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16. Abstract

The Louisiana Department of Transportation and Development (DOTD), like many state highway agencies in the United States, lacks a comprehensive system for inventorying and maintaining records of traffic signs. To address this problem, state highway departments around the country have, or are beginning to develop, computer-based sign inventory systems that allow highway department personnel to count, locate, and monitor the maintenance and condition of their sign inventories. This project involved the initial step in creating a statewide traffic sign inventory system in Louisiana.

As part of this project, an inventory of 3,646 traffic signs was compiled on 147.4 miles of state highways in Ascension Parish using a state-of-the-practice computer-based GIS mapping and GPS referencing database. In addition to providing the Ascension Parish sign inventory in digital form, it is expected that the results of this project will also help the DOTD to evaluate the merits of the equipment, technologies, and methods used in the project and serve as the basis for estimating time, labor, and equipment requirements for future sign inventory programs.

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Louisiana Traffic Sign Inventory and Management System

by

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ABSTRACT

The Louisiana Department of Transportation and Development (DOTD), like many state highway agencies in the United States, lacks a comprehensive system for inventorying and maintaining records of traffic signs. To address this problem, state highway departments around the country have, or are beginning to develop, computer-based sign inventory systems that allow highway department personnel to count, locate, and monitor the maintenance and condition of their sign inventories. These new systems can be used by construction, maintenance, and engineering personnel to monitor sign condition, track performance changes over time, determine locations where additional signs may be needed, monitor field maintenance and replacement programs, and locate unwarranted or “exception” signs. The latest of these systems also integrate geographic information systems (GIS) to form more robust asset management systems that can include statistics on a variety of highway features such as signs, guardrails, traffic signals, pavements, bridges, survey markers, etc.

This project involved the initial step in creating a statewide traffic sign inventory system in Louisiana. As part of this project, a manual traffic sign inventory was conducted for state highways in Ascension Parish. This inventory was then entered into a state-of-the-practice computer-based GIS mapping and GPS referencing traffic sign database. In addition to providing the Ascension Parish sign inventory in digital form, it is expected that the results of this project will also help the DOTD to evaluate the merits of the equipment, technologies, and methods used in the project and serve as the basis for estimating time, labor, and equipment requirements for future sign inventory programs.

The project was initiated in April 2001 and was conducted over a period of about 20 months. The survey involved the field measurement, data entry, and storage of descriptive traffic sign information for 3,646 signs covering 147.4 miles of roadway. The project also included a brief review of the traffic sign inventory practices of other states. As part of this project, educational sessions were also conducted for DOTD personnel currently using (or planning to use) the same or similar sign database systems. The sessions covered the methods used for collection of data in this project and provided additional training in the use of the data collection apparatus and inventory software. The educational sessions also highlighted the techniques that were found to be most productive, recommendations for improving and enhancing the system, and the labor and cost requirements that might be expected if/when the DOTD expands this pilot project into a statewide program.

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IMPLEMENTATION STATEMENT

This project was undertaken primarily for field data collection and, to a lesser extent, the evaluation of an existing commercially available traffic sign database software package. As such, the focus of the project was nearly exclusively on data acquisition as well as the storage and organization of this information in the database rather than on any analytical assessments of the results. Thus, the implementation of the results of this project may be somewhat different from other, more experimentally oriented research projects.

It is expected that the database developed in this project will assist DOTD personnel in several ways. First, it will give the DOTD one of its first detailed traffic sign field inventories. In addition to this permanent record of traffic signs in Ascension Parish, the database can be used as the basis for a more comprehensive state-wide computer-based sign inventory system that will allow DOTD personnel to monitor sign condition, track sign performance changes over time, determine locations where additional signs may be needed, monitor field maintenance and replacement programs, and locate unwarranted or "exception" signs. In the longer term, such a system could be integrated with geographic information systems (GIS) to form more robust comprehensive asset management systems that could include statistics on a variety of highway features such as signs, guardrails, traffic signals, pavements, bridges, survey markers, etc.

This project also involved purchasing and using new field-testing equipment. The experiences documented herein can help the DOTD determine practical and effective methods for future inventories as well as serve as the basis for estimating the time, labor, and equipment requirements for other sign inventory programs. This information may be used as part of future educational sessions to report on the methods of sign data collection and for collection apparatus and inventory software training. These sessions could highlight the techniques that were found to be most productive, give recommendations for improving and enhancing existing systems, and evaluate the labor and cost requirements that might be expected if/when the DOTD expands this pilot project into a statewide program.

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INTRODUCTION

Currently, the Louisiana Department of Transportation and Development (DOTD) has no comprehensive system for inventorying and maintaining records of traffic signs. Although this is similar to most state departments of transportation, several of them have recently begun developing computer-based sign inventory systems. Most of these new systems have been initiated to take advantage of more advanced and affordable spatial referencing systems and data recording-storage technologies that provide more accurate measurements and increased data access.

When used to their full potential and combined with geographic information systems (GIS), these newly developing sign inventory systems can serve as the cornerstone for fully comprehensive asset management systems that can also include information on a variety of highway agency properties like guardrails, traffic signals, pavements, bridges, survey markers, etc. Since these types of systems allow agencies to precisely count and locate these items in the field, monitor their condition, and track changes over time, they can be used by construction, maintenance, and engineering personnel to help highway agencies maintain their inventories. They can also be used by trained personnel to find unwarranted or "exception" signs and equipment, help to determine whether additional signs may be needed, and monitor field maintenance and replacement programs.

This project initiated the development of such a comprehensive asset management system in Louisiana starting with traffic sign inventory in a single parish. Its goal was to undertake a pilot field inventory of sign attribute data for Ascension Parish. Objectives included training regional DOTD officials for their own inventories and providing DOTD with a basis for estimating time, labor, and equipment requirements for future sign inventory programs.

OBJECTIVE

The goal of this project was to complete a pilot field inventory of sign attribute data for Ascension Parish and using a commercially-available software system, develop a data entry and storage system and enter the sign inventory information into the database. The inventory used state-of-the-practice mapping and referencing systems that may serve as a model for future statewide inventory and management systems. These future systems could permit the DOTD to track and monitor the number, location, and condition of every traffic sign within their inventory.

As part of the project, DOTD officials were trained to develop procedures for use in their own inventories and databases. A final objective of the project was to evaluate the amount of effort needed for this project so that the DOTD can estimate future time, labor, and equipment needs that may be involved in similar future sign inventory programs.

SCOPE

This pilot study involved collecting key data items from traffic signs adjacent to state roadways within Ascension Parish. To assess the variation between rural and urban conditions, a variety of different roadway locations as well as functional classifications (arterial, collector, etc.) were selected for data collection to provide the DOTD with a variety of road environment conditions.

The key data that were collected included sign type, location (based on GPS coordinates, route number and log mile, and with respect to the roadway), condition, and support device. All of these data were initially recorded by hand then later entered and stored in a computerized database.

In addition to the field inventory database, the project also included the purchase, set up, and testing of all the systems and equipment that may be used to perform similar inventories by DOTD personnel. The investigators trained selected DOTD personnel regarding the operation of equipment and the methods used in data collection and database set-up. Within this report, additional information such as sign density and labor requirements is also documented. This information may assist in developing cost and labor estimates for future inventories.

METHODOLOGY

The project was completed within a framework of six task items over a period of approximately 20 months. These task items included equipment acquisition and set up, data collection, validation of data, inventory updating, and training. The final task was the transfer of the data and equipment to the DOTD.

Equipment Acquisition and Set Up

The first step of project was to acquire all necessary equipment and supplies. Equipment was configured and tested to assure compatibility with the project objectives. Student data collection teams were also trained as part of this task.

The equipment purchased for this project included a laptop computer, a desktop computer, digital cameras, a Garmin ™ eTrex Vista ™ global positioning satellite (GPS) receiver, a DELTA RetroSign 4500 ™ digital retroflectometer and extension pole kit, and Carte'Graph™ SignView ™ (version 4.5) traffic sign software with an unlimited sign database license for the desk top computer and a 7,500 sign database license for the notebook computer.

