Automated On-Board Next Stop & Route Identification System Using GPS Technology

Conducted by

Rochester-Genesee Regional Transportation Authority

For

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Statement of the Problem

Transportation regulations implementing the Americans with Disabilities Act (ADA) (49 CFR, Part 37, Section 37.167) specify that fixed route transportation providers shall announce transfer points, major intersections and destination points, and intervals along a bus route sufficient to permit individuals with visual impairments or other disabilities to be oriented to their location. In addition, at those locations where more than one bus route serves the same stop, the transportation provider shall provide a means by which an individual with a visual impairment or other disability can identify the proper vehicle to enter or be identified to the vehicle operator as a person seeking to ride on a particular route.

Urban transit operators essentially have three (3) options available to them as responses to the ADA mandate.

a) The first option is to do nothing. Transit operators selecting this option incur no capital or operating costs associated with new equipment, nor do they place additional duties on bus operators with regards to making announcements. However, should the transit operator be cited by FTA for non-compliance, future funding could be

jeopardized. If a lawsuit is filed by a patron with a disability or on behalf of a patron by an advocacy group, significant legal fees and monetary penalties might be incurred by the transit operator.

b) Option two is to rely on manual announcements to be made. This option requires extensive planning and personal instruction to carry out. First, the major intersections, transfer points, and other significant locations must be identified for each route. Then, the listings of the points to be announced must be given to each operator on the route. Operators would be instructed to call out the required stops to the passengers on board. External announcements of the bus route could be made by the operator at those stops served by multiple routes. However, unless the bus is equipped with an external speaker the practicality of this approach is limited. The operator's voice may not be heard outside the bus due to traffic or crowd noises. The operator is also occupied with fare collection and other responsibilities as passengers board.

In some cities, visually impaired bus patrons carry numbered cards denoting bus routes. A card is held up by the patron to show which bus route he or she wishes to ride. The bus driver, upon seeing the card for his route, then gets the patron's attention and lets the patron board the bus. Success is dependent upon the bus driver seeing the card and

responding properly. The card method is quite unpopular among some visually impaired patrons who feel that it stigmatizes them. They also frequently express the opinion that bus drivers ignore the cards.

Manual announcements require ongoing supervision by transit managers to insure that the required announcements are being made properly. Still, the human factor will produce uneven reliability. Operators may forget to make announcements, make the wrong announcements or be distracted by other matters. Difficulties with traffic or with passengers could interfere with the bus driver's reliability in announcing stops.

c) The third option available to transit operators is to rely on an automated system to make announcements. Potentially, this option provides the most consistent solution. An automated system requires minimal operator intervention to provide the announcements at the appropriate time. The bus operator's attention can be directed toward the safe progress of the bus, fare collection and other duties.

Transit operators should note that if an automated system is used as the primary means of providing the required information to passengers, manual announcements must still be made if the automated system is not functioning.

The Rochester-Genesee Regional Transportation Authority (R-GRTA) and its operating subsidiary, Regional Transit Service, Inc.(RTS) teamed up with Luminator Company and local advocacy groups for the disability community to implement and test an automated on-board next stop and route identification system using Global Positioning technology. The system is intended to provide totally automated visual and audible announcements to waiting passengers identifying the route upon which the bus is operating.

History of Rochester's Approach to the Problem

Rochester's transit bus drivers had not been required to make announcements on buses until mandated by ADA. Typically, visually impaired persons were asked by the driver to sit near the front of the bus and the driver would personally notify the individual when the bus approached the requested destination.

Prior to the implementation of ADA, R-GRTA's advisory committee, the T.H.E. Committee, requested that a pilot program be instituted, whereby location announcements would be made on a specific bus route that was highly utilized by persons with disabilities. Despite extensive training of the drivers and enforcement efforts to ensure driver compliance, the pilot program was unsuccessful.

R-GRTA implemented system-wide manual announcements in September, 1994. This program, like the pilot program before it, has not been successful.

