Computerized Highway Inventory System for Clinton County, Ohio

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ABSTRACT

In the light of a recent Ohio Supreme Court ruling, Ohio governmental entities can no longer rely on the protection of sovereign immunity. To reduce possible liability suits and the number of accidents that may be caused by faulty or substandard highway features and traffic control devices, Clinton County initiated a program to identify, locate, and record all roadside features. These items can then be compared with current standards to establish a priority system for repair or replacement as well as to prepare work sheets for the maintenance crews. Because of the large amount of data gathered for the highway inventory system, a microcomputer was procured to store, manipulate, update, and sort this information.

Clinton County is typical of many rural counties in Ohio. The primary industry and consequent traffic generator is agriculture, and local roads serve as the only means to get grain and livestock to the marketplace. Average daily traffic (ADT) counts are generally low on local roads (less than 500 ADT), and many traffic accidents involve only one vehicle. A major contributing factor in all accidents is driver judgment, which is based on instantaneous site information and individual reaction time. Adequate advance warning of road conditions and proper delineation of roadside hazards could properly warn the driver of site conditions and provide a longer reaction time thus reducing the number of accidents in that area.

To determine whether existing site conditions were meeting state and federal guidelines, it was necessary to identify, locate, and record all existing roadside features and traffic control devices. This process was aided by a computerized inventory program. From this program a priority list could be established for systematic correction of deficient conditions within current budget restraints.

The terms "priority" and "systematically correct deficient conditions" have recently become important owing to an Ohio Supreme Court ruling eliminating sovereign immunity. Because budget limitations often are not considered a legitimate reason for not taking corrective measures, a logical, engineered approach must be applied to establish a list of priorities to correct deficient areas. Often the risk of liability suits can be reduced when reasonable intent can be shown that a systematic approach is being taken to correct problems.

The long-term goal of this program is to reduce the number of accidents caused by faulty or substandard highway features and traffic control devices as well as reduce the possibility of liability law suits.

The highway inventory system for Clinton County required completion of six phases as follows: (a) identify and locate items, (b) gather data on the items, (c) enter data into computerized data base, (d) establish priorities, (e) add new data, and (f) devise reporting forms and perform periodic inspections. Each of these phases is described below.

IDENTIFY AND LOCATE ITEMS

With 270 miles of county roads, 290 bridges, 1,100 culverts, and 2,300 signs located on the county, township, and state road systems, it is imperative that an effective system be established to identify and locate each roadside feature and traffic control device. The logical tool to handle a large data base such as this is the microcomputer. The microcomputer can store large amounts of information, manipulate the data to establish a priority system, be updated easily as corrective measures are taken, and generate reports as necessary.

To obtain financing for this program, Clinton County submitted a proposal to the Ohio Department of Highway Safety and subsequently received approval. A total project cost of $12,600 was approved; the county was eligible for reimbursement of 90 percent of this amount.

The county agreed to use local funds to perform a field survey of signs, pavement markings, intersections, guardrails, and pavement widths. The information gathered at each site would include a general condition rating, location from a fixed point at the west or south end of the road, measurements of size, and location from edge of pavement. All items were correlated with the county photolog system to provide an accurate pictorial review of the system.

Competitive bids were taken on computer equipment, and the bid was awarded to the low bidder, a women-owned business complying with the minority business terms of the agreement with the Department of Highway Safety. The computer and associated software were delivered in April and the distance event data printer in July.

GATHER DATA

Two full time employees were assigned to assist with this project on an "as-needed" basis. Also two summer employees were hired specifically to assist the above employees in gathering all field data and entering the data into the computer. A total of more than 1,000 man-hours and 5,572 road miles were covered to complete all phases of the inventory.

The field inventory system progressed in several phases as manpower became available. In anticipation of this project a night inspection was made in January of all signs in the county to determine their general condition and reflectivity. A total of 171 signs were found to be deficient and were corrected on a priority system of whether the sign was regulatory, warning, or informational.