Originally, peripherals for the Carte'Graph™ system were expected to be purchased, including a GPS receiver interface, a digital camera interface, and an electronic distance measuring instrument (DMI) interface. These peripherals would have permitted measurements to be automatically loaded into the database without the need to manually enter them. However, at the time of the software purchase, none of these connections were ready for commercial release. Thus, their purchase, as well as the need to purchase the originally proposed DMI's, was negated.

Originally, it was expected that the use of GPS would provide a high degree of positional accuracy for the project. While high accuracies can be attained using GPS, the price of the necessary equipment was cost-prohibitive. The GPS receiver used in the project was purchased for about $350 and had a manufacturer-certified accuracy of approximately 24 feet spherical error probability (SEP). This was a fairly common accuracy for GPS receivers priced less than about $2,000. However, to obtain accuracies in the range of about 1 foot (the original expectation for this project) minimum equipment prices were in the range of about $8,000. These types of systems would also require related infrastructure to achieve these levels of accuracy. In addition to the eTrex Vista™ receiver's ability to provide acceptable accuracies at an economical price, it also had several other desirable features. These included differential correction capability; storage for 500 waypoints; automatic track log to retrace up to 10 paths; a trip computer that provided current speed, average speed, maximum speed, trip timer and trip odometer. Unfortunately it also had some of the significant shortcomings common among most GPS devices including frequent signal blockages in areas near thick tree coverage and signal deflection by high-rise buildings and other tall structures.

Traffic sign retroreflectivity measurements were taken using a RetroSign 4500 ™. An important feature of this model was its relative ease of calibration. Calibration is critical to insure consistency between measurements taken at different times and under different conditions. The RetroSign 4500 ™ featured both a "Fast" and a "Full" calibration mode. Fast calibration was used for "everyday" calibrations using a factory zero calibration and default reference value. It was initiated by pressing calibration activate menu, then mounting the reference cap (reflective bottom) before pulling the handle trigger. Calibration in this mode was executed immediately. Full calibration is typically used for high accuracy calibration of a zero reference value.

The SignView™ (version 4.5) software package served as the database system for this project. SignView™ was created and is sold by Carte'Graph™ Systems of Dubuque, Iowa. The software was developed specifically for sign maintenance programs. It is a Microsoft™ Windows™ based program that could be loaded on both stationary and portable computers. SignView™ also contained a preloaded library of signs and also allowed for new sign creation and allowed photographs of signs to appear as an accompanying attribute of a sign data record within the database.

SignView ™ can also generate reports such as maintenance history, history log and other customized reports, although none of these features were used for this project. Other more recent enhancements of the program permit it to be interfaced with GPS and bar code scanners. Another useful part of the program was that it allowed integration with a geographic information system (GIS). The program can be easily integrated into Arcview ™ GIS 3.2 as an application plug-in program and was done so as part of a separate test study project using the data collected in this project. An advantage of GIS integration is the ability for field crews and database managers to view their signs on a map by route, reference post, or address with associated database and show the specific condition and visibility of each sign. It can also display queries, reports, and work orders at associated locations on the map.

In addition to these major equipment purchases, purchases of consumable supplies were also required to accurately and efficiently collect the required data. These included Windex™, AA batteries, cleaning cloths, measuring tapes (16 foot long), and a road map of Ascension Parish.

Data Collection

Data collection took place exclusively on DOTD highways in Ascension Parish, starting with the portion of the parish east of the Mississippi River. Ascension Parish was selected because of its proximity to the LSU campus and its mixture of rural and urbanized land development characteristics. It was expected that this type of land use mixture would also feature a significant diversity of rural and urban roadway functional classifications.

The data attributes that were collected for each sign included the following:

- Sign type, including MUTCD designation. If the sign was not a MUTCD standard sign or a location specific guide sign, or if the sign had any damage, a digital photograph was also taken.
- Date of installation. The installation date, as found in the field when available, was recorded for each sign. As such this date may not necessarily reflect the installation date of the original sign.
- Size. In cases where the sign was not accessible, the size was estimated.
- GPS latitude and longitude coordinate location.
- DOTD control section location.
- Sign condition.
- Retroreflectivity reading in its existing state and after wiping with cleaning solution.
- Sign support system.
- Inventory number.

Data was collected using two-person crews driving DOTD vehicles. All of the information was recorded by hand in field notes. It was initially expected that the various data acquisition interface devices could be used to enter data directly into the database via notebook computer in the field. However, due to the unavailability of these devices, all data was noted by hand then entered into the database immediately upon return from the field.

Each data collection crew included at least two undergraduate LSU student workers and, at varying times, a supervising graduate research assistant. Prior to beginning any field data collection, each crew member completed the DOTD defensive driving training course. Each crew member also received training and orientation from the LSU research investigators with the expectation that it would result in an overall increased level of standardization and efficiency in recording and measuring the data.

To reference specific signs based on DOTD control segment number, the number was first determined from a DOTD control section map. The crew driver then drove to the start of the control section and reset the initial DMI reading to zero. The DMI reading at the sign was recorded as the “distance” on the data inventory sheet.

Among the hindrances to efficient data collection was a lack of shoulders on many road segments. The DOTD vehicle was stopped on the shoulder if one was present or was stopped at a nearby safe place. When neither shoulders or driveway were available, the collection vehicle was stopped on the road and clearly marked with cones to alert oncoming drivers to proceed with caution. As an additional safety precaution the emergency flashing lights of the car were on at all times during data collection.

Typically, the driver carried the data collection forms and noted the sign orientation, sheeting type, date of installation, GPS coordinates, sign support system, sign dimensions for each sign. The passenger was responsible for taking retroreflectivity measurements at each sign. The retroreflectivity measurement of each sign in the unwiped condition was recorded first. Then the measurement point was cleaned using a mild, non-abrasive solution and dried with a paper towel to avoid abrading the sign surface. The retroreflectivity of the washed signs (in wiped conditions) was also then recorded using the retroreflectometer. For signs mounted above arm height, the retroreflectivity readings were taken using an extension pole and remote display unit.

The field crew next recorded the MUTCD code of the sign on the inventory form. After visually inspection, the condition of the sign was recorded in the “Sign Description” column of the inventory form. The team concluded its inspection with a digital photograph of the sign, if required.

Validation of Database

To maintain the integrity and quality of the database, a periodic validation of the inventory was also conducted. Over the duration of the project 200 signs were randomly selected for secondary verification. The information collected during the validation effort was used to determine if errors existed in the data set as well as to determine the source of these errors so that appropriate corrective actions could be taken to reduce the future occurrence of the errors.

Database Configuration and Data Entry

Periodically, after building up a backlog of field data, the sign attribute information recorded manually on the inventory forms was entered into the database. SignView^{TM} simplifies data entry through its use of predefined forms, online libraries, and user-defined fields, and filters. It makes searches for particular records or groups of records easier by allowing a user to include or exclude particular records with certain attribute information.

Forms were created in the program that included all recorded attribute information associated with the signs by using the "Filters" and "Design Form" features. Another helpful feature of the software was its built-in MUTCD library that helps a user to locate MUTCD sign designation numbers. SignView^{TM} also allows information regarding any changes made to the traffic sign, including replacements or repairs, to be saved so that a maintenance log can be created over time. In this way stored data can be manipulated for various reports including summaries of sign numbers, costs, types, date of maintenance, and other related items.

Sign Form Creation

SignView^{TM} data entry "forms" may include predefined forms, online libraries, user-defined fields, filters, and records. Forms are created using the "Filters" and "Design Form" features of the software. In general, the following procedure summarizes the process of designing new forms:

1. Select the "New Form" window.
2. Add required attribute input fields (i.e., MUTCD Code, Route, Background Color, Legend Color, Description, etc.) from the "Sign Fields" window by selecting the field and dragging it on to a blank form.
3. For custom fields not already included in the "Field Chooser," the "Administrator" icon may be selected and the "Signs Record" can be used to add custom fields such as "R_a Before Cleaning"

and "R_a After Cleaning." Custom fields may be added to the "Field Chooser" by selecting the "New Field" icon and setting the properties for these attributes, such as "Description Type," "Display Type," etc.