It is R-GRTA's experience that even the best-intentioned system of having drivers make internal announcements with respect to location and external route number/name, announcements offers only a marginal level of reliability, consistency and quality. While it could be argued that transit agencies should merely impose and enforce this ADA mandated requirement, R-GRTA's experience with this issue has proven that to depend on the driver to provide these services is not realistic. A bus driver's job has become increasingly demanding. Drivers must deal with higher levels of technology in transit equipment. Traffic congestion and potentially volatile passenger situations also concern the drivers. Announcing of stops is often perceived as a low priority at best. It is interesting to note that during RGRTA's pilot program, some bus operators simply "felt uncomfortable" making announcements - essentially they were shy about using the coach public address system.

R-GRTA has also had long-standing concerns for providing on-board information to transit customers with hearing impairments. The Rochester area has a significant number of hearing impaired residents; the National Technical Institute for the Deaf (NTID) is located here. Many individuals with hearing impairments use public transit.

Project Strategy

In September, 1993, R-GRTA submitted its proposal for the testing and evaluation of an automated next stop and route identification system to Project ACTION. The system was to be supplied by Luminator Company of Plano, Texas. Luminator is a major manufacturer of both bus and rail transit products, and is particularly known for destination signs. Luminator had developed its Integrated Next Stop Information System and was willing to test it in partnership with R-GRTA, if R-GRTA's proposal were to be accepted.

Project implementation also included R-GRTA's advisory committee. This committee is composed of human service agency and advocacy group representatives, as well as consumers who are concerned about transportation for persons with disabilities. At the beginning of the project, the advisory group was known as the T.H.E. Committee. It has since been renamed the Accessible Transportation Advisory Committee (ATAC).

The ATAC and R-GRTA together selected two urban transit routes on which to test the Next Stop Information System. Both routes, No. 5 South Ave./St. Paul and No. 11 Joseph Ave./South Clinton, serve a large number of transit customers with disabilities.

Several important destinations are located along Route 5. The Al Sigl Center houses several rehabilitation and training programs for children and adults with disabilities. Strong Memorial Hospital, the University of Rochester's Medical Center, is the area's largest hospital. Highland Hospital, another major medical facility, is also located on Route 5. The route serves the Rochester School for the Deaf, which provides educational and training services for children through the 12th grade.

Route 11 provides transit service to the Monroe Developmental Center, which provides training and care for a large number of clients with developmental disabilities. Also located along the route is the Association for the Blind and Visually Impaired (ABVI), which houses training and workshop programs; and ARC Works, a large sheltered workshop run by The ARC (Formerly The Association for Retarded Citizens). Both routes also serve several group homes and subsidized apartment complexes, which house residents with disabilities.

The Automated Voice Annunciator System

The Integrated Next Stop Information System designed by Luminator is fully integrated with the bus destination sign. It is capable of automatically announcing information to the passengers based on the bus location and progress along a predetermined route. Next Stop information is also displayed inside the vehicle. The system uses the destination sign code entered

by the driver at the start of the route to select and present the proper sequence of announcements.

Luminator's system design consists of several major components.

A. GPS Receiver. GPS (Global Positioning System) is a means of precisely determining the latitude, longitude, altitude and velocity of an object located on or above the earth's surface. The United States Department of Defense has placed twenty-four (24) satellites in orbit approximately 12,000 miles high. Normally, a point on or above the earth's surface is "visible" to four to six GPS satellites. When a receiver on the ground triangulates signals from three or more GPS satellites the location of the receiver can be accurately determined. Signals from GPS satellites are limited to "line-of-sight" and are unable to penetrate solid obstructions such as bridges, tunnels or buildings.

B. Odometer Sensor. An odometer sensor is used by the Luminator system to measure the progress of the bus along its route starting from a known location. At predetermined distances, appropriate bus stop announcements are made. The odometer sensor is intended to maintain precise system accuracy that could not be obtained if the system depended on GPS alone. Since GPS is military technology, the Department of Defense

varies the accuracy of GPS signals on a random basis in the interest of national security. Luminator chose to limit the dependency of its Next Stop Information System on GPS and improve its accuracy by combining GPS with an on-board odometer sensor.

