A Pavement Feedback System for the Illinois Department of Transportation: Feasibility and System Requirements

R. J. ROMAN, M. B. SNYDER, M. I. DARTER, and M. R. BROTEN

ABSTRACT

Presented in this paper are the results of an investigation of the need for an improved Illinois pavement feedback system (IPFS) for the collection, storage, retrieval, and utilization of important pavement information. The study clearly showed that there is a critical need for improved procedures for feeding back pavement performance data and correlating it with design, traffic, and other information for the pavement management purposes of the Illinois Department of Transportation. The system requirements of the IPFS were limited to address development and evaluation of pavement policies and guidelines as well as design methods and standards, pavement life prediction models for new and rehabilitated pavements to aid in projecting future performance and in answering "what-if" questions, special pavement studies and research needs, and initial implementation on the Interstate highway system plus selected other pavement sections. This paper will be of interest to state highway agencies that are either developing or improving their pavement feedback systems.

Presented in this paper is a summary of the results from a study on the need for improved pavement feedback information and analysis for pavement management in the Illinois Department of Transportation (IDOT). Research study IHR-517, the Development and Field Testing of an Illinois Pavement Feedback System (IPFS), was begun in January 1984 by the Department of Civil Engineering, University of Illinois, in cooperation with the Illinois Department of Transportation. The major work phases included

- Investigative study,
- Definition of system requirements,
- Logical design of the system,
- Physical design of the system,
- Implementation, and
- System adjustment.

Discussed in this paper are the results of the first two phases only. This discussion is intended to provide the primary background documentation for determining the future development and direction of the IPFS. The results presented in this paper were obtained through numerous interviews held with IDOT personnel, identification of pavement management information flow, and evaluation of current information sources.

PROBLEM DEFINITION

There are many problems facing highway administrators and engineers today, but many of the most critical deal with the maintenance and management of highway pavement facilities. These problems include

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1. The rapid deterioration of United States' pavement systems,
2. The effective expenditure of limited resources for maintenance, rehabilitation, and reconstruction to maximize the benefits of the transportation dollar, and
3. The preservation of credibility among legislative bodies and the public regarding the maintenance and management of the pavement network.

The 1960s and 1970s were a period of unprecedented highway construction, but many of the pavements built during that period have already reached or are now approaching the end of their service lives and are in need of major rehabilitation or reconstruction. Others are showing signs of serious distress much earlier than expected. This realization has led many highway administrators to take a new look at the way they have programmed, designed, constructed, and maintained pavements, and to attempt to find ways to manage their pavement systems more effectively.

Pavement management encompasses many of the daily activities of every highway agency, such as allocation of financial resources, pavement maintenance and rehabilitation activities, design and construction of facilities, special studies of pavement failures, and so forth. Central to the pavement management picture are the directors, bureau chiefs, district engineers, and others who are responsible for the execution and coordination of these activities and for weighing the alternatives to achieve the best possible benefits from the available funds. To manage pavements effectively, it is essential that these managers and engineers have rapid access to adequate information about the pavement network on which to base their decisions. This includes detailed information (such as design, traffic, performance, and costs) about the thousands of individual pavement sections that make up the highway system. The flow of major pavement-related information in IDOT is shown in Figure 1.