4. The design of the forms was facilitated using the "Toolbox" from the "Design Form" menu. Various types of boxes such as "ComboBox," "ListBox," etc. and different types of buttons such as "Toggle," "Option," and "Spinbutton" were selected as required.
5. Icons in the "Form" dialog box became active after adding a field to the form. This aligned the various fields by centering them, setting tab orders, and spacing them evenly horizontally and vertically, and moved the fields to the front or the back of the form, etc.
6. Finally, captions on the labels were modified by "right clicking" on a label and selecting "Properties" dialog box to edit the label.

The screen layout of the SignView™ form creation window is shown in figure 1.

After a form was designed, the "Run Form" icon could be selected to enter the information from each sign onto a new form. The software's "Record Control" was used to list all records in the database as well as all attributes and information pertaining to a particular record. This form of record control worked in a manner similar to a Microsoft™ Excel™ spreadsheet, which made data entry simple and less time consuming. Figure 2 shows a completed record for a typical sign in the project inventory.

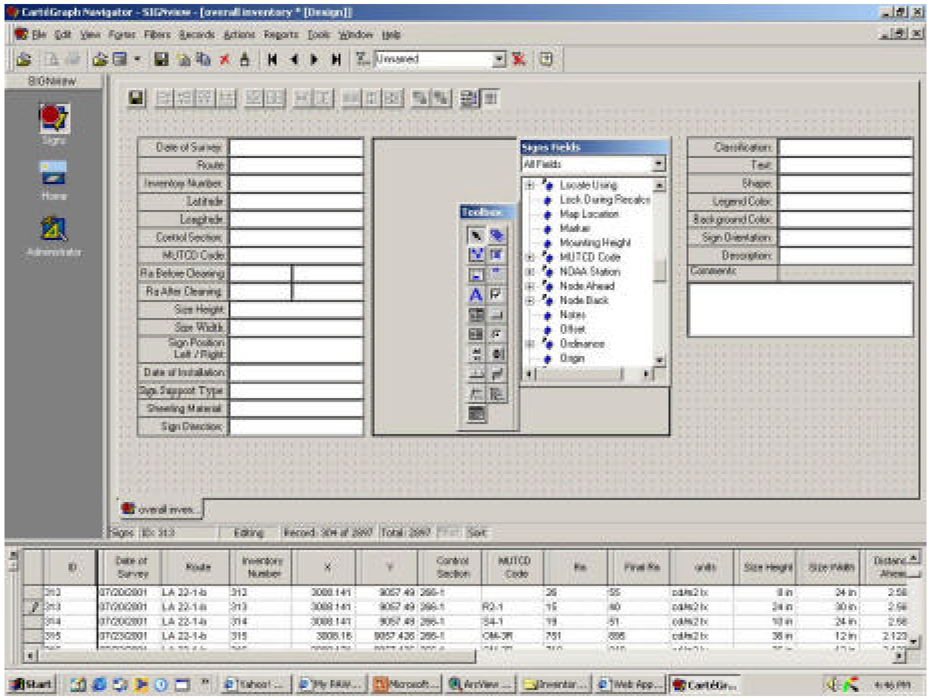


Figure 1
Creation of a sign form within Carte'Graph™ SignView™

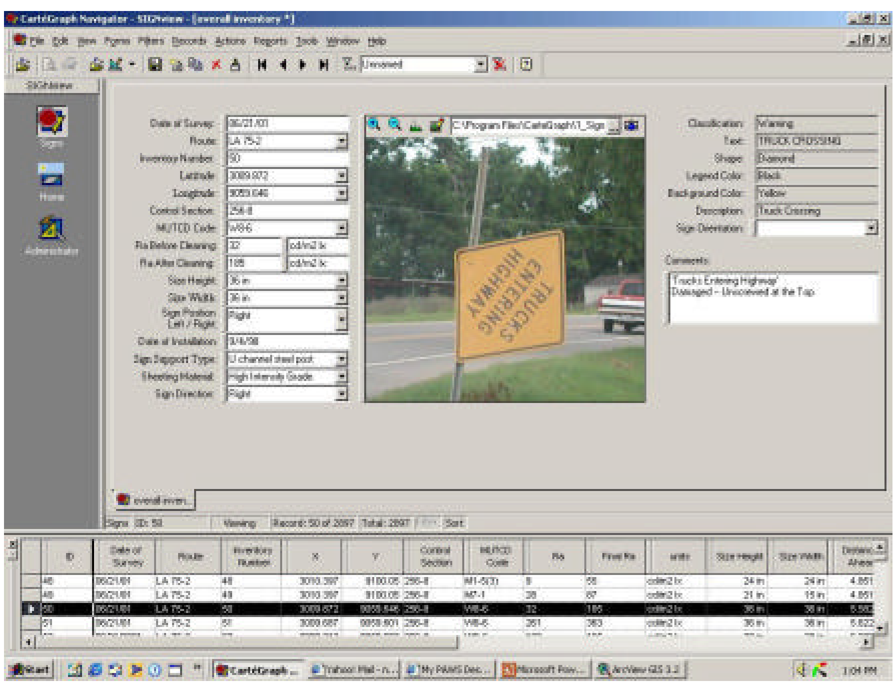


Figure 2
Record from the Ascension Parish sign inventory in SignView™

DISCUSSION OF RESULTS

This project did not involve the type of hypothesis testing typically associated with traditional experimental research. Rather, the emphasis of this project was focused primarily on collecting, processing, and storing sign data. Thus, the results discussed in this section are presented as a qualitative discussion of the approach that was taken, including its overall efficiency and effectiveness and the processes that were used. A quantitative summary of certain aspects of the data highlights some of the general aspects of the sign inventory, including a quantification of the general distribution and condition of the signs in Ascension Parish.

Database Overview

Data attributes from a total of 3,646 traffic signs were collected over the duration of the project. The inventory included signs from 42 separate control segments on approximately 147 miles of state highway in Ascension Parish. The amount of road mileage covered includes approximately 56 percent of the estimated 264 miles of total state highways within the parish.

Table 1 shows the length of each control segment as well as the number of signs located within that segment. In the rightmost column of the table, the sign installation density (signs per mile) is shown. Overall, the sign density on the roads inventoried in Ascension Parish averaged about 25 signs per mile. The table also shows that the sign density varied significantly between the urbanized and rural areas of the parish. This is most evident in the extremes of the density scale in which a maximum of 80.6 signs per mile was observed on LA 932 through more densely developed areas in Gonzales and a low of 5.3 signs per mile was observed on LA 75, also known as River Road, that runs parallel to the Mississippi River.

Prior to the start of the project, the DOTD had no data on the density of sign installation on its highways, nor any reliable methods to estimate it for the various functional classification and land use areas within its jurisdiction. These estimates will be useful when estimating the labor effort and costs for a statewide sign inventory effort.

Table 2 shows some more general sign attributes. Of the total sign database, over a thousand were object markers. This represents more than one quarter (27.5 percent to be exact) of all the signs that were inventoried. The two largest sign groups were regulatory signs (15.5 percent) and warning signs other than objects markers (13.5 percent). This distribution of sign type is consistent with the distribution of sign sheeting color.