C. Door Opening Sensor. The door opening sensor performs the function of a trigger to recalibrate the odometer at a known GPS location. The door must be opened for this recalibration to be performed. The bus operator normally recalibrates the odometer at the end point of the route at the same time he enters the destination sign code.

The door opening sensor also functions as a trigger to cancel the "Stop Requested" visual display on board the bus and to initiate the exterior bus route announcement once the bus has stopped and the door is opened. The bus route announcement corresponds to the text of the destination sign and is made via the external speaker to passengers waiting at the bus stop.

D. Internal Speakers. The internal audio announcements are heard over speakers placed at various points along the interior ceiling. By using multiple speakers, the announcement volume is uniform throughout the bus and is understandable over the ambient noise from the

engine, traffic, passengers or other sources.

E. Internal Display. An LCD Display is prominently located inside the bus, above the front windshield. This dot-matrix display provides the text of all next stop announcements at the same time the audio announcements are heard. The unit also displays the words "Stop Requested" whenever a passenger uses the chime signal to alert the driver to make the next stop. Text appears as black letters on a yellow background.

F. External Speaker. The external speaker is located underneath the bus floor, just to the rear of the front door. This speaker announces the route number and name to passengers waiting to board. The announcement is timed to occur immediately after the front door opens.

G. Operator Display Keypad (ODK). Located above and to the left of the driver, the Operator's Display Keypad is used to enter the destination sign code. The driver typically enters the code at the beginning of the route. When the proper code is entered, the system recalibrates the odometer sensor and verifies the bus location on the route. It is then ready to begin the proper announcement sequence.

System Configuration and Programming

Once R-GRTA had been notified by Project ACTION that its proposal had been accepted for funding, project implementation activities were begun. News of the project's acceptance was communicated to the ATAC.

On April 21, 1994, R-GRTA's Director of Evaluation and Development, and representatives from Luminator met with the ATAC. A video explaining the technology behind the Luminator voice annunciator was shown to the group and the Luminator representatives responded to questions.

R-GRTA staff developed the list of bus stops to be announced. All major intersections, transfer points and points of interest on Route Nos. 5 and 11 were included. Bus stop announcement lists were presented in a preliminary form to the ATAC members for their review. ATAC suggested minor modifications which were incorporated into the final list of bus stop announcements. The list was then sent to Luminator's Manager of Electronic Engineering. R-GRTA also provided Luminator with a Rochester city street map showing the two bus routes and all stop locations. A total of ninety-two stop announcements were to be made as shown in Table 1:

TABLE 1
NUMBER & FREQUENCY OF BUS STOP ANNOUNCEMENTS

Route No. 5	Number of Announcements	Mileage	Average Distance Between Announcements
Northbound	25	17.9	0.72 miles
Southbound	27	17.9	0.66 miles
Route No. 11			
Northbound	19	8.4	0.44 miles
Southbound	21	8.4	0.40 miles

Once it was determined which stop locations would be announced, Luminator proceeded with the process of voice recording. The Luminator Integrated Next Stop Information System utilizes digitized recordings of the human voice to make audio announcements. In developing its product, Luminator staff recognized that voice quality would be one of the most critical aspects of system operation. A properly timed announcement would be of no value if it was not easy to hear and understand. To provide optimum voice quality, Luminator's system was designed with quality audio components and the ability to adjust to varying levels of ambient noise. This latter function is done by using microphones inside and outside the bus to pick up ambient noise. The volume of internal and external announcements are adjusted accordingly.

Selection of the proper voice was another important compo-

nent. Luminator recommends that the announcer have a "commentator-style" voice. An announcer with on-the-air commentating or news-reading experience is preferred. An "advertising-style" voice may be too energetic and annoy regular patrons and bus drivers. Luminator also recommends a male voice be used. The lower frequency is more easily understood by those with high-frequency hearing loss and is more easily heard in conditions of high ambient noise.