Before summer all culverts (any structure with a span of less than 10 ft) were located and a detailed inspection was made. Information gathered included the size and length of the culvert, location of headwalls, skew, grade to stream bed, general condition, guardrail, channel alignment, and the distance from ditch to ditch. All the above items were entered into a separate data base file for quick access of more detailed information. In the large highway inventory data base file, only the information common to the rest of the file was entered.

When the bidirectional distance event data printer was delivered the main drive to gather the field inventory was begun. Each roadside item was assigned a separate code that was keyed in at the site. The information on the tape showed the code item and distance from the point of beginning. Each road tape was correlated and adjusted to correspond with the photolog file. This information was used in designing two separate field data sheets to be used by the two crews.

To expedite the gathering of these data each crew was assigned to gather specific roadside information. Detailed data were obtained at all guardrail, sign, catch basin, county and township stone, and utility crossing locations; also cross sections were taken every 1,000 ft along the road. Data on bridges were included in the master inventory file; but bridges were not included in the field survey because all data were available within the office. As with the culverts, a separate data base file was compiled for bridges so that detailed information could be included, see Figure 1.

ENTER DATA

A generalized data base entry sheet was created so that a common format could be used to enter all the data into the computer. A sample of this entry sheet is shown in Figure 2.

It soon became apparent that a 5 1/4 floppy disk was insufficient to store the amount of data that would be gathered. A reassessment of needs indicated that a 20 megabyte hard disk drive was more than adequate. About 10 megabytes of hard disk drive could store the entire inventory file as one unit with the diskettes acting as backup copies, thus providing a quick, efficient access system. The remaining peripheral, 10 megabyte storage could be used for other engineering and administrative programs.

Because the computer system supplied by the contract was compatible with existing computer equipment, it was not necessary to purchase another daisy wheel printer, which was part of the original contract. Through discussions with the Department of Highway Safety, the original contract was revised to delete the printer and include a 20 megabyte hard disk drive system with no deviation from the agreed contract price. The equipment and software purchased are as follows:

1. Apple III microcomputer with 256K,
2. Apple III monitor,
3. Apple III external disk drive,
4. Transwave NK 1203 P distance event data printer,
5. Nu Metrics DE-140LC bidirectional distance-measuring,
6. Sola Computer Regulator 1500 VA,
7. Corvus 20MB hard disk drive, and
8. Software included Apple Business Basic, Apple Graphics, Apple Pascal III, and VisiCalc.

ESTABLISH PRIORITIES

When the inventory data file is completed, the data base management program will be used to establish priority lists for upgrading substandard conditions on the county road system. Working within the budget restraints of this office, several programs will be undertaken annually to provide a safe highway system for the citizens of Clinton County. See Figure 3 for a sample report that can be generated by the computer. This report is merely a listing of the signs along one road, but the computer could have easily printed out only the stop signs that are

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  Road Name: Hunt                                    Date: 82-06-14
Road Number: 280      Mileage: 02.47              Township: Jefferson

Bridge Description: High Pratt Truss
              Code: 344          Wearing surface: Wood deck   Year built: 1889

     Percent Legal: 100         Operating Rating: 39
      Suff. Rating: 68.63       Inventory Rating: 30
 General Condition: 7           Ave. Day Traffic: 50

   Number of Spans: 1              Drainage Area: 24.85
Span lengths (C/C): 78.7                   Q 25 : 4288
     Roadway Width: 15.8                   Q 50 : 5013
    Overall Length: 80.8                   Q 100: 5788

Vertical Clearance: 10.5        Height Grade to Stream bed: 16.8
              Skew: none        Height Grade to High water:
      Railing type: Steel Channel       Date of High water:

Comments:
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FIGURE 1 Data base form with sample input.

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Road Name: New Burlington                    Date: 1-6-84
Type: Sign              Number: 005        Mileage: 03.642  Side (L or R): R
Type Code: W-1          Description:                          Condition: 1

Size/Dimensions: 30" x 30"        Length:                     Width:

Dist. from E/P: 6.5        Hght. from E/P: 5.5        F/F Guardrail:
Post Condition:            Post spacing:            Anchor Assembly:
Reflectivity  : yes        Background color: Yellow     Legend color: Black

Berm  Type:                C/L to Ditch:            C/L to Fence:
Berm Width:                Depth from E/P Left:             Right:

Suff. Rating:         % Legal:        No. of spans:       Span Lengths:
Crd-Strm Bed:                         E/P to headwall:

Inter. rd(s):                              Adjacent Co./Twp.:

Catch basin top (type):                Condition:          Depth:
Comments: new 12-16-83
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FIGURE 2 Data base inventory form with sample input.