Table 1
Sign inventory overview

Segment Number	Control Section	Route Designation	Sign Count	Segment Length (mi)	Sign Density (signs/mi)
1	256-6	LA 44	35	1.8	19.4
2	256-8	LA 75	48	7.9	6.1
3	256-9	LA 75	13	2.5	5.3
5	264-04	LA 429	152	5.3	29.0
6	265-1	LA 44	120	7.6	15.7
8	266-1	LA 22	203	9.9	20.6
9	256-7	LA 942	62	5.2	12.0
10	414-03	LA 30	170	10.8	15.8
12	426-3	LA 70	59	3.2	18.6
13	77-1	LA 73	159	3.4	46.8
14	77-2	LA 73	167	4.6	36.3
17	803-20 & 803-12	LA 934	57	5.1	11.2
18	803-21& 803-10	LA 935	117	7.1	16.5
19	803-31	LA 3251	105	3.8	27.6
21	266-02	LA 22	174	7.8	22.4
26	803-25	LA 427	63	2.4	26.8
28	77-3	LA 73	114	3.0	38.0
30	7-7	US 61	633	13.5	46.9
32	803-8	LA 621	206	7.0	29.4
33	803-16	LA 931	72	3.2	22.8
34	803-17	LA 931	41	2.4	17.0
35	267-2	LA 431	201	6.8	29.6
36	260-1	LA 42	278	8.3	33.4
37	803-24	LA 937	13	1.8	7.2
38	7-6	US61	146	5.5	26.8
40	803-19	LA 932	174	2.2	80.6
42	803-7	LA 928	64	5.7	11.2
Total			3,646	147.4	

Table 2
General sign attributes

MUTCD Classification	# of Signs
Warning Sign	494
Regulatory Sign	566
Object Marker	1001
Sign Sheeting Color	**# of Signs**
Red	27
White	818
Yellow	1510

Data Collection Process

Crews of LSU undergraduate students completed the data collection using DOTD vehicles. Data collection was conducted on all state highways in Ascension Parish, except on I-10. I-10 was excluded primarily due to safety concerns for the field crews. Data collection was completed primarily during off-peak travel hours. This permitted the survey vehicle to operate at lower speeds and reduced the number of potential traffic conflicts. Weather also occasionally impacted data collection because it was difficult to work on rainy or high humidity days. The DOTD vehicles were equipped with distance measuring instruments (DMI). The crews measured the distance between successive traffic signs. Crews were required to approach each sign on foot to measure GPS latitude and longitude and used inventory forms to record descriptive information regarding the inventory element (figure 3).

Figure 3
Recording field measurements

Data Attributes

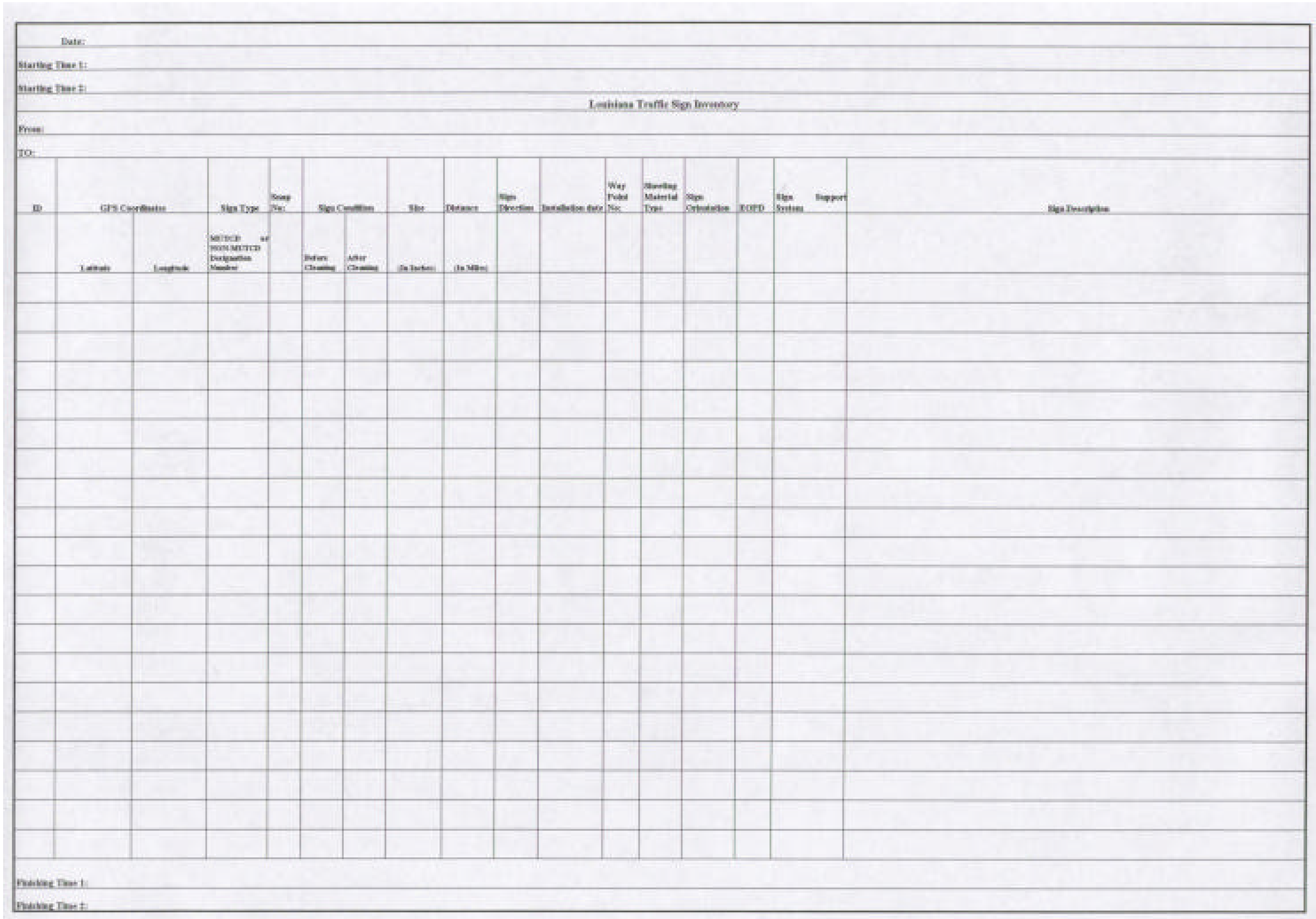
Manual sign inventory forms were also developed for the project to record the key data items. One of these forms, shown in figure 4, illustrates the information that was collected for each sign:

- Date of Survey
- Route Specification (From Node and To Node)
- Inventory Number
- GPS Coordinates (Latitude and Longitude)
- Control Section
- Photograph Number
- MUTCD Code / Non-MUTCD Signs
- Retroreflectivity of Signs (In Wiped and Unwiped Conditions)
- Date of Installation
- Sign Support System
- Sheeting Material
- Sign Orientation

- Edge of Pavement Distance
- Sign Description and Comments

Most of these attributes are self-explanatory. However, some of them are explained below. "Route Specification" was recorded to specify the direction of travel and "Node to Node" distance was recorded to more easily locate the referenced sign. "Sign Inventory Numbers" were used to enable unique identification at each sign, reducing the potential for confusion between signs similar signs on a single route.

A typical completed field inventory form is shown in figure 5. Some of the notes used by the field crews can be seen. These notes were particularly important when recording data for sign clusters like T-intersection dead-ends. At sign cluster installations, all signs on the right hand side of the direction of travel were given the lowest number and sign numbers increased from right to left. Similarly, for signs installed on the same support, sign numbers were ordered from top to bottom.