Luminator employed a Dallas-area radio announcer to record R-GRTA's bus stop announcements. The resulting voice quality was very satisfactory. Voice recordings were made in segments to avoid duplication of words and phrases, thereby keeping computer memory requirements to a minimum. For example, the phrase "now approaching", which precedes nearly every announcement, was only recorded once. The digitized voice segments are stored on a Flash Memory Card, manufactured by Intel Corporation. The Flash Memory Card is about the size of a credit card and about twice as thick.

One card is installed in the System Control Unit on each bus and operates both the Next Stop Information System and the electronic destination signs. The card functions in the same way as a disk in a computer, holding all the necessary files and programs in memory. A 4-Megabyte card was required for R-GRTA's data. In addition to the digital voice data files, each card contains the complete system operating program, including the

instructions for linking phrases together into coherent announcements. It also contains all destination sign messages for every route in the RTS system.

R-GRTA's data requires 2.8 Megabytes out of the 4 Megabytes available on each Flash Memory Card. Voice files account for 2.5 Megabytes, or about 90%.

System Installation & Training

Luminator sent two technical staff members to Rochester on July 10, 1994 for the installation of the Voice Annunciator equipment. They were later joined by a service technician from Luminator's Northeast Service Center, located in New York City. Installation began on Monday, July 11 and work on the ten buses was completed by August 1. Software adaptations and testing were completed by August 10.

The installation process took longer than anticipated. All ten buses were 1993 Orion V model 40 foot transit buses, manufactured by Ontario Bus Industries/Bus Industries of America. The Next Stop Information System had not previously been installed on this bus model. Luminator's technical personnel found some differences in the Orion V as compared to other types of buses which presented problems in the installation. Among these were the routing of wiring and the placement of electrical connections. In addition, it was necessary to modify the door

opening sensor to obtain proper registration of door opening and closing.

Luminator subcontracted with R.J. Turner Company of Bristol, Vermont to map the GPS coordinates along the two bus routes. This task began on July 18 and was completed on July 22. Initially, each route was driven in an automobile. A special antenna, capable of receiving signals from GPS satellites, was magnetically attached to the automobile roof. The car was stopped at selected points along the routes and signals from several GPS satellites were recorded. This information was later interpolated to provide the precise latitude and longitude for these points. Route maps showing the GPS points are included in Appendix C and Appendix D.

Several locations along each route were selected as "recalibration points." These locations, with known coordinates derived from the GPS data, would be points where the driver could reset the system if necessary. If the bus were to leave the regular route for a detour or if a replacement bus were to enter service in the middle of the route, it would be necessary to reset the odometer sensor to start at the designated recalibration point. From there, announcements would be made at the proper distances to the end of the route. Recalibration points were designated by a highly visible orange stripe placed horizontally immediately above or below the bus stop sign. Thus, they could be readily identified by the bus drivers. Fifteen

recalibration points were set up on Route 11 and twenty were set up on Route 5. All route end points are recalibration points since the driver resets the destination sign at these locations.

To recalibrate the odometer, the bus driver stops the bus with the front door aligned with the bus stop sign. The driver opens and closes the front door. The Operator's Keyboard Display (ODK) displays the "Current Location" within 5 to 10 seconds. If the "Current Location" displayed is not correct, the driver uses the "Next" or "Previous" Keys on the ODK to scroll through the list of locations until the correct one is reached. The bus may then continue on its route and bus stop announcements will be made at the proper time.

Once the GPS coordinates were determined, this information was loaded into the Next Stop Information software program. Finally, each bus was calibrated to insure that odometer readings would trigger the bus stop announcements at the proper time. After calibration, each bus was tested to verify that the Next Stop Information System was working properly.

During the entire installation process, R-GRTA mechanics were working alongside Luminator's team. This satisfied the requirements of the mechanics' Union and also provided training in the installation, troubleshooting and servicing of the equipment. The three mechanics involved have the servicing of

electronic destination signs among their normal duties. Shortly after all the voice annunciator equipment was installed, Luminator provided a one-day training session for R-GRTA mechanics and their supervisors.