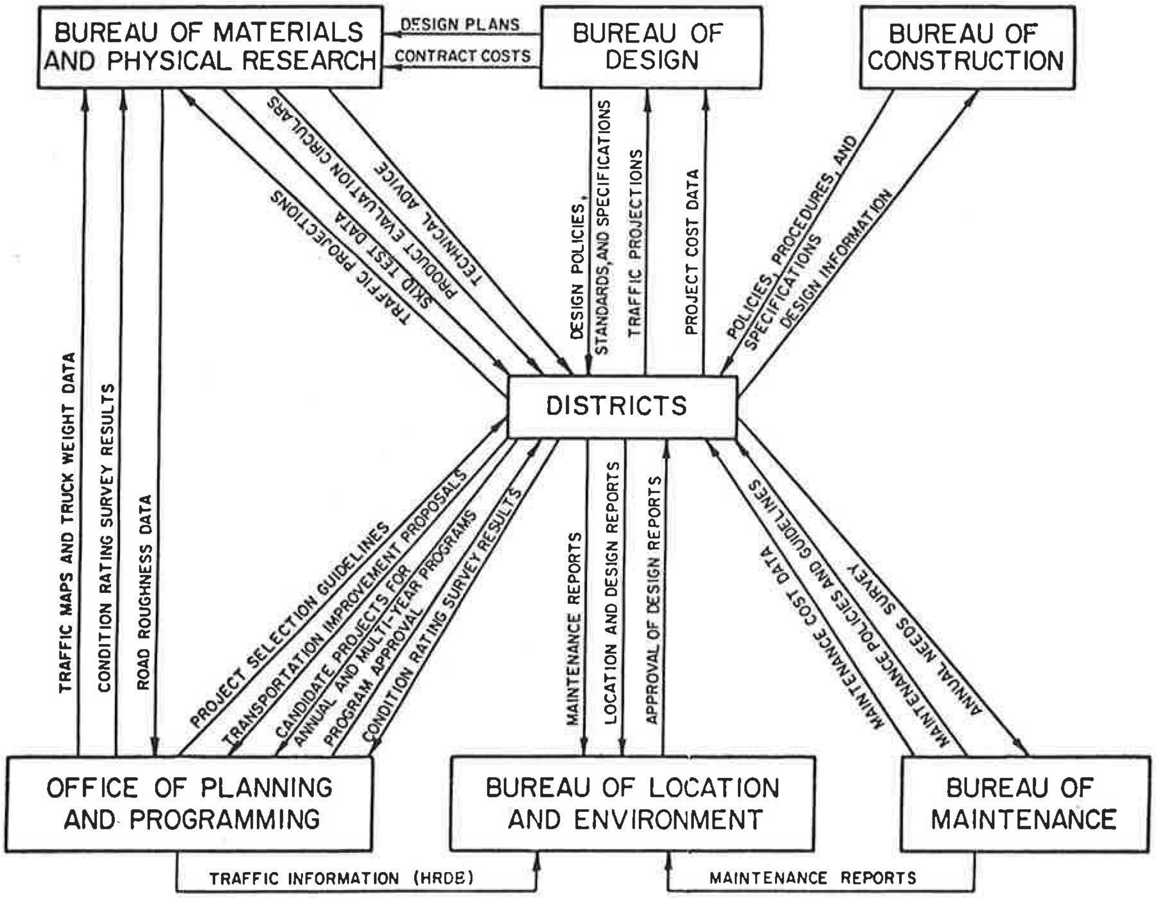

FIGURE 1 Flow of major pavement-related information in the IDOT.

The process of collecting information, analyzing it, and making decisions takes place at two different levels. One is the project level where decisions are made about specific projects (e.g., a decision to overlay or restore a particular section of pavement). The other is the network or program level, where decisions are made that affect the entire system of pavements. At either level, the heart of the pavement management system is the data base, as shown in Figure 2.

IDOT managers are currently facing many general pavement management-related questions that could be addressed quantitatively with pavement feedback data, including

1. Are current pavement design procedures producing pavements that perform satisfactorily?
2. Are current rehabilitation standards and policies resulting in acceptable rehabilitation project performance?
3. What will be the overall condition of the Interstate Highway System in 5 and 10 years?
4. How quickly are traffic loadings (equivalent single-axle loads) accumulating on the pavement network?

More specific questions include

1. What effect have underdrains had on pavement performance?
2. Have 2-in. asphalt-concrete (AC) overlays of continuously reinforced concrete pavements (CRCP) performed satisfactorily?
3. What has been the relative performance and cost-effectiveness of full-depth Portland cement concrete (PCC) and AC repairs in PCC pavements?
4. What has been the performance of 8-in. CRCP as opposed to 9-in. CRCP?

Many questions such as these cannot be answered if the pavement feedback data are inadequate. Experience has shown that a comprehensive pavement data feedback system would provide the means to address these and many other questions, including identifying the consequences of certain policies and funding levels (answering "what-if" questions). It was this perceived need to improve procedures for information gathering, processing, and analysis to aid in better management of the highway system by the IDOT that resulted in the initiation of this study (1).

DEFICIENCIES IN CURRENT IDOT INFORMATION SYSTEMS

The IDOT currently maintains more than 40 different data bases that address various pavement management tasks (2). However, there are several serious deficiencies in these information systems that prevent them from forming the foundation of a comprehensive pavement feedback system. These deficiencies can be grouped into the two following general categories (a) data availability deficiencies and (b) system deficiencies.