New Oglesbee Road Sign Inventory

Number	Mileage	Side	Type	Description	Size	Reflect	Lat. Pos.	Height	Background	Legend	Cond.	Comments
059	00.005	L	R-1		30" x 30"	075	6.5	5.5	Red	White	1	rplc 11-4-83
		L	RN	Center, New Oglesbee	18" x 6"	yes	8.0	7.0	Green	White	1	2RN 30"x 6", rplc 10-26-82
	00.014	L	RN	Hawkins	24" x 6"	yes	26.5	6.8	Green	White	1	
	00.015	L	R-1		30" x 30"	080	5.2	5.5	Red	White	1	replaced 7-6-83
	00.020	R	W-5		30" x 30"	096	7.6	5.5	Yellow	Black	1	raised 3-2-83
		R	W-143	45 mph	18" x 18"	094	7.6	4.0	Yellow	Black	1	new 3-2-83
	00.124	L	W-45		36" x 36"	086	9.5	3.3	Yellow	Black	1	
	00.240	L	W-5		30" x 30"	080	9.4	5.5	Yellow	Black	1	raised 3-2-83
		L	W-143	45 mph	18" x 18"	120	9.4	4.0	Yellow	Black	1	new 3-2-83
	00.713	R	W-2		30" x 30"	092	7.0	5.5	Yellow	Black	1	raised 3-2-83
		R	W-143	30 mph	18" x 18"	098	7.0	4.0	Yellow	Black	1	new 3-2-83
	00.872	R	W-18		30" x 30"	148	6.8	5.5	Yellow	Black	1	raised 3-2-83
		R	W-143	20 mph	18" x 18"	108	6.8	4.0	Yellow	Black	1	new 3-2-83
	00.941	L	W-1		30" x 30"	108	5.3	5.5	Yellow	Black	1	raised 3-2-83
		L	W-143	30 mph	18" x 18"	096	5.3	4.0	Yellow	Black	1	new 3-2-83
	01.136	L	W-18		30" x 30"	150	5.7	5.5	Yellow	Black	1	raised 3-2-83
		L	W-143	20 mph	18" x 18"	100	5.7	4.0	Yellow	Black	1	new 3-2-83
	01.233	R		Slow Children at Play	18" x 24"	144	4.3	4.0	Yellow	Black	1	
	01.358	R	W-45		36" x 36"	136	5.8	3.9	Yellow	Black	1	
	01.467	R	R-1		30" x 30"	071	7.4	5.5	Red	White	1	raised 9-15-83
		R	RN	Gurneyville	30" x 6"	yes	4.0	8.0	Green	White	1	
						Count:	21				21	

FIGURE 3 Sample output of the sign inventory.

less than 5 ft above the edge of the pavement. These reports can be used as a checklist by the road crews to upgrade deficient conditions.

Figure 4 is a sample output of the detailed bridge report. Again this information may be sorted on any field to obtain the desired results. For example, the office may be interested only in all bridges with a sufficiency rating less than 50, a span of less than 50 ft but greater than 20 ft, and a road width less than 20 ft. The data base program sorts all available data and prints out only those bridges that meet the established criteria.

Before the data were entered into the computer, several deficient items became obvious and immediate corrective measures were taken. As previously mentioned, nonreflective signs were replaced based on the nature of the sign. After logging the catch basins within the county, another deficiency became apparent. Many catch basins had either old broken down covers or no cover at all. Therefore, a program was initiated and completed to provide each catch basin with a metal top capable of supporting the weight of a motor vehicle.