In preparation for the Next Stop Information System's introduction to scheduled transit service, R-GRTA's Training Specialist ensured that Luminator's printed instructional materials were distributed to the bus operators. The Training Specialist had become familiar with the operation of the Next Stop Information System while Luminator staff was completing the testing of the ten buses. She also led instructional sessions for Road Supervision and Radio Dispatch personnel to ensure their familiarity with the equipment's operation.

In January, 1995, Luminator shipped a Voice Development System to R-GRTA. The Voice Development System consists of an IBM Personal Computer, Luminator's Voice Development and Destination Sign Message software, and the equipment required to digitally record new bus stop announcements and other messages.

The equipment was set up by a Luminator technical service representative on January 19, 1995. The following week, two members of Luminator's electrical engineering staff came to Rochester to train R-GRTA's Scheduling Staff, which is responsible for maintaining the destination sign database. Two days were spent on training although no recordings or major

changes to the Next Stop Information System were made. Luminator provided written documentation for future programming needs.

System Operation

The ten buses were scheduled to begin regular service on Route 5 and Route 11 on Labor Day, September 5. Being a holiday, service levels were reduced. Normal service resumed the following day. Since only ten buses could be equipped with automated Next Stop Information Systems, it was not possible to cover every trip with one of these buses. R-GRTA's Maintenance Department was instructed to assign the ten buses to those blocks spending the longest time on these routes. As such, only a minimum number of trips operated without automated next stop information. Table 2 below shows the bus requirements for the two routes:

TABLE 2
NUMBER OF BUSES REQUIRED FOR ROUTES 5 & 11

	Weekday AM Peak	Weekday Base	Weekday PM Peak	Saturday	Sunday & Holiday
Route 5	7	5	8	3	3
Route 11	5	2	4	2	2
Total Buses Required	12	7	12	5	5

It is important to note that even though ten buses are equipped with the Next Stop Information System, not all ten may be available for service on a given day. Buses may be unavailable for use due to preventive maintenance, schedule

inspection, mechanical problems or repairs.

Ideally, fourteen buses are needed to provide full service on both routes with a spare factor. Since only ten buses could be equipped with the Next Stop Information System, R-GRTA could not guarantee fully automated announcements on all trips on Routes 5 and 11.

Tuesday, September 6, and Wednesday, September 7, 1994, were the first two days that all ten buses were in service on their assigned routes. R-GRTA staff made special efforts to assist drivers in using the Next Stop Information System.

The progress of the Voice Annunciator demonstration project continued to be monitored by the advisory committee, ATAC. R-GRTA staff members attended several ATAC meetings to provide updates and to receive feedback on the project.

On Thursday, November 17, 1994, ATAC members and other interested parties were given the opportunity to ride a bus equipped with the Next Stop Information System. Eighteen Committee members and guests took the demonstration ride.

Surveys

During October and November, R-GRTA staff developed questionnaires for bus passengers and operators on the Next Stop

Information System.

A. General Passenger Surveys. Passenger surveys were distributed in early November. A special effort was made to provide questionnaires to the ATAC members and the agencies and advocacy groups represented on the committee. Over 150 questionnaires were circulated, with 104 responses.

Initial passenger responses were very favorable to the Next Stop Information System. Seventy-nine percent of the responses stated that the system was helpful. Seventy-two percent indicated that the number of announcements was appropriate. Nineteen percent felt that there were too many announcements.

Passengers were most pleased with the quality and volume of the internal audio announcements. Eighty-four percent indicated that the internal audio announcements were loud enough to hear clearly and 80% stated that the voice quality was such that the internal announcements were <u>always</u> easy to understand. An additional 16% stated that they were <u>usually</u> easy to understand.

The external audio announcements were not quite as well received by the passengers surveyed. Seventy-two

percent stated that the external announcements were loud enough to hear. Seventy-three percent stated that the external announcements were always easy to understand, while an additional 11% said they were usually easy to understand.

