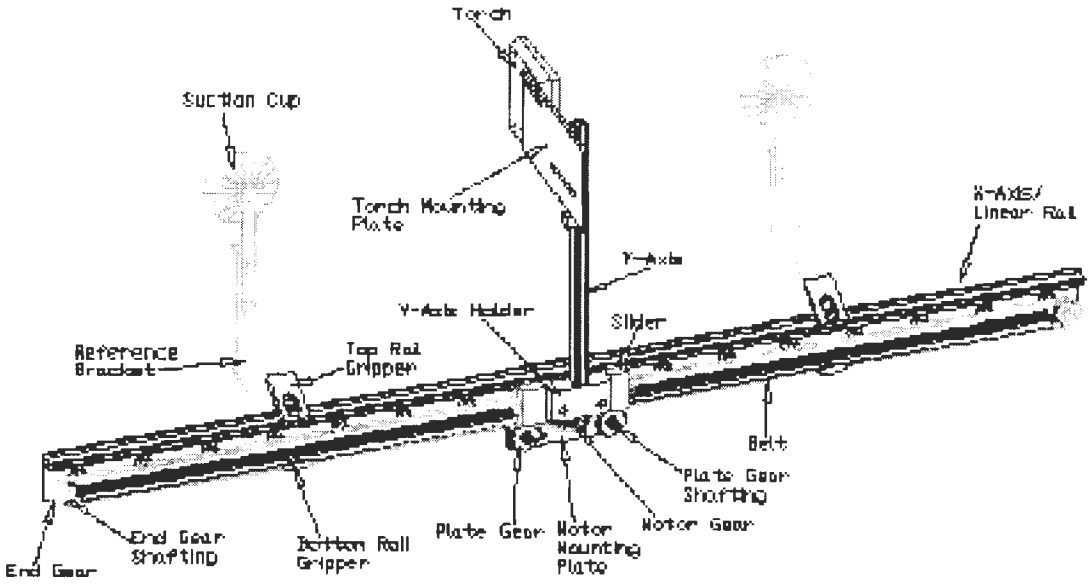


Figure 1

A rail attached to the window holds a motor driving an arm that would sweep a flame across the window. When the glass cools, it is scratch free.

[1] Columbia University, Department of Mechanical Engineering, 234 Mudd Bldg. W.120th Street, New York, NY 10027. Telephone: (212) 854-2957. E-mail: sh295@columbia.edu

to the depth of the scratch, and allowed to cool down naturally. During the cooling process, the surface tension of the melted glass evens out the scratching indent. After cooling and without grinding or polishing it, the glass is as even and smooth as it was originally. In this process, the glass remains solid and structurally sound during this operation to prevent any distortion of the glass panel. This process can flatten and smooth the surface and restore its optical transparency, in an environmentally safe manner. It can significantly reduce costs compared with replacing subway car windows.

Project Results

This Transit IDEA project has successfully demonstrated the feasibility of this innovative process in the laboratory. Investigators at Columbia University surveyed and characterized the scratchitti, investigated the glass or polycarbonate properties, designed the heat source, ran a heat transfer analysis and temperature computer simulation, and designed and built a motor driven prototype tool for removing scratchitti for initial test. The project has demonstrated the feasibility of the proposed system and collected the necessary data and parameters for controlling the process.

To facilitate the smooth operation, a uniform, linear, narrow, and high temperature flame as the heat source provided cost effective tool for fire polishing. This was achieved through our three iterations of nozzle development. The machine we designed and built, *Scratchitti Buster*, is a motor driven slider controlled by a computer to move the nozzle at a constant speed during the polishing process. Light and portable, this machine has suction cups to cling to the glass panel for positioning. It uses the glass surface as reference by a pair of brackets so that the nozzle will keep a constant distance while moving. The brackets are adjustable to fit the machine with different sizes of windows. Oxy-fuel used can be acetylene-oxygen for high speed fire polishing or propane-oxygen for convenient and easy operation.

Analytical and numerical heat transfer simulations of the flame and glass pane interaction yielded satisfactory operational parameters for the desirable steady-state temperature distribution. The control parameters included the flow rates of the fuel and oxygen and their mixing ratio, the flame travel speed and distance from glass surface. The desirable temperature distribution enabled the glass surface to re-flow and remove etches, while preventing glass distortion and cracking. Experimental testing of the fire polishing process was performed, and the feasibility of the process was demonstrated by glass samples that recovered from heavy scratches to a smooth, clear and transparent state. The ranges of optimum operating parameters for high polishing quality have been identified through a range of testing conditions.