Data Availability Deficiencies

The data availability deficiencies can be subdivided into the following categories:

1. Lack of required data. Much of the data required for a comprehensive pavement feedback system are not stored in any existing computerized IDOT data base. This information includes both inventory and monitoring data as follows:

- Inventory data are defined as pavement design and materials data, traffic volumes and characteristics, climatic data, past rehabilitation activities, and so forth. Inventory data are required for project level planning and network-level analysis activities such as special studies, developing performance models (e.g., predictive equations for serviceability and various distresses), and evaluating policies and guidelines, and design standards and procedures.
- Monitoring data are defined as data that are routinely collected and stored and that include pavement distress and serviceability data, skid resistance, pavement roughness measurements, and nondestructive deflection testing results. Monitoring data are the basis for the development of models for the accurate prediction of distress occurrence (such as cracking, edge punchouts, or deteriorated joints) or system condition at any time in the future. Monitoring data are also required to evaluate pavement performance and the impact of management decisions on pavement performance (e.g., condition and traffic monitoring data are needed to evaluate the effects of the recent increase in allowable truck weights on pavement performance). Much of this type of information is not readily available.

2. Inadequately detailed data. Much of the information currently stored in IDOT's computerized data banks is insufficiently detailed for pavement feedback applications (3). In addition, the existing condition rating survey value (CRS--a numerical rating between 1.0 and 9.0 based on visual estimates of distress quantity and severity) is not sufficiently detailed or objective enough for research and evaluation purposes. Additional field surveys are often required to provide the kind of quantitative information needed (i.e., type, severity, and measured amount of distress) to evaluate pavement performance, policies, and guidelines, and design procedures and standards.

3. Lack of up-to-date information. The information used for many pavement management activities is often not current. Many data elements are collected only every few years, and there is often a considerable delay in entering these data elements into the data bases. Current information must often be obtained through nonstandard channels (e.g., by special request, conducting a special survey, or manually searching files awaiting data entry). The accuracy of these data (i.e., lack of currency) adversely affects the usefulness of the strategies developed using the data.

4. Inaccessibility of data banks. Because the data required for many pavement management activities are not all stored in a centralized, computerized data base, the accessing of required data is often a problem. Data required for pavement management decisions often come from a variety of sources that have been developed over many years, using the technology (and addressing the needs) of the day. Thus, older data storage systems (i.e., manual files) often hinder the retrieval of the large amounts of data typically required for pavement management purposes. This is particularly true for the retrieval of inventory data such as original design, materials, traffic, and construction information for existing pavements. Obtaining these data, if they are even available, often involves manually searching several existing files.

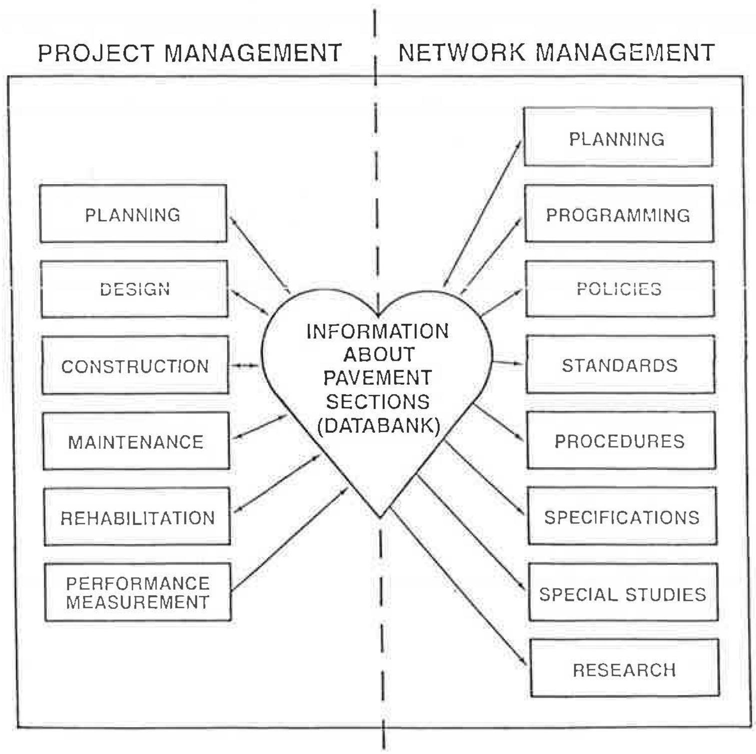

FIGURE 2 Pavement management system showing the importance of information flow and analysis.

System Deficiencies

In addition to data availability deficiencies, there are also several data storage and retrieval system deficiencies that would prevent these systems from forming the foundation of a comprehensive pavement feedback system. These system deficiencies can be broken down into categories as follows:

1. Inadequate data storage. Existing computerized systems do not currently store all of the inventory and monitoring data necessary to address IDOT's pavement feedback data needs. These systems are not set up to handle the volume of data required, and even if these systems could be expanded, data handling and processing times would continue to be unacceptable (4).