B. ABVI Surveys. A Braille version of the questionnaire was distributed to clients of the Association for the Blind and Visually Impaired (ABVI). The responses to these questionnaires were then transcribed onto the text version for tabulation. Nineteen surveys were completed by ABVI associates.

ABVI respondents were also very positive about the Next Stop Information System. Seventy-four percent stated that the automated announcements were helpful. Sixty-three percent felt that the announcements were made often enough. However, 26% expressed the opinion that there should be more frequent announcements. ABVI associates were very positive about the volume (84% approval) and voice quality of the audio announcements (89% approval).

The external announcements were not regarded as positively as the internal announcements. Sixty-eight percent of those responding felt that the external announcements were either not loud enough or were only

loud enough to hear if there was no other noise. By comparison, only 42% found the voice quality of the external announcements difficult to understand.

In early March, 1995, the ABVI representative on R-GRTA's advisory committee requested that ABVI associates be surveyed a second time because many of them had expressed disenchantment with the operation of the Next Stop Information System. The main reason for this change in attitude seemed to be the perception that the system could not be depended on to make announcements accurately.

To investigate this perception, a second survey of ABVI associates was conducted in mid-March. Only eleven associates took the opportunity to respond to the second survey.

Of those responding, 82% stated that they found the announcements helpful; an increase of 8% from the previous survey. Seventy-three percent indicated that the announcements were made often enough. This was up from 63% in the first survey. Only one respondent in the second survey expressed the opinion that announcements should be made more frequently. Approval of the volume of the internal announcements dropped from 84% to 64%, but 92% of respondents felt that the voice

quality of the internal announcements made them easy to understand.

The external announcements were still reported as being difficult to hear by 72% of those completing the survey. Forty-five percent stated that the voice quality made the external announcements difficult to understand. These numbers are comparable to those reported in the November survey.

It was concluded that the perception that ABVI associates were becoming increasingly disenchanted with the Next Stop Information System was not supported by the survey data.

C. Bus Operator Surveys. Over 50 bus operator surveys were distributed. These surveys were given to bus drivers who are assigned to drive Route 5 or Route 11 from one to five days per week. Only seven surveys were returned. After several weeks, a follow-up generated eleven more responses.

Nearly all operators who responded (94%) prefer automated announce-ments to making announcements themselves. On the other hand, operators were not overly enthusiastic about the Next Stop Information System's performance. Twenty-eight percent felt that

the system was reliable most of the time, while 39% felt that it was only reliable from 50% to 80% of the time.

Tabulated results for both the Passenger and Bus Operator Surveys are included in Appendix F.

System Maintenance

One positive aspect of Luminator's Next Stop Information System was how infrequently it experienced mechanical problems. The ten buses equipped with the system spent minimal time in the shop for system-related repairs. Maintenance records are provided in Appendix G.

Table 3 shows the number of buses, events and hours logged for maintenance to the Next Stop Information System on the ten buses:

TABLE 3
NEXT STOP SYSTEM MAINTENANCE

	Number of Buses to Shop	Number of Events	Diagnostic and Repair Hours
Sept. - Nov.	5	9	4
Dec. - Feb.	6	10	2.25

It should be noted that "Events" include occasions where the bus was brought into the shop but no problem was found.

Based upon the data provided by the Maintenance Department, the Luminator Next Stop Information System does not require excessive maintenance by shop forces. The system appears to require a level of maintenance comparable to Luminator's standard destination signs.

Operational Difficulties

A. Too Few Buses. Evaluation of the Next Stop Information System was hampered by the fact that R-GRTA was only able to equip ten buses with the system. As previously stated, the ideal number of buses needed to cover both Route 5 and Route 11 is fourteen. This number would provide a spare factor for buses out of service due to maintenance or repairs.

   On a normal weekday, passengers expecting to ride a bus with the Next Stop Information System might find a bus without the system in its place. Some patrons may have been misinformed that all buses on Route 5 and Route 11 would be equipped with the system. Many times, when passengers encountered a bus not equipped with the system, they concluded that the equipment was not working or suspected that the bus driver had turned it off.