ADD NEW DATA

Although it was not within the bounds of the contract, the Clinton County engineer determined the need to study all curves in the county because many of the posted advisory signs were questionable. As recommended in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), a ball bank indicator was used to determine the safe speed through each curve. All information was entered in the computer, and the data base program was used to determine curves that were improperly signed. Out of 462 potential sign locations the study showed that 443 locations were incorrectly signed or not signed at all. The County engineer immediately issued an order to purchase the necessary advisory speed signs

Bridge Report

Road #	Mileage	Road	Description	Code	Wear. Surf.	Q 25	% Legal	Suff. Rat.	Cond.	Span	Width	GTSB	ADT
002	00.25	Spring Hill	Prestressed Concrete Box Beams	231	Asphalt	15142	150	91.61	9	64-80-64	28	23.2	1800
	00.39	Spring Hill	Steel Sect. Plate Pipe Arch	395	Asphalt	1543	150	99.73	9	16.5	24	12.0	1800
003	00.44	Nelson Ave.	Howe Truss	344	Asphalt	2382	100	71.44	6	70	24	12.0	2500
004	00.03	Creek	Camelback Truss	344	Asphalt	14971	100	77.45	7	88.5-31.5	24	19.5	500
	01.92	Creek	Steel Beam CSD	321	Asphalt	676	100	84.73	7	29	23.7	6.4	250
	02.62	Creek	Steel Beam CSD	321	Asphalt	758	110	74.76	7	29.2	19.8	11.8	250
005	03.40	New Burlington	Steel Beam with Concrete Deck	321	Asphalt	389	85	65.43	7	15	22.6	6.5	270
	03.63	New Burlington	Steel Sect. Plate Arch	395	Asphalt	442	150	99.94	8	18.3	21	10.0	270
	04.33	New Burlington	Camelback Truss	344	Asphalt	6461	60	47.02	6	105	18	14.8	280
	07.23	Port William	Steel Beam CSD	321	Asphalt	1933	100	85.85	8	42	24	8.0	350
	08.82	Port William	Stone Slab - Steel Sect. Arch	595	Asphalt	406	150	85.66	7	16	17.5	10.0	340
	09.33	Port William	Camelback Truss	344	Asphalt	4616	100	51.11	8	88.8	22	18.0	350
	09.85	Port William	Prestressed Concrete Box Beams	231	Asphalt	4082	150	99.85	8	46-46	33.4	16.0	340
	10.63	Sabina	Cont. Reinf. Conc. Slab	112	Asphalt	1734	150	99.86	8	24-30-24	28	13.0	310
	12.25	Sabina	Steel Sect. Plate Pipe Archs	395	Asphalt		150	97.77	8	5-5	24	4.0	300
	12.49	Sabina	Steel Beam with Concrete Deck	321	Asphalt		100	85.65	8	14.2	25.6	5.5	300
	14.06	Sabina	Steel Beam with Concrete Deck	321	Asphalt		112	66.88	8	13.3	21.3	6.2	300
	18.74	Sabina	Steel Sect. Plate Pipe Archs	395	Asphalt	753	150	99.89	9	9.5	24.0	8.0	250
006	01.63	Westboro	Steel Beam Concrete Encased	321	Asphalt	545	65	49.13	7	17	22	7.5	620
	03.88	Westboro	Steel Beam with Concrete Deck	321	Asphalt	448	100	76.26	8	14.2	21.5	5.7	540
	04.17	Westboro	Steel Beam with Concrete Deck	321	Asphalt	655	150	78.38	8	12	21.1	7.8	540
	04.40	Westboro	Steel Beam with Concrete Deck	321	Asphalt	763	150	80.65	7	12.3	22.5	7.7	540
	04.88	Westboro	Steel Beam with Concrete Deck	321	Asphalt	3721	150	81.93	8	44-55-44	25	17.0	650
	10.82	Lynchburg	Steel Beam Jack Arch-2 ext.	321	Asphalt	1116	95	69.72	7	27.5	22	9.3	300
	12.52	Lynchburg	Camelback Truss	344	Asphalt	4603	100	72.34	8	102	24	16.5	820
007	01.62	Farmers	Steel Beam with Concrete Deck	321	Asphalt	1225	150	80.74	8	35.5	20	9.5	400
	03.42	Farmers	Steel Beam Jack Arch-1 ext	321	Asphalt	638	100	83.53	6	(varies)	19.2	8.6	480
	05.69	Farmers	Steel Sect. Plate Pipe Arch	395	Asphalt	536	150	99.69	8	13	24	7.5	680

FIGURE 4 Sample output of the bridge inventory file.