Project Payoff Potential

This project addressed the pressing "scratchitti" vandalism issue faced by rail transit agencies operating subways. Unlike paint or ink graffiti, the glass etchings cause permanent damage. Scratchitti is prevalent on many subway car windows of New York City's subway lines. Because replacing the damaged window is so time consuming and costly, transit agencies have not been able to replace all of the damaged windows. Currently, New York City Transit (NYCT) replaces glass only when it becomes so scratched it cannot be seen through, or when it has obscenities or racial slurs etched into it. In 1997, NYCT replaced approximately 62,000 pieces of damaged subway window glass for a material and labor cost of $2.6 million. NYCT has estimated that, in order to run a scratch-free subway rail car fleet, they would have to spend $60 to $70 million per year in window replacement and labor costs.

Technology Transfer

A process demonstration was performed at Columbia University for representatives from New York City Transit, who have supported this project from its beginning and have provided assistance to the researchers. The results from this Transit IDEA project have successfully demonstrated the feasibility of this innovative process in the laboratory. The final report for this Transit IDEA project has been completed

The information from this project could serve as a basis for product development and design in commercialization stages. It could move into development of an operational instrument. Following this project, the investigators propose to develop a well-controlled operational instrument or tool for removing graffiti from subway car glass windows, based on the results of this project, if they can find financing. A final effort could deal with automating this graffiti removal system.

Figures 2 and 3:

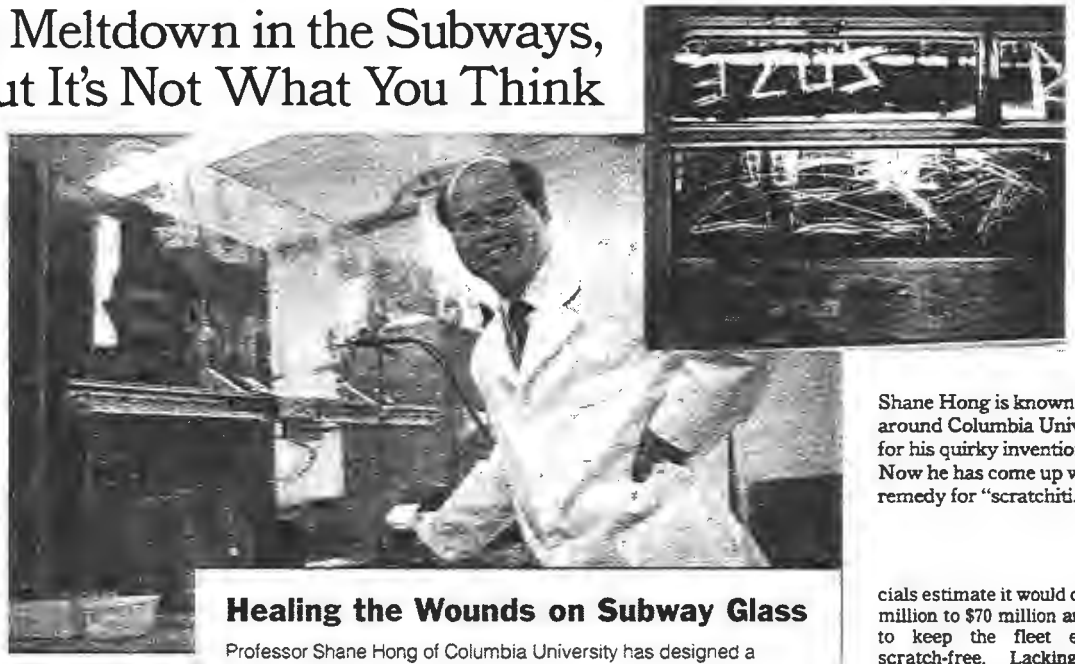
Scratchitti on the rail car windows in the New York City subway

THE NEW YORK TIMES, SUNDAY, APRIL 16, 2000

Neighborhood Report

NEW YORK UP CLOSE

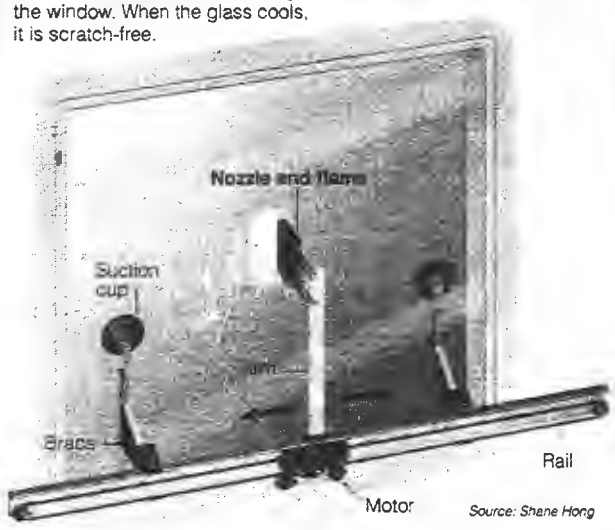
A Meltdown in the Subways, But It's Not What You Think



Shane Hong is known around Columbia University for his quirky inventions. Now he has come up with a remedy for "scratchiti."