B. **Irregular Bus Assignment.** It was also found that the buses equipped with the Next Stop Information System were being assigned to routes other than Routes 5 and 11. Despite the vigilant efforts of R-GRTA's Operations management, this problem was not consistently corrected.

System Problems

A. **Glare from Interior-Sign Display.** A prominent feature of the Next Stop Information System is the large LCD sign, mounted inside the bus, directly above the windshield. This sign displays the text of the recorded announcement as each bus stop announcement is broadcast over the speakers. Almost immediately after the installation process ended, R-GRTA began receiving complaints from bus operators that the LCD display's yellow background was excessively bright. The glare from the display reflected on the windshield and interfered with the drivers' ability to operate the bus at night.

R-GRTA notified Luminator about this potentially hazardous situation on August 18, 1994. After several weeks, the problem remained unresolved. R-GRTA staff contacted Luminator directly at various times during

late September and October only to be told that a solution would be forthcoming shortly. In mid-November Luminator provided R-GRTA with translucent tubes, cut to fit over the display's light source and reduce the amount of light emitted. R-GRTA maintenance personnel installed the tubes.

Operator comments indicated that while the glare problem was diminished, it was still present to the extent that it was a potential safety hazard. R-GRTA found it necessary to install a second translucent tube over the first to reduce glare to a comfortable level. The lower light output from the display did not appear to impair passengers' ability to read the display. No complaints were received from drivers or passengers after the second set of translucent tubes was installed.

Each round of translucent tube installations required 7.5 hours to perform (.75 hours per bus). Since this work was not considered routine maintenance the hours required were not included with the data on system maintenance.

B. Volume Control for Exterior Speaker. The first week that the ten buses equipped with the Next Stop Information System were in regular service on Routes 5

and 11, two complaints were received by the R-GRTA Customer Service Department. Both complaints came from residents along Route 5 who stated that the external announcements were excessively loud and could be heard inside their homes. From the information provided, R-GRTA staff identified a single bus as the culprit. This bus was brought to the shop for adjustment. No further complaints of this nature were reported.

Adjusting the external speaker's volume control required that the bus be removed from service and brought into the garage. The volume control is located in the System Control Unit, which is mounted on the interior wall of the bus, just behind the driver's barrier. The aisle-facing seat immediately behind the driver's compartment must be removed in order to access the System Control Unit.

The placement of the volume control in an inaccessible location prevents drivers or passengers from tampering with it. However, it would be preferable to have the control accessible enough so that adjustments could quickly be made by a mechanic or a transit supervisor while the bus remains in service.

C. Need for Bus Operator Intervention. After the Next Stop Information System had been in operation for

several months, concerns were raised regarding the amount of operator intervention required to maintain system accuracy. Construction detours, which lengthened the routes, caused announcements to be made at the wrong locations. Once the bus returned to the regular route, the driver would reset the odometer sensor at one of the designated recalibration points by following the instructions provided by Luminator. However, a few operators complained that the recalibration progress was not working properly.

After discussions with Luminator in early February 1995, R-GRTA was provided with a revised and more dependable set of calibration instructions. The revised procedure improved the accuracy of bus stop announcements, but the need for driver intervention has not been eliminated.

D. System Clock. As originally installed by Luminator, the Next Stop Information System's LCD display showed the current time when it was not displaying the text of specific audio announcements. Bus drivers complained that the time display caused problems with some passengers. The drivers reported that passengers would inquire why the time on the display did not agree with their watch or accuse the driver of running ahead of or behind schedule. At the request of R-GRTA, Luminator

removed the time display from the program.

E. Programming Additional Routes. One of the Authority's goals in evaluating the Next Bus Stop Information System was to determine the feasibility and anticipated cost of programming all stop announcements for the R-GRTA bus system into the ten buses. To date, R-GRTA staff has been unable to accomplish this.