(W-143 OMUTCD). Upon delivery of these signs, all curves were properly posted with the correct advisory speed.

The curve study program also revealed sites where bridges were located within a curve area. Guardrails usually extend beyond the limits of the bridge which creates an additional hazard within a curve. Guardrail reflectors were purchased and placed at numerous sites to delineate the curves better for night driving.

DEVISE REPORTING FORMS AND PERFORM PERIODIC INSPECTIONS

A form was devised for the sign crew to use in reporting actions taken at each sign location. These forms are turned in to the office and the information can be used to update the master inventory file. The forms will also be retained for 3 years in the office as hard copy.

A retroreflectometer was used to measure the reflectivity of each sign. The data obtained from these measurements were converted to a percent of total reflectivity and included in the master inventory file. Periodic measurements will indicate the rate of deterioration and a long-term sign replacement program can be established. Also new signs are checked to ensure that reflectivity meets the specified standards.

A program to periodically recheck inventory items along roads has been established to ensure that the current daily reporting system is adequate to maintain an up-to-date inventory file. The inventory files are only as reliable as the data stored in the system. Therefore accurate data are important to the proper use of the system for upgrading programs as well as any liability suits.

SUMMARY

Any manager realizes that before a program is undertaken, a list of facts must be compiled and presented in a meaningful report form based on a preestablished priority system. For the program described the process includes locating each incident, identifying the specifics of each item, rating the overall condition, and then establishing priorities for upgrading substandard conditions.

This program has successfully completed the first three phases of this process. When priorities have been established, a program will be instituted to upgrade roadside features and traffic control devices. As previously mentioned, several programs have already been instituted to improve the highway system.

The goal of the Clinton County engineer to provide a safer environment to the traveling public can now be realized. Only time will tell if the long-term goal of reducing the number of accidents caused by faulty or substandard highway features and traffic control devices can be achieved.

Discussion

Kenneth A. Brewer*

Mr. Nimz has outlined one of the uses for a microcomputer system in engineering management of lower order highway systems that is a favorite of mine. Local transportation agencies in many states are under pressure from diminishing resources and increasing litigation to manage more precisely the maintenance and operation of an old highway network. Because the city or county network under the jurisdiction of a local highway agency is often small enough that the memory size and storage capacities of microcomputers are large enough to handle the descriptive and analytic data sets, these information systems become a powerful engineering management tool.

The paper documents the steps and phases that Clinton County, Ohio, proceeded through in developing a source of funding to acquire the microcomputer system, and the data collection practices they had to establish to provide the data base necessary for implementing a microcomputer highway inventory. The paper implies that the acquisition of the microcomputer system was significantly funded by the use of highway safety funds. I can see this as a logical and justifiable use of these funds. However, I am not certain that persons with less exposure to the rigors of trial preparation, defense of accident litigation, and attempting to justify the "engineering judgment" decisions in setting priorities for highway maintenance may see the connection as clearly as Mr. Nimz and the Ohio Department of Highway Safety did. I believe it would be informative to the audience, both local agency highway engineers and state agency and federal agency engineers, for Mr. Nimz to outline how the acquisition of the microcomputer was justified. For such an acquisition program to be successful, responsible persons at all review levels must understand both the potential and the limitations of microcomputer systems in enhancing highway safety.

At one point in the paper Mr. Nimz outlines a legal point in defense of highway management practices with respect to Ohio Supreme Court rulings associated with "priority" and "systematically correct deficient conditions." He goes on to state "Often the risk of liability suits can be reduced when reasonable intent can be shown that a systematic approach is being taken to correct problems." It may be helpful to outline how the development of a computerized highway inventory permits an engineering manager to demonstrate that a systematic approach is being taken to correct problems. Some people are afraid that having a more precise inventory without changing the way problems are attacked will only systematize the discovery of deficiencies.