Date:

Starting Time 1:

Starting Time 2:

Louisiana Traffic Sign Inventory

From:

TO:

ID	GPS Coordinates		Sign Type	Snap No:	Sign Condition		Size	Distance	Sign Direction	Installation date	Way Point No:	Sheeting Material Type	Sign Orientation	EOPD	Sign Support System	Sign Description
	Latitude	Longitude	MUTCD or NON MUTCD Designation Number		Before Cleaning	After Cleaning	(In Inches)	(In Miles)								

Finishing Time 1:

Finishing Time 2:

Figure 4 Sign field inventory form

Date: 06/23/01

Starting Time: 2:30pm

Louisiana Traffic Sign Inventory

From: Hermitage Antebellum Home JCT LA 942 & LA 22

TO: Borage Antebellum Home JCT LA 942 & LA 941 (on LA 942)

ID	GPS Coordinates		Control Section #	Sign Type	Snap No	Sign Condition		Size	Distance	Sign Direction	Installation date	Sign Support System	Sign Description
	Latitude	Longitude		MUTCD or NON-MUTCD Designation Number		Before Cleaning	After Cleaning						
81	N3006.871	W9058.022	256-7	OM-3R	-	17	836	12x36	11.361	L	6/99	US	"OM"
82	N3006.853	W9057.962	256-7	R2-1		356	491	24x30	11.450	R	2/9/00	US	"Speed limit 55" B/w
83	N3006.835	W9057.881	256-7	OM-3R		881	971	12x36	11.531	R	5/99	US	"OM"
84	N3006.841	W9057.880	256-7	OM-3R		249	967	12x36	11.531	L	5/99	US	"OM"
				OM-3R				12x36					(Replaced) (placed at the side of the road) damaged old
85	N3006.824	W9057.798	256-7	R2-1		287	488	24x30	11.613	L	2/9/00	US	"Speed limit 55" Knocked, Not visible w/B
[illegible]	[illegible]	[illegible]	256-7	[illegible]		1	4	[illegible]	11.615	L	[illegible]	US	"No passing zone" [illegible]
[illegible]	[illegible]	[illegible]	[illegible]		-	2	4	[illegible]	[illegible]	R	—	US	"Hermitage Antebellum Home" [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	OM-3R	-	901	[illegible]	12x36	[illegible]	R	5/99	US	"OM"
[illegible]	[illegible]	[illegible]	256-7	OM-3R	-	[illegible]	[illegible]	[illegible]	[illegible]	L	5/99	US	"OM"
90	[illegible]	[illegible]	256-7		[illegible]	3	4	[illegible]	[illegible]	L	[illegible]	US	"Hermitage Antebellum Home" [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	5	30x30	[illegible]	R	[illegible]	US	[illegible]
[illegible]	[illegible]	[illegible]	256-7	[illegible]		22	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	OM-3R		[illegible]	1006	12x36	[illegible]	R	5/99	US	"OM"
[illegible]	[illegible]	[illegible]	256-7	[illegible]		[illegible]	[illegible]	12x36	[illegible]	L	5/99	US	"OM"
95	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	L	[illegible]	US	[illegible] (GOLL)
[illegible]	[illegible]	[illegible]	256-7	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	L	[illegible]	US	[illegible]
[illegible]	[illegible]	[illegible]	256-7	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	L	[illegible]	US	[illegible] (GOLL)
98	[illegible]	[illegible]	256-7	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	L	[illegible]	US	[illegible]
99	[illegible]	[illegible]	256-7	D1-1	-	4	2	[illegible]	[illegible]	R	[illegible]	US	"Borage Antebellum ←" [illegible]

Ending Time: [illegible] pm

Figure 5
Completed sign field inventory form

Sign Location

When recording GPS coordinates, the receiver was turned on at least one minute prior to collecting location data of the signs. This allowed the receiver to acquire enough satellite signals (at least four) to specify the sign location. When operational, the “Ready To Navigate” message appeared at the top of the receiver display screen.

Location coordinates (latitude and longitude) were shown at the bottom of the display screen. To expedite data collection, coordinates for signs were stored in the receiver for later retrieval. This negated the need to write each one at the sign location. The location of each sign was also double-checked by marking it as a waypoint in the receiver map. Each waypoint was given a unique number by the receiver and these were recorded for future use. The eTrex Vista™ GPS receiver allowed storage of up to 500 waypoints.

In Louisiana, segments of all state highways are sub-divided into control sections. The beginning and ending points of a control section may be major intersections, beginnings of new construction, political or jurisdictional boundaries, etc. Thus, each road section is uniquely numbered. Control section numbers were also used to reference the field data. This helped to reduce confusion stemming from data collected by different crews at different times.

Damaged and Distressed Signs

In cases where signs were damaged or defaced, digital photographs of the signs were taken to have a visual reference for the evaluation of sign condition. Various types of distress are shown in figure 6. Each photograph is numbered using a photo (snap) number on the inventory form (referenced by the display on the digital camera). In the lab, these photographs were downloaded into the database and were attached to the data form of the respective signs using attachment feature of the Carte’Graph™ software.

During the inventory, a total of 889 signs warranted a photograph due to damage distress. While these signs made up nearly a quarter of the total inventory, it should be noted that damage or distress does not always render the sign to be unusable. The types of damage and distress varied widely within Ascension Parish. Examples of sign distress included bent sign supports, scratched or peeled reflective sheeting, and various forms of vandalism (spray paint, bullet holes, etc.). Table 3 shows the frequency of the most common types of sign damage observed during field data collection.

Figure 6
Examples of varying sign damage and distress

Table 3
Frequency and type of sign damage and distress

Damage/Distress	**# of Signs**
Scratched	394
Peeled & Scratched	34
Peeled	120
Vandalized	7
Bent	252
Bent & Scratched	53
Bent, Peeled & Scratched	6
Knocked Down	23

Sign Designation and "Non-Conforming" Signs

All the traffic signs were also referenced based on the numeric designations of the Manual of Uniform Traffic Control Devices (MUTCD). Any signs that did not conform to standard MUTCD designations were noted in the database as "Non-MUTCD" signs and a photograph of the sign was taken. The nonconforming signs in Ascension Parish included those with non-standard legend types, colors and dimensions. Photographs of some non-conforming signs are shown in figure 7.


JCT
LA 3115
IBERVILLE PARISH
TOWN OF ST. GABRIEL, LA CORP. LIMIT


TRUCK ENTERING ROAD

Figure 7

Examples of non-conforming signs

Sign Retroreflectivity and General Performance

Traffic sign retroreflectivity is a measure of the amount of light from a vehicle headlamp that is reflected from the sign surface back to the driver. As part of this project retroreflectivity measurements were taken for a significant percentage of the signs to assess the general condition of the signs and to evaluate their overall performance relative to DOTD performance specifications. While analyses of sign performance was never proposed to be a part of this project, a general discussion of some of the qualitative aspects of the data that was collected is presented for informational purposes.

The number of signs from which retroreflectivity measurements were taken numbered approximately 1,000. Retroreflectivity measurements were not taken for all signs in the inventory primarily because of initial concerns regarding the value of the data given the added expense to obtain the data. It was later decided that the added expense and collection time would be minor within the overall scope of the project and that retroreflectivity measurements would be taken.

Two retroreflectivity measurements were taken for each sign. The first was recorded from the sign in its existing condition as encountered in the field. It should also be noted that these measurements were taken only from the reflective portion of the sign sheeting and not on the legend text or symbol portion of the sign. Since the existing condition measurements were affected by the amount of dirt and grime on the sign a second retroreflectivity measurement was also taken after a small area of the sign was cleaned with a common household cleaner. This second measurement (also referred to as the "wiped" reading) was taken in the same location as the first. In addition to getting a true assessment of the sign's performance, prior research studies have shown that sign cleaning can significantly increase the measured rate of specification compliance. It was expected that this information could be used in the future to estimate the existing traffic sign performance or even forecast the future performance and compare the Ascension data set to prior similar studies of traffic sign retroreflectivity in Louisiana.

Since the deterioration characteristics of retroreflective sheeting materials and their performance depend heavily on a sign's age, or "in-service life," the date of installation was also recorded (when available) to calculate the age of the traffic sign at the time of survey. The recorded dates mainly included the original sign installation date, although in some cases dates were also noted if they described when the sign had been repaired or replaced.