2. Lack of a common referencing scheme. One of the major deficiencies in IDOT's current pavement management program is the lack of a common referencing scheme for pavement sections. This inhibits communication and leads to time-consuming manual transactions and analyses. Figure 3 shows the major IDOT data bases and the flow of information between them. The connecting arrows indicate communication or cross-referencing between data banks, and the direction of information flow. In most cases, the existing independent systems appear to serve their intended purposes well, but it frequently takes a great deal of work to get even a few of these systems to work together toward a common goal. This figure clearly shows that there is no common tie between all of the data banks and that many of them are practically stand-alone systems. There is also no standard pavement "section" definition for management purposes that would enable a common referencing system to be keyed to each section.

A good pavement management program requires good communication within each bureau and between the various bureaus, offices, and districts as well. The IDOT Referencing Committee recently prepared a report on their findings and recommendations for a statewide referencing system to be used by all IDOT departments. A link-node referencing system has been selected for statewide use.

3. Limited special studies applications. The existing computerized systems are not flexible enough to address special pavement studies applications. In addition to the lack of inventory and monitoring data in the existing systems, and the problems many users have in accessing the system, much of the software currently in use has very limited report-generation and statistical-analysis capabilities.

"What-if" and special study questions that IDOT managers need answers to, such as the following, are impossible to address quantitatively with the current systems:

- What has been the performance of thin AC overlays on CRCP?
- What has been the performance of 10-in. CRCP compared to 9-in. CRCP in similar traffic and climatic conditions?
- Do retrofit underdrains extend remaining pavement life and are they cost-effective?
- What effect does placing dowel bars in full-depth concrete repairs have on long-term repair performance?
- How much do intensive maintenance practices extend pavement life?
- What are the relative effects of traffic and bituminous mix design properties on rutting of AC overlays?