Healing the Wounds on Subway Glass

Professor Shane Hong of Columbia University has designed a machine to erase scratches on subway windows. A rail attached to the window holds a motor driving an arm that sweeps a flame across the window. When the glass cools, it is scratch-free.



Source: Shane Hong

A decade ago, New York subway riders often had to squint through windows covered with painted graffiti to see a station. Today, the graffiti is gone, but many windows are still obscured, with deep, ugly scratches known as scratchiti.

But a Columbia University professor thinks he has found a way to attack the scratchiti scourge. The professor, Shane Hong, has designed what he calls a scratchiti-buster, a device that applies a flame to melt the window surface just enough so scratches dissolve and the glass regains its smoothness as it cools.

In the prototype, which is in production, the small propane flame would be controlled by a mechanized arm that would attach to a subway car window. An operator would not have to control the flame, but would move the arm, weighing less than 10 pounds, from one window to the next.

Mr. Hong, who teaches mechanical engineering and is known around campus for his quirky inventions, said he came up with the idea during a subway ride several years ago. Last year, he approached the Metropolitan Transportation Authority with his plan.

M.T.A. officials say they hope Mr. Hong's device will be a money-saving improvement over the only current remedy — replacing scarred windows. The agency spends $3 million a year on replacements, and officials estimate it would cost $60 million to $70 million annually to keep the fleet entirely scratch-free. Lacking that kind of money, or even a budget for research, they helped Mr. Hong get a $135,000 grant from the National Research Council to build a prototype.

A graduate student and several undergraduates are helping him design the motor and arm, taking into account the varying dimensions of subway car styles. The team is also figuring out how hot and how large the flame must be to lightly melt — but not shatter — the bulletproof glass.

Through the testing, Mr. Hong said, he remains focused on his goal: clear subway windows. "Some people think that professors in a place like Columbia should only study theory," he said with a grin, "but I think making people's lives better, even just a little, is the way to go."

Transit officials say that scratchiti first appeared in 1994, the year after a well-publicized crackdown eliminated most spray-painted graffiti from the subway's 5,792 subway cars.

"We've tried a lot of things, but nothing has worked so far," said the M.T.A.'s senior director of facilities, planning and car appearance, Carol Florio. "We're just hoping that Professor Hong is holding the golden key."

HANNAH FAIRFIELD

Fare Machine Tactile/Audio Instruction System Transit-IDEA Project 29

George A. Earnhart[1]
KRW Incorporated, Alexandria, Virginia

IDEA Concept and Product

The project addresses the difficulties that people with vision impairments encounter when they try to use most existing transit fare and ticket vending machines. The complex fare structures and operating mechanisms on many transit fare machines make it difficult to design and fabricate raised letter and Braille operating instructions that are independently usable by persons with vision impairments. Working collectively with the Tri-County Commuter Rail Authority (Tri-Rail) and the National Federation of the Blind (NFB), an audio device has been developed that can be programmed and installed on existing equipment to assist people with vision impairments to use these complex fare machines.

Project Results

The project consisted of three stages. Stage 1 documented the design and procurement process that was used to develop the tactile/visual instruction face plate for the existing Tri-Rail ticket vending machines. Extensive one-on-one testing with individuals who are blind or have vision impairments was undertaken to determine the usability of the existing tactile/visual instructions. During stage 2, the audio system consisting primarily of a microprocessor, power supply, speaker, and response button, was designed and tailored to fit within the existing ticket vending machine cabinet. Audio instructions were composed and programmed to provide a question and response dialogue to make the ticket vending machine independently usable by persons with vision impairments. Initial responses from individuals with a broad range of vision impairments who were involved with the testing were very positive and provided insights on how the original design could be further improved before conducting additional testing to "fine tune" the text for the audio instructions. Additional testing was conducted to "fine tune" the text for the audio instructions. Stage 3 consisted of a three month trial period where usability, reliability, maintainability and overall patron acceptance was monitored. The results of the stage 3 testing of the equipment provided valuable insights into factors that must be considered to ensure that the equipment will be reliable and continue to function effectively in a range of environments.

Product Payoff Potential

The project demonstrated conclusively that the fabrication and installation of an audio instruction system, supplemented by a tactile instruction system, can greatly improve the usability of fare vending equipment by individuals with vision impairments. The project provides a blue print for replication of these efforts. The project generates two products that will be useful to the transit industry. The first will be a User Guide documenting a step-by-step process

[1] KRW Incorporated, 1008 Pendleton Street, Alexandria, Virginia 22314, Telephone (703) 836-4691 E-mail: gearnhart@krwinc.com

illustrating how to design and procure usable tactile/visual instructional face plates for complex ticket vending machines. The second will be instructions on how to design, fabricate and install a supplemental audio system on existing ticket vending machines, and how to program concise, to-the-point audio instructions to effectively supplement the tactile/visual instructions. These products will show transit agencies how to make existing ticket vending machines independently usable by persons with vision impairments.