By comparing the retroreflectivity measurements to the dates of installation, it was possible to assess the overall condition of the sign inventory with respect to the current DOTD sign performance criteria (DOTD 2000). This comparison is shown in Figures 8 and 9. Figure 8 presents the data for Type I, or Engineering Grade, sheeting and Figure 9 presents the same information for Type III, or High-Intensity Grade, sheeting.

Figures 8 and 9 are presented as four-quadrant maps in which each point represents the relationship between a sign's age and its retroreflectivity reading. On each of the graphs the retroreflectivity measurement is shown on the Y-axis and the sign's age is on the X-axis. The graphs are also bisected by two additional lines. The horizontal line represents the minimum retroreflectivity reading specification for new signs. The vertical line on each graph represents the end of the new sign warranty period.

Thus, all data points in quadrant II (the upper left) include the signs that met the specification requirement and were within the warranty period. Signs in quadrant IV (the lower right) did not meet the performance specification requirements, but were also out of warranty. The signs in quadrant I (upper right) were the best performers. These were signs that are out of warranty but still meet the performance specification criteria. An area of potential interest to the DOTD might be quadrant III (the lower left). Signs in this region did not meet the performance specification although they were still within the DOTD specification warranty period.

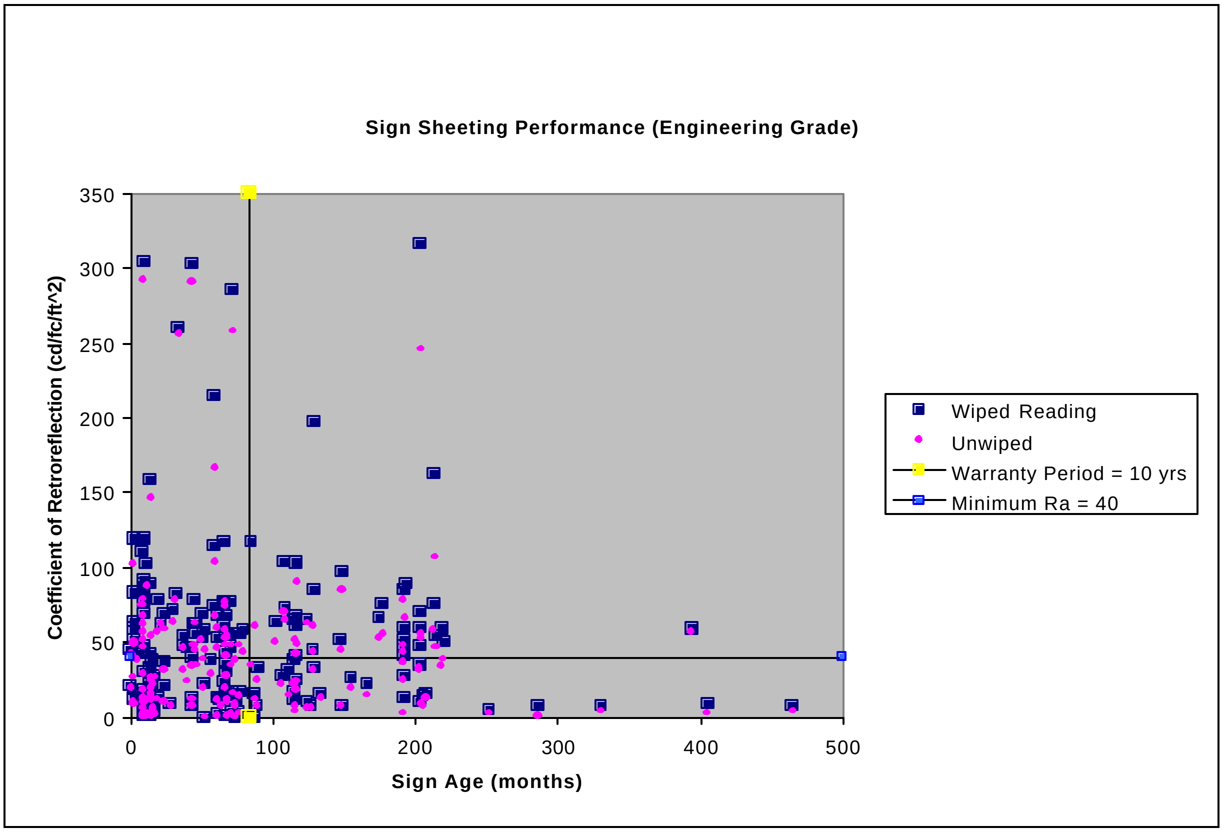


Figure 8
Engineering grade sheeting performance

As an additional means of comparison the wiped reading data shown in figures 8 and 9 is also presented in tabular form in table 4. The data shows that, generally speaking, the traffic signs in the sample were performing reasonably well in comparison to the DOTD specification criteria. Of all signs covered under warranty, more than 70 percent were performing at or above the minimum specification level. Of the signs that were out of warranty, about 66 percent continued to perform at or above the minimum levels of retroreflectivity. Overall, the high intensity grade signs were performing very well, with over 84 percent compliance within the warranty period and nearly 82 percent after this period. An area of potential concern to the DOTD, however, is the compliance rate of the engineering grade signs. The data showed that nearly 60 percent of the signs were performing below the minimum specification rate while under warranty. This was nearly the same for signs past the warranty period as well. With additional analyses of the data it could also be possible for the DOTD to evaluate these sign groups with respect to FHWA "end-of-service-life" criteria to determine signs which may need to be replaced. Further analyses of this nature were not conducted as part of this project.

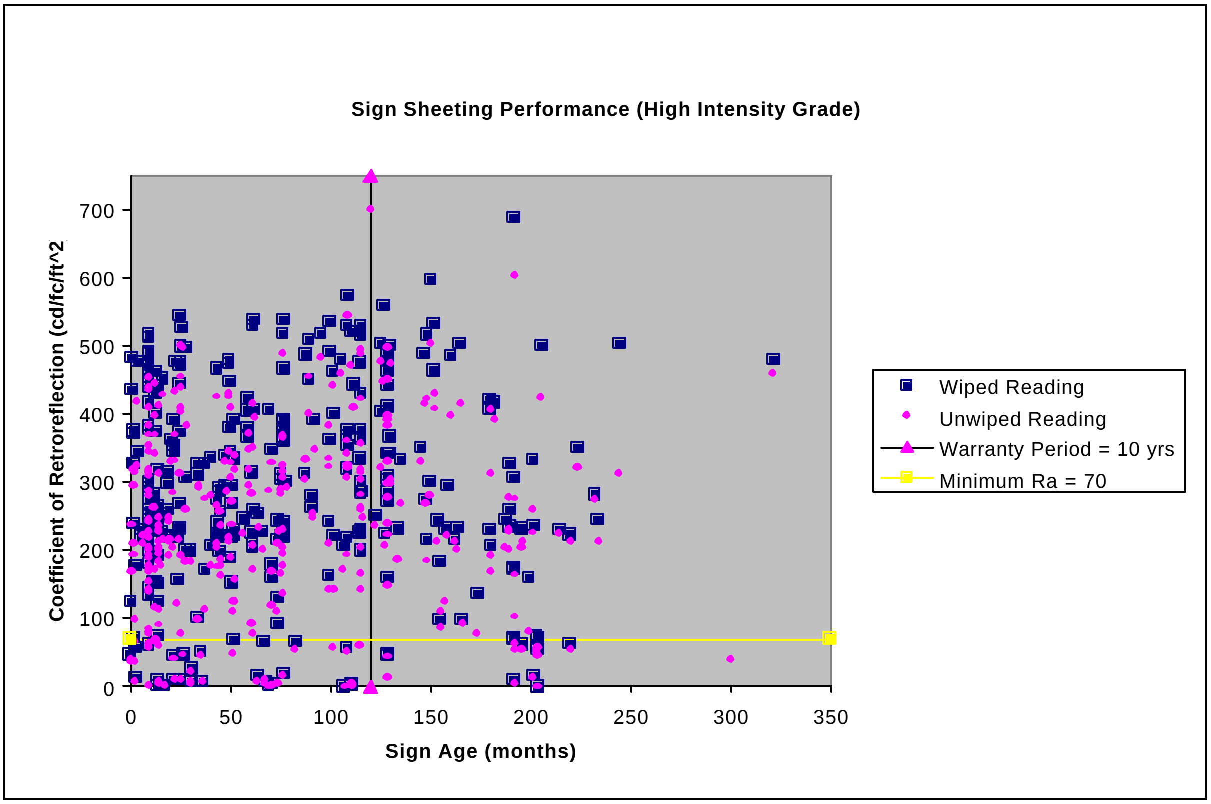


Figure 9
High-intensity grade sheeting performance

Table 4
Comparison of overall sheeting performance (wiped readings)