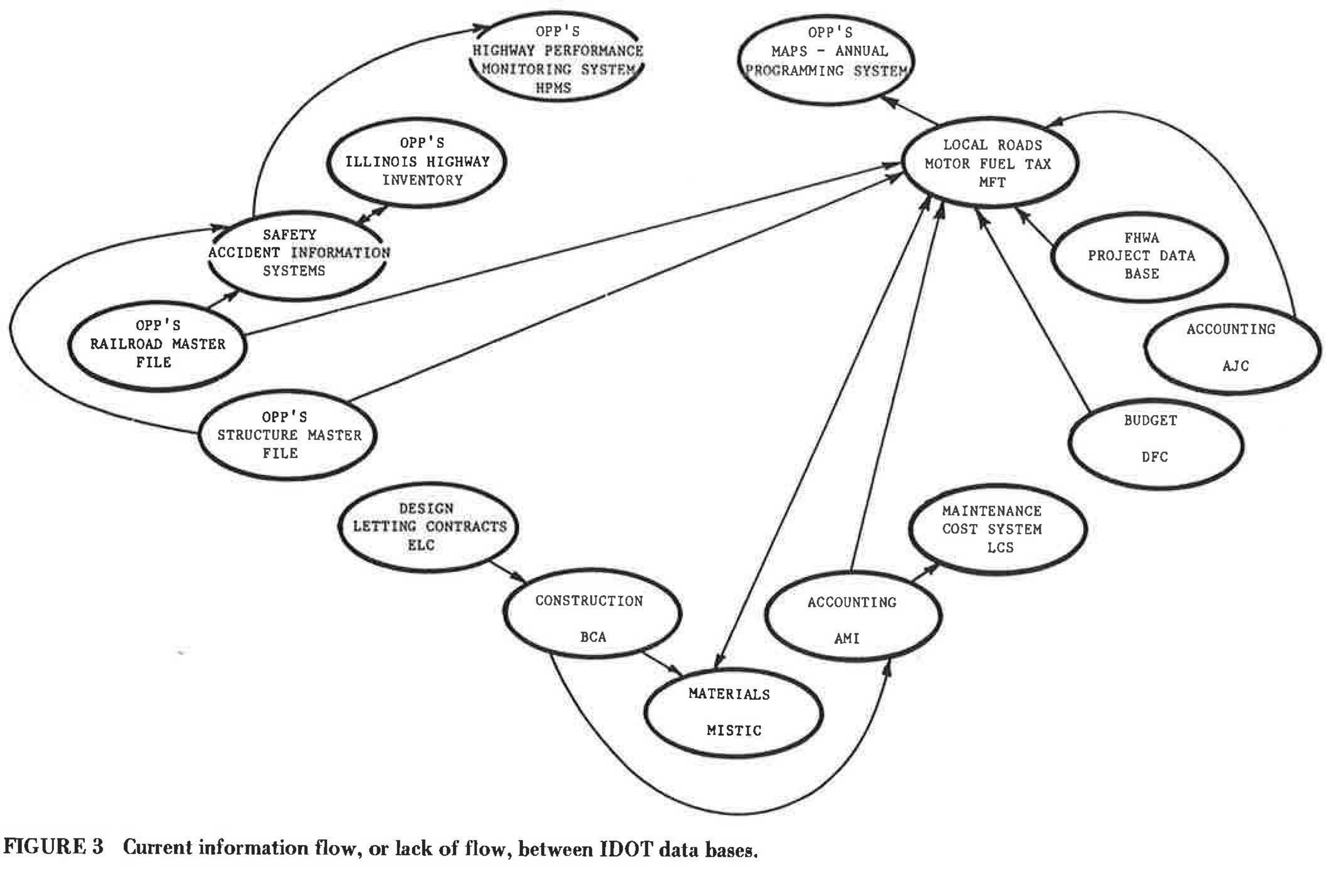

FIGURE 3 Current information flow, or lack of flow, between IDOT data bases.

• What PCC pavement rehabilitation technique has proved to be the most cost-effective and reliable--concrete pavement restoration (CPR), thin AC overlay, or "crack-and-seat" followed by a structural AC overlay?

A single system with the required data, analysis capabilities, and flexibility is needed to aid in efficiently performing special pavement-related studies such as these.

4. Lack of graphical data display capabilities. The data display of most pavement management outputs is currently limited to hard copy listings of information. Existing computerized data bases have little graphical data presentation capability. Graphical capabilities are needed for several purposes, however, including: (a) to display trends in pavement performance versus selected design, construction, traffic, or climatic variables on particular pavement sections; and, (b) to aid in quickly identifying, locating, highlighting, and describing areas and selected items of interest on a computer-generated pavement network map. Thus, a graphics-capable system would greatly assist in communicating pavement needs and conditions to management.

The preceding deficiencies have resulted in the lack of a formalized, systematic approach to pavement management. Over the years, the pavement management system that has evolved at IDOT has done so in a piecemeal or as-needed way (1). The resulting system is not as efficient as it could be, it may or may not perform as desired (depending on what is demanded of it), and it has limited capabilities for expansion and upgrading. In addition, these deficiencies have led to many functional problems for the central offices of the IDOT. The following are representative of the types of problems that were identified during the investigative study portion of this project:

1. Policies and guidelines are sometimes established without full consideration of technical data, which are often unavailable. As a result, these policies and guidelines are sometimes established based on an office perception of a field problem--which may not be completely accurate.
2. Design procedures and standards are also sometimes adopted and continued for a long period without full knowledge of their performance history on previous projects. This failure to monitor the performance of new and existing designs and rehabilitations may result in the construction of many additional miles of unsatisfactory pavement.
3. It is often desirable to obtain background information for policy development, research, and so forth. Current data are frequently unavailable to produce reports in the required format or on short notice. In addition, original design, construction, and materials data are often not readily accessible, if available at all.

Findings

This investigative study identified significant problems and deficiencies in the current IDOT pavement feedback system. It was concluded that some type of an improved IPFS is greatly needed to improve IDOT's pavement management system.

RECOMMENDED SOLUTION

There are two possible alternatives for providing an improved IPFS: (a) utilize one or more of the existing computerized data banks and add the required data elements and analysis capabilities, or (b) develop a new computerized pavement feedback data bank, but draw from and interact with the existing data banks as much as possible.

Much consideration was given to expanding one or more of the existing data banks. However, the technical requirements of the IPFS would make it difficult, if not impossible, to utilize these data bases as the primary data base, even with major revisions to them. (This was also the general feeling of IDOT personnel who currently manage these data bases.)

Thus, it was concluded that a new pavement feedback data system must be developed that specifically addresses the pavement management needs defined in this study. This system must meet the joint requirements of providing both rapid interactive response to system users while maintaining a large data bank. There is a considerable amount of background and developmental work in this area that can be used by available systems (5,6).