Product Transfer

The project was being undertaken with the full collaboration and participation of the Tri-County Commuter Rail Authority and the National Federation of the Blind. The research has had successful results, in that patron acceptance has been positive and Tri-Rail has taken steps even before the project was completed, to expand the use of the devices to all stations. The original project plan called for four audio instruction devices to be installed and tested at four Tri-Rail stations. Tri-Rail, with assistance from the National Federation of the Blind, purchased six more devices which were installed at four additional commuter rail stations during the stage three evaluation period. Positive feedback from the disability community prompted Tri-Rail to apply for funding from the Florida Department of Transportation for funds for the fabrication and installation of audio devices at all of Tri-Rail's 17 commuter rail stations. The funding has been approved and the machines are scheduled for installation in 2003 so that all of the commuter rail stations on the Tri-Rail system can be equipped to provide fully usable and accessible fare vending equipment to its patrons.

The project will produce a Final Report, which will document the three stages of this project and the results of the project. A User Manual will provide a step-by-step guide describing how to design, fabricate and install the necessary hardware and how to compose and program effective audio instructions to implement tactile and audio instructions that make existing fare vending equipment usable for persons with vision impairments.

Figure 1.

Face of the Tri-Rail fare vending machine showing the large green audio response button and speaker grille unit installed on the right side of the face plate, just below the credit card insert slot.

Figure 2.

Audio System hardware components, including, left to right, power surge protector,audio response button and speaker grille, microprocessor cabinet, speaker, and audio amplifier/controller.

Predictive Diagnostics for Bus Maintenance Transit IDEA Project 30

Gary S. O'Neill[1],
The Georgia Tech Research Institute

Idea Concept and Product

This project intends to develop an efficient method to provide maintenance and operations managers of metropolitan transit systems with routine bus performance information to enhance the scheduling of maintenance tasks, improve technician performance and reduce maintenance turn around time.

Transit buses are becoming more technologically advanced, affording the opportunity to use data created by onboard sensors and data buses to more completely understand the condition of the vehicle. The investigators intends to develop a method to capture bus performance information at a common node or data port, and use this information to improve maintenance diagnostics and troubleshooting. The information drawn from the bus will also permit tailoring of scheduled maintenance by providing accurate details on the condition of the vehicle's brakes, transmission, engine and auxiliary systems. The project will develop the prototype hardware and software to sample the bus's performance data and detect both out of limit conditions and adverse trends.

Planned Investigation

The project involves two stages of research, each divided into several tasks. The first stage began with a task that conducted a literature search for information on bus maintenance, maintenance intervals, and use of performance data to enhance maintenance tasks. The second task of this stage collected a large amount of historical data from MARTA records to categorize and classify the types of failures experienced by MARTA on its routes. The third and final task of the first stage conducted surveys of the maintenance publications and practices in use by MARTA, and a physical audit of the bus's electrical systems and data buses. The third task also included the use of prototype hardware to collect actual data from the data bus from an operating bus to determine the data available, sampling rates and typical data file size for an average route.

The second stage of the project will expand the prototype to include the ability to detect limits beyond normal operating limits and adverse trends. The second task of this stage will then determine the process and system architecture needed to pass that information to the maintenance management system in use by MARTA to aid in troubleshooting, scheduling and decision making, and finally to archive the information for continuing trend analysis. This stage will also test the common node data port for connectivity to data sensors and reader/download devices. It will also determine any standards used on the system.

[1]The Georgia Tech Research Institute, 925 Dalney Avenue, Atlanta, GA 30332-0834. Telephone: (404) 385-1581. E-mail: gary.oneill@gtri.gatech.edu

The work is being performed at one of three Metropolitan Atlanta Rapid Transit Authority (MARTA) maintenance facilities and at the Georgia Tech Research Institute, with the cooperation of MARTA staff.

Project Payoff

It appears that improved methods for maintenance can have several beneficial effects:

- Improved reliability of buses will increase rider confidence in the system.
- Improved reliability and material condition of the buses will sustain their material condition for a longer period of time.
- Improved reliability and availability can either make additional buses available for route assignment at the same capital cost; or reduce the number of buses required to support the routes.

Product Transfer

The project is being conducted with the cooperation and collaboration of MARTA. MARTA's engineering and maintenance staff are represented on the regional panel of experts, along with members of the Georgia Tech faculty. Successful development of the prototype will lead to additional refinements and implementation at MARTA. The same process and system architecture is potentially of value to other metropolitan transit agencies.

A Tool for Evaluating and Optimizing Bus Stop Location Decisions Transit IDEA Project 31

Peter G. Furth[1]
Northeastern University, Boston, MA

IDEA Concept and Product

This project will develop a tool for evaluating and optimizing bus stop locations. In evaluation mode, it will determine the impacts of a proposed change in bus stop locations, adding or removing a stop. In optimization mode, it will select the optimum stop locations from a set of candidate locations (generally, all the intersections along the route).