Type of Sheeting	w/i warrantee			post warrantee		
	pass %	fail %	n	pass %	fail %	n
Type I (Engineering Grade)	41.5	59.3	118	44.2	55.7	61
Type III (High Intensity Grade)	84.2	15.7	260	81.9	18.1	83
All Sheeting Types	**70.9**	**29.1**	**378**	**66.0**	**34.0**	**144**

Data Collection Rate

In addition to the number of signs and sign density on state highways, another key question for this project was how much labor effort would be required to collect this type of data from signs. During this project a total of 2,601 hours of student worker labor was expended on the various project efforts. A comparison to the total number of signs that were reviewed shows that the average amount of time spent on each sign was approximately 43 minutes.

While this rate of collection sounds high, it is not necessarily abnormal given the nature of the project. The labor effort included time spent on several additional activities not directly involving the acquisition of sign data. The most significant of these included driving time to Ascension Parish as well as time fueling and servicing the vehicle; the completion of DOTD safety training classes; equipment usage training; and some data entry. Student unfamiliarity with DOTD procedures and occasional limits on vehicle availability also slowed the overall rate of data collection. Thus, it would be expected that personnel more familiar with DOTD methods and procedures would have a higher level of data collection efficiency.

Database Validation

To verify the integrity and quality of the database, a periodic validation of the inventory was also conducted. Over the duration of the project, 200 signs were randomly selected from the prior data collection logs for secondary verification. The verification process involved the re-collection of all data measurements by a separate single-person field crew. In addition to verifying the overall accuracy of the database, this information was also used to verify the consistency of various data collection crews as well as their ability to make accurate measurements and the consistency of the measuring equipment between the various collection periods.

Overall, it was found that approximately two percent of the sign inventory records has some form of error. The sources these errors varied significantly, although most appeared to be attributable to the lack of familiarity of some of the crews with the various sign materials or inconsistencies between the crews with respect to the conventions used in measuring and referencing. Over the duration of the project attempts to reduce these errors and discrepancies were made to better inform and train the field personnel. While this was not confirmed scientifically, anecdotal evidence indicated an improvement in overall consistency and accuracy. It was not known whether the improvements were the result of retraining or the general increase in experience that the crews built up over time.

The following is a list of the errors found as part of the validation effort. Along with the type of error, the number of occurrences of that particular type is also shown.

- Incorrect entry of sign direction (left/right) (66),
- Discrepancies in sign retroreflectivity measurement (43),
- Incorrect recording of date of installation (11),
- Wrong sign legend data recording (10),
- Sheeting material type recorded incorrectly (6),
- Not entering all the dates at the back of the sign (5),
- Missed signs along the route (4),
- GPS coordinates recorded incorrectly (4), and
- Retroreflectivity measured on the wrong part of sign (3).

CONCLUSIONS

In this project a pilot study was conducted to collect key data attributes from traffic signs adjacent to state roadways in Ascension Parish. This area was selected because of its proximity to LSU as well as its widely varied functional road classifications (arterial, collector, etc.) and rural versus urbanized development areas. It was expected that these varying conditions would give the DOTD an idea of the sign installation characteristics for a variety of road environments.

Although this project was primarily an exercise in data collection, the results from it also allowed the DOTD to evaluate and assess several issues associated with initiating and completing additional, larger-scale, traffic sign inventories. These issues include new data acquisition equipment and technologies; the development and assessment of techniques for collecting the data and setting up the inventory database; and a basis for estimating the number and type of traffic signs in their inventory as well as the labor requirements that would be required to conduct a similar inventory state-wide.

A total of 3,646 traffic signs were inventoried in Ascension Parish during the 20-month period from April 2001 through December 2002. The inventory includes signs from 147.4 miles of state highway, including the following routes:

- LA 75
- LA 942
- LA 44
- LA 73
- LA 3251
- LA 22
- LA 70
- LA 30
- LA 74
- LA 928
- LA 427
- LA 429
- LA 936
- LA 934
- LA 621
- LA 931
- LA 431
- LA 932
- US-61

The data that was collected included sign type, location (based on GPS coordinates, route number, and log mile with respect to the roadway), condition, and support device. All of these data were initially recorded by hand then later entered and stored in a computerized database.

In addition to the inventory, some empirical analyses associated with sign retroreflectivity performance were also conducted. The analyses were centered primarily on the relationship between sign retroreflectivity and age and the performance of the signs relative to DOTD performance specification criteria. The various comparisons showed that, generally speaking, the high intensity grade sheeting signs were performing very well with respect to the DOTD specification criteria, with over 80 percent of the surveyed signs in compliance with the specification both within and after the seven-year warranty period. However, the comparisons also showed that the compliance rate of the engineering grade signs was substantially lower, with nearly 60 percent of them performing below the minimum specification rate while still within the specification warranty period.

RECOMMENDATIONS

It is expected that results from this project will be used by the DOTD to initiate more comprehensive traffic sign and field inventories. A review of practices in other states showed that these inventories are used in various highway agencies to precisely count and locate items such as traffic signs, guardrails, signals, pavements, bridges, and survey markers in the field. With this information, agencies can monitor sign condition and track changes in performance over time. These inventories can also be used by construction, maintenance, and engineering personnel to help highway agencies find unwarranted or "exception" signs and equipment, determine whether additional signs may be needed, and monitor field maintenance and replacement programs.

A brief review showed that other states are using computerized sign inventory systems to provide timely and accurate information to support decision-making. The databases are used to identify, classify, and prioritize signage assets for future replacement, repair or upgrade. History log features of the software systems can be used to develop schedules and track work orders based on the information contained in specific sign database queries. After the maintenance is performed on an asset, the activity can then be recorded and dated into the history log.

These systems can also help with documentation in legal proceedings, since they can be used to track the age and condition of signs systematically. They have also been used to provide additional service to the public through procedures to include public contacts (including recording of names, phone numbers, dates, and other information) based on actions taken from complaints. These inventory systems have also been used for conducting a life cycle cost analysis for budgeting purposes. Models have been developed to predict when certain signs are likely to need replacement by comparing the predicted retroreflective levels with minimum retroreflectivity standards. These models minimize the resources required to locate, inspect, and replace signs that are in the most serious need of maintenance (5).

Of course, these benefits also come with a cost. The primary expenses associated with these types of inventories are the costs associated with the labor time, equipment, and materials necessary for field data collection. This project should give a reasonable indication of the approximate labor investment that would be required as well as the number of signs that would exist on certain types of roadways.

Currently, there are several different commercially available software packages that allow the development of sign inventory systems like the one demonstrated here. These systems vary widely in terms of their complexity, flexibility, and price. The system used for this project is among the more sophisticated (and correspondingly expensive) of these. And while the system appears to be comprehensive in its ability to deliver a robust platform that is adaptable to a wide range of uses, it has also been demonstrated to be very complicated for the average user. In fact, the experiences of this project have shown that most users have been unhappy with the product specifically for this reason. It is highly recommended that the DOTD invest in additional training (directly from the developer) for any users of the system if it plans to implement this system more widely in the future.

Data Integration Project

To investigate the potential for integration with other systems, a test project was carried out separately from the sign inventory to examine the potential for the integration of the Ascension Parish sign inventory data between Carte'Graph SignView™ and ArcView™ GIS.