The scope of this pavement feedback data bank will be limited initially to address the pavement management activities of the central offices, and, to aid in implementation, the initial design and implementation of the system will be limited to the Illinois Interstate system and selected sections of the primary and secondary systems. As a minimum, however, the data base will contain an adequate number of pavement sections to summarize pavement information over the entire Illinois Interstate highway pavement network and to address specific design questions regarding pavement designs not found on the Interstate system.

The primary users of the initial data feedback system will likely include the following offices:

- The Bureau of Materials and Physical Research,
- The Bureau of Design,
- The Bureau of Maintenance,
- The Office of Planning and Programming,
- The Bureau of Location and Environment, and
- The districts.

These offices should be able to incorporate the new system into their operations quickly and to utilize its benefits effectively. Some of the district offices may also wish to access the data bank, and this should not be discouraged. As the system becomes established, it is likely that most of the district offices will utilize the system.

DATA REQUIREMENTS

General data element types that address the potential pavement data feedback system uses discussed earlier were identified and are listed as follows for inventory data:

- Pavement section identification/location,
- Shoulder, geometrics,
- Layer properties and design,
- Drainage systems,
- Subgrade properties,
- Original materials and construction data,
- Historical climatic information,
- Past maintenance/improvements,
- Rehabilitation design, and
- Traffic data.

General data element types were also identified for monitoring data and are as follows:

- Roughness, skid, and CRS,
- Distress,

- Deflections,
- Annual maintenance,
- Pavement improvements/rehabilitation,
- Annual climatic information, and
- Annual traffic information

Specific data elements that should be included in the proposed system have also been identified. These were selected to facilitate generation of the many specific outputs that were identified to address IDOT's future pavement feedback data needs.

DATA COLLECTION REQUIREMENTS

The collection of the initial set of required inventory and monitoring data will be a major work task. After collection, the inventory data will remain essentially unchanged in the data bank. The monitoring data, however, must be collected at regular intervals to keep the data bank up-to-date. These intervals should be reasonably short at first (e.g., 1-2 years), but may be lengthened after several years when the need for large amounts of monitoring data decreases as the distress and serviceability trends for individual pavement sections become better defined.

The data collection effort must be carefully planned and efficient data collection procedures must be developed. The collection of monitoring data will be formalized in a streamlined procedure that provides for the collection of the most required field data in a single visit to the project site. Some other data, such as roughness, can be collected rapidly with high speed equipment. This will result in efficient data collection that eliminates duplicate efforts and provides consistent data for all IDOT users.

Special equipment may be needed to collect and enter the required inventory and monitoring data in an efficient manner. Although IDOT currently has most of the equipment required to collect the needed data elements, the use of high-speed photography and a stable roughness profilometer would aid greatly in the rapid collection of distress and roughness (and serviceability) data.

Procedures and equipment do exist that can be used to further minimize the effort required for data collection and storage (5,6). For example, the Minnesota Department of Transportation currently uses small hand-held computers to code all distress data in the field. At the end of each day, the data stored by these machines is transferred via phone lines directly into the data base.

DATA BASE AND DATA PROCESSING

The IPFS will ultimately include a large amount of data. A major automated data base manager will be required to handle the data. The use of the "Geo-Facility Data Base" is one concept that will be carefully investigated.

The gas and electric utility industry has developed the concept of a Geo-Facility Information System (GFIS). The primary goals of a GFIS are to "reduce the cost of maintaining facilities records, to store the records in standard form on a computer data base, and to make the facilities data available in the form best suited to user requirements." These goals are similar to those of IPFS and the layout of highway pavement segments are similar to pipe or electrical distribution systems (7-9).

The GFIS provides for a combination of software, hardware, and data bases that could potentially support IPFS applications requiring the use of graphic representation of facilities. A conversion from a GFIS to a transportation information system is currently underway at Pennsylvania State University (8).

The hardware components required to implement a GFIS system include centralized and distributed processors and graphics workstations. Software needs include data base support, interface support, graphics workstation support and applications support. Figure 4 shows the major hardware components and their position in the operational system (9).

The five major hardware components include

1. The host (centralized) processor, IDOT's main computing system;
2. Distributed processors, which are smaller computers located at graphics workstation sites that may be used to relieve the host processor of high interactive overhead and to relieve communications lines of heavy traffic;
3. Direct access storage space for DFIS data bases;
4. Graphics workstations; and
5. Nongraphics workstations.