Users of this prototype software tool will be able to specify the relative importance of walk distance, riding time, and operating cost. The tool will be realistic in accounting for transfer demand and demand arising along side streets that is more like point demand than like continuous demand. It will account for roadway and traffic parameters that affect stopping delays (grade, cruise speed, traffic control). While this project addresses urban bus routes in general, special attention will be paid to bus rapid transit applications.

Changing stop spacing has three predictable, quantifiable impacts: it affects walk access distance, riding time for through riders, and operating cost. While the mathematical relationship of these impacts to stop spacing were published 20 years ago, this knowledge has not been translated into practice because the mathematics was expressed in terms of data inputs that were not generally available. The concept in this project is to develop a software tool that will calculate the impacts of changing stop spacing, using generally available data—on/off counts and geographic data such as road maps and assessor's maps.

There is a general awareness that part of what detracts from bus transit's attractiveness is the frequency of stops. Urban bus routes in the U.S. typically have stops about 200 meters apart (8 stops per mile), compared with 320 or 400 meters in Europe (5 or 4 stops per mile).

Project Results

A mathematical model was developed for creating the demand distribution along a route, from on-off counts and map data. This model results in a set of continuous and point demands that permit accurate estimation of access walk distance. Mathematical models were also developed for impact evaluation for a set of proposed stops and for optimization, using dynamic programming to find the set of stops with least overall societal cost. Recent refinements have included rider shed line formulas that differ depending on whether one is boarding or alighting, consistent with user travel time optimization; impact of grade and traffic control on delay impacts; and adjustments for evaluating and optimizing sections of a route instead of an entire route.

[1] *Peter G. Furth, Northeastern University, 360 Huntington Avenue, Room 420 SN, Boston, MA 02115.* Telephone: (617)373-2447. Email: p.furth@neu.edu.

The first generation models have been programmed in Visual Basic in a Microsoft Excel environment and tested on an MBTA bus route in Boston for a single period and direction. The results show that the method is practical—it yields practical results using readily available inputs. Just as importantly, they show that improved decisions about stop location can yield significant benefits. In the example, the optimization recommended 19 stops on a route that now has 37 stops, changing the average stop spacing from 202 meters to 404 meters. While reducing the number of stops increases average walk access time by 0.6 minutes, it decreases average passenger ride time by 1.8 minutes and decreases one-way running time by 4.2 minutes—enough to save a bus without changing service frequency. This also reduces operating costs.

Figure 1 shows a comparison between existing stop locations and those recommended in our first generation study for Route 39. It also compares existing and optimal stop density along the route. It emphasizes the fact that the tool being developed recommends not only the spacing between stops, but their actual locations as well.

Planned Investigation

Work is currently underway to develop a second generation evaluation and optimization tool using the C++ programming language. It will be faster than the first generation tool and will account for demand in both directions and over the entire day. The investigators also plan to develop GIS modules to automatically generate geographic inputs from assessor's maps.

The second generation tools will be applied to bus routes at three transit agencies: the Massachusetts Bay Transportation Authority, the Chicago Transit Authority, and the Capital District Transportation Authority (Albany, NY). Feedback during the application stage will be used to refine the tools to reflect available inputs and desired outputs.

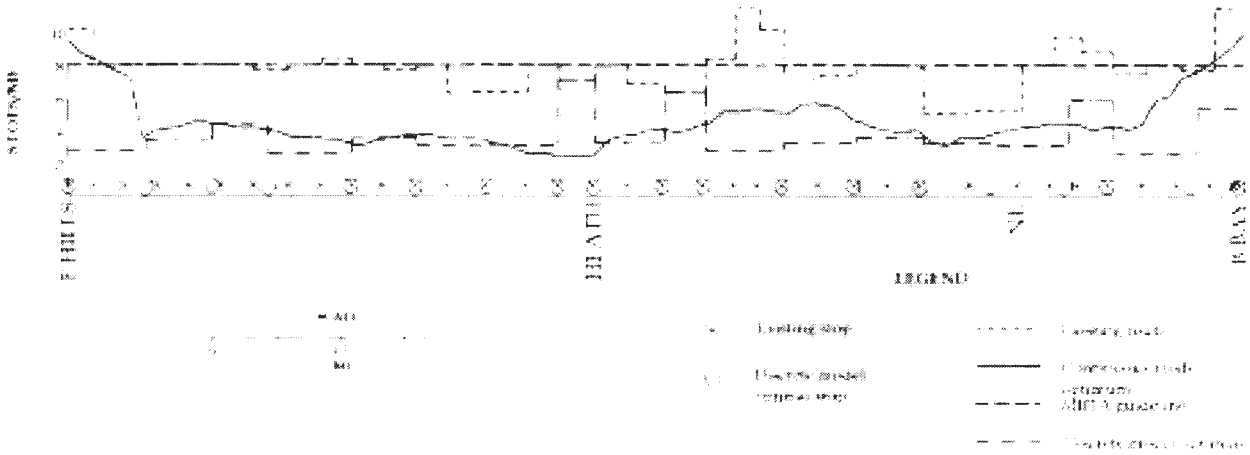


FIGURE 1:

Comparison of Existing and Optimal Stop Locations and Stop Densities, MBTA Route 39

Product Payoff Potential

The tool, when fully developed, could offer transit agencies an automated and accurate method of evaluating stop location decisions and rationalizing stop locations. It could be an important tool for Bus Rapid Transit route development, as well as for improving the efficiency of all urban bus routes. By providing the technical support needed to justify stop rationalization, it can lead to making transit faster, more it cost efficient and attracting greater ridership.

Product Transfer

Once the stop location evaluation and optimization tools have been demonstrated, they will be described in technical papers so that anybody who wants can program and apply them. The programs that have been developed are being upgraded to provide a user-friendly interface and are expected to be made available by a no-cost license to the transit industry.

Community Design of Light Rail Transit Oriented Development Transit-IDEA Project 33

Ted Grossardt[1] and Keiron Bailey,
University of Kentucky Transportation Research Center

Idea Concept And Product

This project is aimed at enhancing community involvement in the design of proposed light-rail transit-oriented development. A combination of an advanced decision technique and virtual reality computer visualization is to being tested. This process is designed to enhance public input and cooperation in the planning process, and to provide recommendations for transit agencies, planners, and architects. The process is being tested in Louisville, Kentucky, in cooperation with the local transit agrency, Transit Authority of River City (TARC).

Planned Investigation

The research team has devised a novel visual assessment methodology termed Casewise Visual Evaluation (CAVE). This process uses a fuzzy set-theory based modeling system. When there are many design parameters, the CAVE process translates community preference for complete designs into preference for each of the elements in that design. Preferred combinations of elements can then be determined. There are many design elements in each scenario, such as building type, open space type, height, density and so on.

Once the significant design elements are identified and a highly-preferred combination is determined using CAVE, virtual reality visualization was to be used to display design options and assess community reaction to them.

Project Results

A Structured Public Involvement protocol was used to gather community input. An iterative series of focus group meetings were organized in partnership with the local transit agency, TARC. Community feedback on the desired features of the development was gathered and the forthcoming CAVE process was explained.

An electronic scoring system was then used to assess preference for transit oriented developments (TODs) in other cities, using photographs. This allowed for fair, free and anonymous evaluation by the community, using on a 1 to 10 point preference scale.

[1] University of Kentucky, Transportation Research Center, 343 Waller Avenue, Suite 300, Lexington, KY 40504. Telephone: (859) 243-0971, ext. 24. E-mail: <thgros00@pop.uky.edu>

The community's response to these pictures was then used as input to CAVE. To code the photos in terms of inputs useful to professionals, architectural experts were consulted and a design vocabulary was defined. The architects described the TOD images in useful and familiar terms. Using these as input parameters, with public preference as the output, the modeling process was started and a knowledge base was built. This modeled how community preference responded to varying height, density, typology, and open space type.

The information was used by the design team to determine which combinations of elements were preferred by the residents. In collaboration with architectural experts, the output of the knowledge base provided guidance for design types. These designs were modeled as scenarios in the virtual reality visualization model.

The CAVE methodology has been demonstrated and provided clear design guidance for experts. Moreover, feedback from community participants has been positive. Comments included an expressed appreciation of the power devolved to the focus group in terms of determining which aspects are preferred. Residents have also commented on the importance of increasing participation at the focus group meetings so that more of their neighbors can participate in the design process. This desire of residents to involve others is a positive indicator.

Figure 1:

Screenshot showing an example of a virtual reality visualization

Project Payoff Potential

By providing an efficient, organized public involvement process using decision modeling and visualization, the public's preferences are translated into specific design recommendations quickly and easily. Because the public feels greater ownership of the design product, as evidenced by feedback comments, there is less resistance and more enthusiasm for participation and implementation. These qualitative improvements translate into fewer problems for transit agencies charged with such development. More effective public involvement also leads to a valuable improvement in the local culture of citizen participation for future projects.

Product Transfer

The lessons learned during the project are being included in a Final Report for this project and a User Guide. The research team has already submitted several papers on the results of this project to research journals, and was invited to present the research at the Community Design Symposium at Harvard University.