GIS-based inventory systems provide a tool for spatial data display and storage as well as an efficient management tool for transportation planning and engineering studies for traffic control devices. With the integration of sign data into a GIS, a user may search traffic signs installed before a certain date, of certain color, sheeting material, and/or sign type. Most GIS systems have extensive visualization capability that can also be used to present sign inventory data in various forms and analyze it. In addition, most systems provide other useful functions such as querying, data layering, visualization and various spatial analysis tools (such as contouring, etc).

The test integration of the sign inventory data was integrated into the ArcView™ GIS by the following steps:

A new project application window was opened. A project file will contain all views, tables, charts, layouts, and scripts that are used for a particular ArcView™ application.

Next, an ESRI folder is navigated in order to trace the shape file that contains U.S. counties. In it a map of Ascension Parish was constructed using the "Theme Properties" button. A "Query

Expression" was built using the "Query Builder/Definition" button. The query expression used for this purpose was "[Parish_Code] >= 005".

All the signs were represented in the Ascension Parish map using the GPS coordinates recorded at each sign location. This geographic data was exported from Carte'Graph™ as a "Text Delimited" file using Microsoft Excel™.

An "Add Event Theme" icon was used to save text delimited table from the "Table" dropdown list. After this was performed, ArcView™ read the field names in the table selected the most likely default names for X & Y fields.

A new point theme was added to the view containing all the sign locations defined in the table and saved as a .shp file. The symbol for the sign locations was changed using the Legend Editor. A screen capture of this data is shown in figure 10.

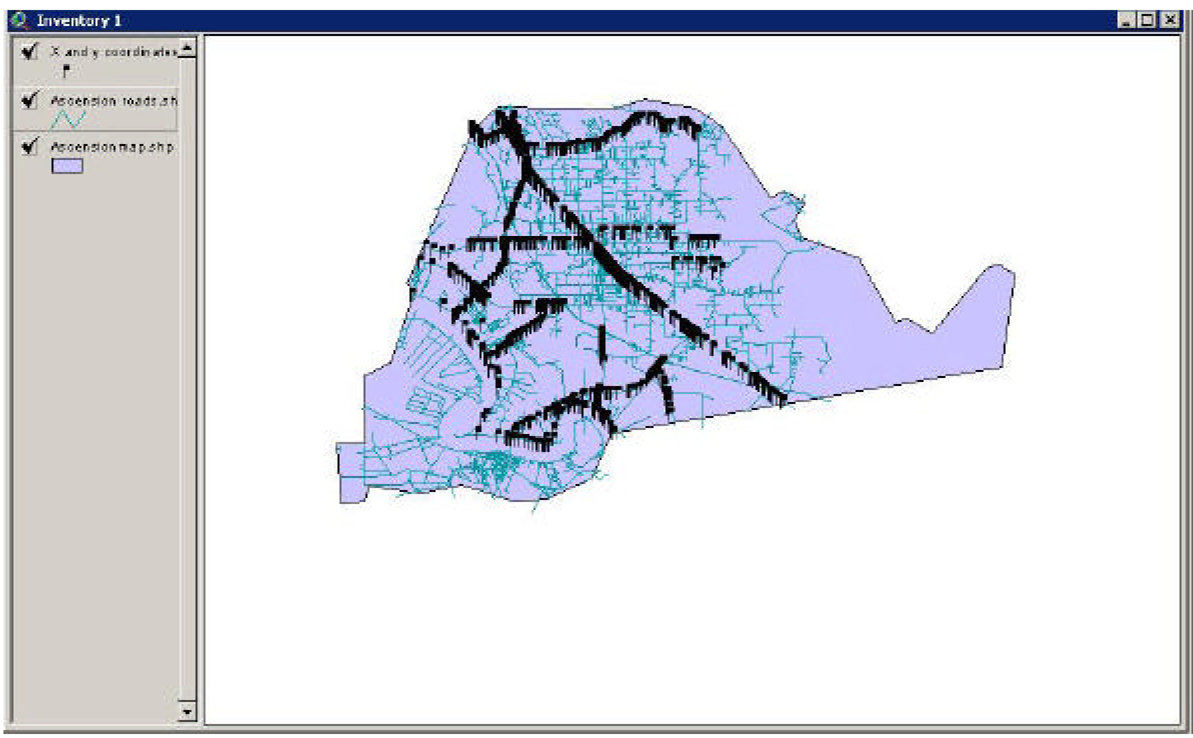


Figure 10
Ascension Parish sign inventory map in ArcView™ GIS

All the attribute data of the signs was then added to the .shp attribute table by adding extra fields. This can also be done by joining two tables with common field name such as Latitude, Longitude or Shape field. Visual information (pictures of damaged signs) of the sign data was also linked to the shape file using the "Hot Link" feature. A field called "image" was added to the text properties of the sign theme attribute table containing the path name of the image that was to be hot linked to each feature. ArcView^{TM} offers several predefined actions for hot links, including link to text file, link to image file, and link to document. In the test data integration project, a link to image file was selected.

To use the Hot Link feature, the signs theme for which hot links were defined was made active, and the Hot Link utilized. To view the attached image of a particular sign, one of the active theme features, e.g., sign symbol on the map, would be selected. All the data joined to the attribute table of the Signs shape file could be viewed by activating the "Identity" icon and using the sign symbol. A screen capture of the photographs associated with some of the damaged signs in the Ascension Parish inventory are shown in figure 11.

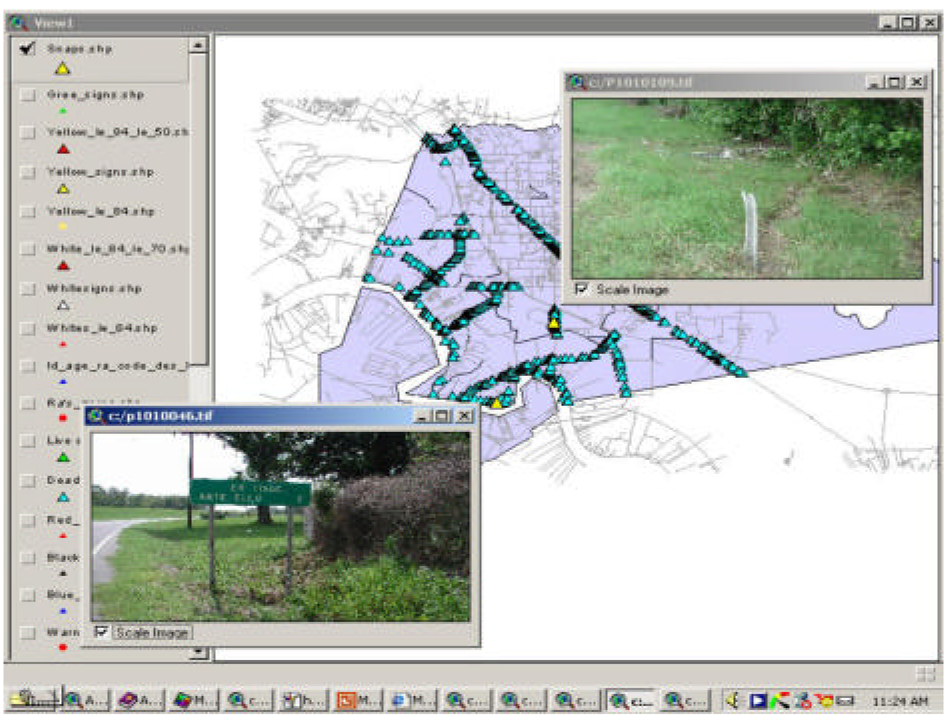


Figure 11
Links of damaged sign photographs in the GIS database

ACRONYMS, ABBREVIATIONS, & SYMBOLS

DMI – Distance Measuring Instrument

DOTD – Louisiana Department of Transportation and Development

GPS – Global Positioning System

GIS – Geographic Information System

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