The graphics display is a monitor screen that displays pictures representing retrieved data, such as highway cross sections or maps. This display unit may have a cursor (a small square or crosshair of light) that can be positioned using a cursor control box (Joystick or mouse). By placing the cursor over any item in the picture and pressing the appropriate keys, the user can instruct the system to modify or delete the item.

The plotter and the hard-copy device both produce a graphic paper document. A typical hard-copy device rapidly prints a small (8.5-by-11-in.) copy of whatever is displayed on the storage tube.

The plotter is slower than the hard-copy device but prints a larger, high-quality document. IDOT may need several workstations with hard-copy devices; only one or two should need to be normally equipped with plotters.

The digitizing tablet provides the means for entering facilities data, including location information. Paper documents (such as maps) and paper keyboards (menus) are laid on the tablet surface, and, through a series of cursor or stylus pointings to menu functions and the document, the data are entered into the computer workspace and shown on the graphics display.

Data processing activities will require the use and purchase of several hardware components including personal computers to ensure the reliable and efficient entry of information into the data base. The personal computers will also be well-suited for most analyses, which will minimize access and turnaround time problems that currently discourage people from trying to use IDOT mainframe machines.

DATA BASE MANAGER

The successful implementation and operation of the IPFS will require that trained IDOT personnel be assigned full-time to the management of the data base. These personnel will perform many tasks, including

- Conduct and coordinate the inventory data retrievals from the various existing IDOT data bases and enter all data into the IPFS.
- Supervise, coordinate, and participate in the annual monitoring data collection activities to ensure uniform and proper data collection without duplication of effort.
- Clean and verify all data that are to be entered into the IPFS.