MECHANICAL PRECISION DOCKING FOR BUS RAPID TRANSIT
Transit IDEA Project 34

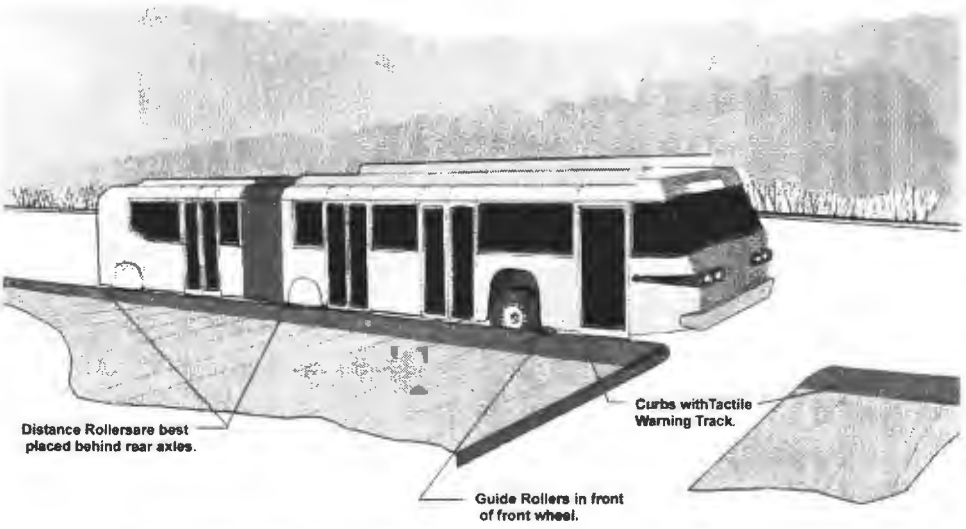
Dave Romeo[1]
Greater Cleveland Regional Transit Authority

Idea Concept

The Greater Cleveland Regional Transit Authority is investigating the development of mechanical precision bus docking systems for bus rapid transit. The objective is to provide transit agencies with an efficient, low cost method of obtaining the benefits of precision docking. Precision docking refers to a variety of systems designed to enable a vehicle to align itself in the same position at a station every time.

Mechanical precision docking has only been applied in a few cases in Europe to transit buses. This project intends to expand their application to the United States. We are accustomed to the operator manually maneuvering the vehicle into the station, doing his/her best to align the vehicle as closely as possible to the curb. Even with the best of operators, consistency is impossible to achieve. In the absence of a guidance system, the bus operator in attempting to closely align the vehicle with the curb, may cause costly tire and or vehicle damage.

There are two general types of precision docking systems: automated and mechanical. The automated systems consist of either magnetic markers/wires embedded in the roadway or an optical guidance system. The mechanical systems use guide wheels with mechanical arms that transmit steering information to a modified stub axle, with the driver continuing to control acceleration, braking and overall safety of the vehicle.



Side View of BRT at Station

[1] Greater Cleveland Regional Transit Authority, 1240 West 6th Street, Cleveland, OH 44113. Telephone: (216) 421-2806. E-mail: dromeo@gcrta.org

Planned Investigation

There are two planned stages to this project:

STAGE I

Task 1. Background Research: Learn from existing mechanical docking Systems with focus on two European systems.

Task 2. Vehicle Application: Identify vehicle dimensions as they apply to the overall width and length of the vehicle.

Task 3. Modification to Existing Technology: Modify existing guide wheel technology to meet local service requirements.

STAGE II

Task 4. Testing: Test and modify system to include failure mode and effect analysis (FMEA) of modified technologies on GCRTA vehicles.

Task 5. Final Report: Document results of testing of prototype components.

Task 6. Deployment Plan: Develop a plan for the implementation of guide wheel technology into current and future transit bus fleets.

Product Payoff Potential

Precision docking has the potential to improve transit service by increasing efficiency, safety and passenger access. These improvements could ultimately contribute to increased ridership and increased customer satisfaction. In addition, each approach alongside a platform curb can be made faster than by manually maneuvering safely into a conventional bus stop.