After the completion of two days of training from Luminator, R-GRTA Scheduling staff attempted to program data for one additional route into the Next Stop Information System. The data was to include all necessary GPS and odometer readings to provide bus stop announcements at designated locations.

Route 2 was selected as the additional route to be tested. This route serves both downtown Rochester and the Greater Rochester International Airport, as well as several residential neighborhoods and commercial districts.

Coordinates and mileage data were obtained from TIGER (Topologically Integrated Geographic Encoding and Referencing) files. These files were supplied by the United States Census Bureau, enhanced by a local vendor and displayed through the ATLAS*GIS program, a product

of Strategic Mapping, Inc. R-GRTA staff attempted to enter the coordinates and mileage data into the Next Stop Information program, but were unsuccessful. The version of Luminator's program supplied to R-GRTA is not user-friendly and will require more time to master.

All of R-GRTA's 219 urban transit buses are equipped with Luminator destination signs. These signs are of four different types; Max, Super Max, Super Matrix Max and the Next Stop Information System. The Next Stop Information System destination signs require a different procedure to make changes than other Luminator destination signs.

F. Single External Announcement. The external announcement feature of the Next Stop Information System informs passengers waiting at the stop about the route and destination of the bus. When the front door opens, the announcement is made through the external speaker, located just behind the front door. The announcement duplicates the text of the bus destination sign; for example "Route 5 Northbound - St. Paul to Summerville."

The primary benefit of the external announcement is that it provides information to patrons who cannot read the destination sign. This is especially important at

bus stops served by multiple routes.

R-GRTA's night and weekend bus service operates on a "pulse scheduling" basis, where a large number of buses converge downtown at the same time to allow passengers to transfer from one route to another. After waiting several minutes, the buses depart for their separate destinations and return downtown an hour or so later.

When a large group of buses are at a stop together, patrons may not hear the exterior announcement if they are more than a bus length away. After the Next Stop Information System was placed in service, R-GRTA began receiving requests from visually impaired riders, asking if the external announcement could be made more than once. R-GRTA was informed by Luminator that having the external announcement made more than once was not possible under the current software set-up.

Having the external announcement repeat at a pre-set interval would allow patrons walking up and down a line of buses the opportunity to hear the information. This modification would enhance the future generations of the product.

G. External Announcement Made Whenever Front Door Opens.

The external announcement feature could also be

improved by a driver-activated override. Presently, the announcement is activated whenever the front door opens. The announcement does not need to be made to passengers boarding at stops served by a single route. Also, it would be desirable to cancel the announcement when passengers are alighting and no one is boarding. This would be especially beneficial in residential areas. The announcement presents a potential annoyance to the general population, especially at night.

Summary

The concept of an automated system providing audio and visual information about bus stops and transfer points is an excellent way of making public transit easier to use for patrons with visual and auditory impairments. This type of system is also beneficial to patrons who are unfamiliar with the city or with a particular route. A dependable automated system is more consistent than manual announcements.

On the other hand, an automated system is not trouble-free. R-GRTA staff was not able to monitor system performance as closely as necessary. Bus drivers were not a reliable source of information about system problems. Despite the efforts of staff, only about one-third of the Bus Operator Survey forms were returned. Those that came back contained little information about problems that were being experienced. It was not until the

final month of the project that R-GRTA staff determined that there was excessive driver intervention needed to keep the system on track. At that point, discussions with Luminator brought to light a revised set of Operator Instructions. Implementation of these instructions has reduced, but not eliminated the need for driver intervention.

As this project progressed, it became apparent to R-GRTA that Luminator was moving ahead with its development of the Next Stop Information System. The next generation of this product, presently being installed on a sixty bus fleet in West Palm Beach, Florida, contains several improvements.

Regrettably, R-GRTA's version of the Next Stop Information System appears to lack the upgradeability that would be desirable in an investment of this magnitude. Transit operators considering the purchase of automated announcement systems should be certain that their choice allows for upgrades over at least a two-year period, since the technology is changing and progressing rapidly.

APPENDICES