I am interested in knowing (and I suspect the reader may also be) whether the equipment and software packages that make up the system were specified in the request for bids or was the system acquired by issuing a request for brand specific quotations? I know of agencies that asked for a low bid on a "generic" specification they thought was written to an IBM-PC system and wound up with Zenith-Heath as the low bid. I know of one that thought the "generic" specification was written for Zenith and Texas Instruments and wound up with a low bidder meeting specifications from Radio Shack.

The paper indicates that a microcomputer with 256K memory and two disk drives was obtained. How were the dimensions of the system determined prior to acquiring it? How much memory will each disk drive handle? Did you know that 256K memory was big enough or bigger than you needed? I know of a city public works department that bought a 256K main memory IBM-PC and several months later found out that they needed more internal memory to do what they wanted. The solution was to have the machine modified to go to 512K memory. Other brands of ma-

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chines are more efficient in memory allocation and would have worked very well for this city with 256K (or perhaps even less); but because the actual uses were only vaguely defined at the time of acquiring the microcomputer, the configuration for initial installation was determined more by price than user definition. Mr. Nimz documents later in the paper that the original printer order was deleted and replaced with a hard disk "with no deviation from the contract price." It would be helpful to know the time sequence of events that produced this change of hardware. Some agencies and suppliers might not have the flexibility to make such a drastic change without an increase in contract price. If an additional cost were incurred, some agencies might not be able to absorb it within a budget year.

Mr. Nimz states in his paper that "the long-term goal of the program is to reduce the number of accidents caused by faulty or substandard highway features and traffic control devices as well as reduce the possibility of liability law suits." This is a typical type of general goal that requires upper level review to make a "leap of faith" in accepting the premise that computerization of some process will be a step toward this goal. Was any measurable objective set that could be used to evaluate the effectiveness of the computerized inventory such as "reduce the ratio of citizen notices to county forces notices of defective traffic control devices by 20 percent"? Was there an attempt to set any operational improvement measures that could be evaluated in the short-term (1 or 2 years) that might justify computerization even if no reduction in accidents or law suits was noticed?

I especially appreciated Mr. Nimz including information on the resources required to develop the initial data base. He indicated that he hired two summer employees and assigned two permanent persons on an occasional basis to inventory 270 miles of county roads with 290 bridges, 1,100 culverts and 2,300 signs. His records indicated that 1,000 man-hours and 5,572 road miles of travel were required to complete the data collection and processing. It is necessary to share that type of information for other agencies to make an intelligent management decision about whether they should or should not computerize with microcomputers. This paper is informative and contains a prime example of the inventiveness of local highway agency managers to try out technological advances to improve their operation.

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Playing Games with the Maintenance Program on A Microcomputer

DENNIS FILE

ABSTRACT

The Illinois Department of Transportation's maintenance management information system (MMIS) is being extensively enhanced and modernized. The new system will be composed of three synergistic subsystems--performance budgeting, maintenance management, and equipment management. Micro- and minicomputers dedicated to the MMIS will play a prominent role in the new system. The project to rebuild the system began in 1980 and the new MMIS is scheduled for installation over a 3-year period, which began in March 1984. Therefore, several of the features described are planned and designed but not implemented at this time. The report examples shown are mock-ups.

In the past decade there have been major changes in the maintenance of state highways in Illinois. Reduced revenues and escalating labor, material, and equipment costs have required that the transportation department take a number of unprecedented steps. Field crews have been pared down to meet reductions in staff allocations; and equipment life has been extended, where possible, by postponing replacements. Levels of service have been reduced to address only the most urgent needs while the backlog of unmet needs continues to accumulate.

Faced with the challenge to do more with less, the transportation department is also in the process of upgrading its system of management controls in the area of highway maintenance. In January 1980, the Illinois Department of Transportation requested proposals for developing the "requirements definition" and "logical design" for a system to better plan and control maintenance efforts and resources.

The selected consultant, Byrd, Tallamy, MacDonald, and Lewis, completed the study in early 1981. The new system is entitled the maintenance management information system (MMIS) and is comprised of three, interrelated, synergistic subsystems:

- Performance budgeting subsystem,
- Maintenance management subsystem, and
- Equipment management subsystem.

The following describes the primary objectives and features of each of the subsystems.