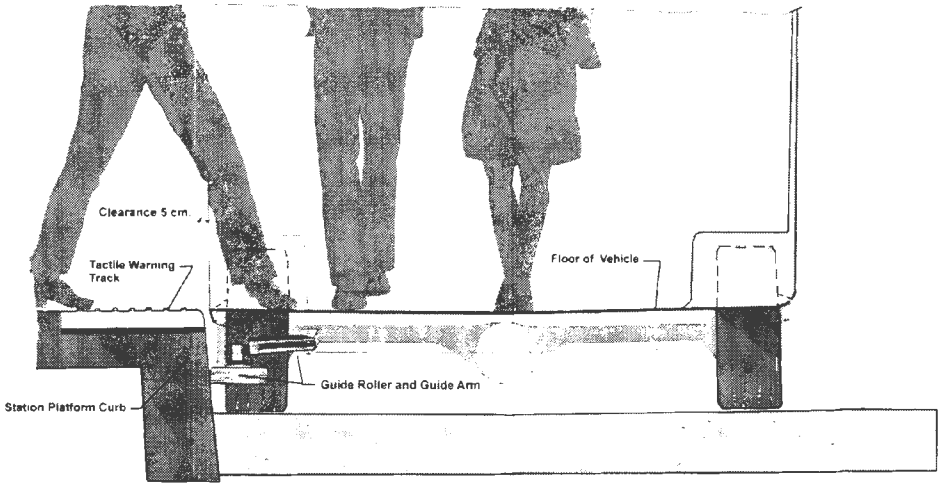


Figure 1
Section Through Vehicle - Single Curb Docking

With the increased interest in the United States in developing bus rapid transit, transit agencies are eagerly examining innovative ways to increase speed and convenience of transit buses. This not only can produce cost savings to the transit agency, but also is a significant improvement in service to the customer. Precision docking, by speeding the boarding and alighting process, reduces dwell times, and consequently would be a significant contributor to the evolution and effectiveness of bus rapid transit projects.

Product Transfer

Mechanical precision docking systems have been used in Europe and the focus is on adapting and transferring the technology to U.S. applications.

Currently in Europe, the vehicles required for mechanical guided bus operation can be obtained by converting already existing standard and/or articulated buses, and in some cases from existing bus fleets. For new vehicles, many European manufacturers can supply the guidance equipment as an option. For mechanical guidance, only a few components need to be fitted to the vehicle.

The final phase of this project includes partnering with U.S. manufacturers to identify potential sources for local production of the various components, and installation by U.S. bus manufacturers, and possible retrofit on present bus fleets.

Innovative Bio-terrorism Detection Technology for Transit Security Transit IDEA Project 35

Dennis S. Stapp[1], Science Applications International Corporation

This project will investigate the detection and identification of potential biological warfare agents in both a benign laboratory environment and a simulated subway situation, using an integrated approach involving proprietary technology. The objective of this project is to demonstrate that biological agents can be quickly detected and characterized in a transit environment. This would have the potential to improve security in subway systems and give an early warning to transit officials so that they could take appropriate actions quickly and effectively.

The investigators will integrate the technology into a demonstration system that will be used in an experiment to prove the principle of biological agent detection and characterization. The system will first be set up and tested in a benign laboratory environment to demonstrate the ability to detect and differentiate the samples.

The investigators will procure typical subway particulate matter from a New York subway station, that will be characteristic of what would be expected in an operational transit subway station environment. They will test the ability of the system to detect and distinguish biological contaminants in the presence of field particulate matter from subway stations. New York City Transit (NYCT) has expressed a particular interest in this project and has agreed to participate in the project by reviewing and commenting on the technical progress of the system. A final report will be prepared documenting the project activities, the test design and results.

[1] Science Applications International Corporation, 6725 Odyssey Drive, Huntsville, AL 35806. Telephone: (256) 971-6772. E-mail: Dennis.S.Stapp@saic.com

Cleaning Device for Electrified Third Rail Insulators Transit IDEA Project 36

Arun Vohra[1], Consulting Engineer

This project will develop and test a prototype device to clean electrified third rail insulators for rail rapid transit systems. The insulators are extremely difficult to clean because of the high voltage, and the third rail cover limits access to the insulators. Dirt and grime can short circuit the insulator and cause arcing, burning and smoke, which can cause the rail system to be shut down. This project includes development, proof of concept, and prototype testing of the cleaning device.

The investigator will work with the Maryland Transit Administration (MTA), in Baltimore, and the Washington Metropolitan Area Transit Authority (WMATA), to test this device on their facilities as part of this project. Other rail rapid transit systems, including the Chicago Transit Authority (CTA), Southeastern Pennsylvania Transit Authority (SEPTA), in Philadelphia, and New York City Transit (NYCT) have also indicated a need for a third rail insulator cleaning device, and plan to participate in the review of this project. The cleaning device has the potential to improve the safety and security of rail rapid transit systems and enhance public perception and confidence in the security of such systems.

The investigator will visit the MTA, WMATA, CTA, NYCT and SEPTA and determine the third rail insulator cleaning needs of these systems. He will identify cleaning system requirements: define cleaning performance needed, allowable wear to surface of insulator during cleaning, electrical safety, and health and safety needs. The investigator will work closely with the MTA, in Baltimore, and WMATA staff to evaluate the potential performance of three alternative cleaning systems.

The project will include construction of a prototype insulator-cleaning device that incorporates the best features of the three cleaning systems that were evaluated. The prototype device will be field tested at demonstration test sites at two transit agencies, MTA, in Baltimore, and the WMATA Metrorail rapid transit facilities. The investigator will document performance and cost effectiveness of the prototype insulator-cleaning device.

A final report will be prepared, documenting the results of this project. The final report will include information so that other rail rapid transit agencies can consider such a device for cleaning their third rail insulators.

[1] 7710 Bradley Boulevard, Bethesda, MD 20817. Telephone: (301) 365-4725. E-mail: trakleaner@masstransitmail.com