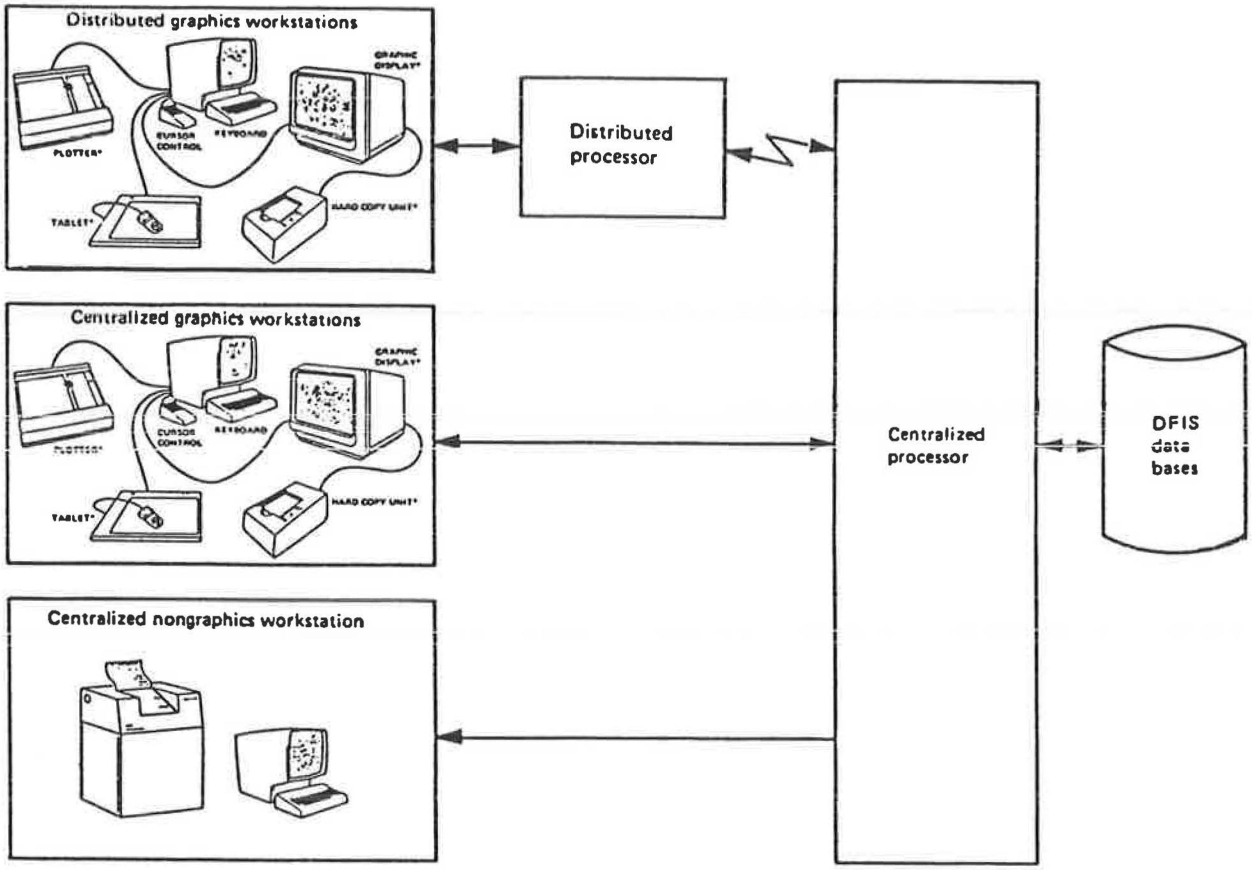

FIGURE 4 Example of geo-facility information system (GFIS) hardware.

- Provide assistance to users in data retrieval and analysis.
- Perform all updates and corrections to the data base to ensure the security and integrity of the system.
- Identify improvements and additional software-hardware needs for efficient operation of the IPFS.

DATA RETRIEVAL AND ANALYSIS

It is recommended that user access terminals be micro or personal computers in combination with a graphics workstation. This will allow the user to retrieve data from the mainframe computer, store it locally on a diskette, manipulate, and even modify the data locally without affecting the integrity of the main data bank. Analyses and reports can also be generated on the personal computer and graphics terminal and printers. This system would provide users with efficient and flexible analysis, report, and graphics capabilities while avoiding lengthy turnaround times on IDOT's mainframe computers. Analysis software can even be developed that will provide the users with additional flexibility in data handling and analysis for the generation of custom reports, graphics, and special studies.

REPORTS AND OUTPUTS

The results of this study suggest that the proposed system must provide three general types of reports (a) standard reports, (b) flexible, user-specified, and generated reports, and (c) graphic or picture reports that may be included in either standard or flexible reports (e.g., maps, graphs, and data plots). All of these capabilities are essential to provide different users with the ability to utilize the system and quickly obtain the desired results.

Most of the standard reports should be menu-driven to maximize the user-friendliness and flexibility of the system so that even a user who is totally unfamiliar with computerized data banks will be able to obtain the information desired with minimal assistance.

Standard reports and outputs could also be run on the mainframe computer to produce data subfiles that would then be downloaded to the personal computers for storage and eventual retrieval, manipulation, analysis, and report generation. Any of these standard reports could be generated on an as-needed basis by the system users or automatically on a periodic basis, as might be required for pavement monitoring or data base management purposes.

The flexible report capabilities will be used to address the numerous special "one-time" research studies that are performed each year and cannot be addressed with standard reports. Software similar to EZtrieve [which IDOT currently uses with the larger data bases (10)] may be developed or purchased to provide flexibility and ease-of-use for producing data subsets that can be more easily manipulated by analysis and report generation software packages.

Specific reports required for IPFS were identified and workups were developed. Examples of the types of reports that may be generated with such a system are shown in Figures 5 and 6. Graphics capabilities are essential in enhancing the preceding types of reports.

POTENTIAL USES OF IPFS

Several pavement management functions and work tasks are performed throughout IDOT that can be addressed and augmented through the use of an improved Illinois pavement feedback system. A formalized pavement feedback system would provide an up-to-date source of readily-available pavement information to address the problems and deficiencies that the current system includes. The pavement feedback system will define the network in such a way that data collected throughout the agency is integrated and supports

ILLINOIS DEPARTMENT OF TRANSPORTATION
RUTTING OF ASPHALT CONCRETE OVERLAYS

PROJECT ID 03108011101 LAST OVERLAY DATE 8/79

	BINDER	SURFACE
THICKNESS	3.0 IN	1.5 IN
PRODUCER CODE	1757.05	1757.05
MATERIAL CODE	101.06	101.06
MARSHALL STABILITY-LBS	1987	1827
FLOW	10.7	11.0
AVERAGE BIG 'D'-PCF	155.3	157.4
AVERAGE DENSITY	98.2	97.3

YEAR	--81--	--82--	--83--	--84--	--85--
RUTTING LEFT LANE	0.14	0.22	0.29	0.37	0.47
ADT LEFT LANE	11700	12000	12400	12800	13200
CUM ESAL LEFT LANE	2.8	4.3	5.8	7.3	9.3
RUTTING RIGHT LANE	0.06	0.07	0.8	0.10	0.12
ADT RIGHT LANE	1950	2000	2100	2100	2200
CUM ESAL RT LANE	0.2	0.4	0.6	0.8	1.1

PROJECT ID 03107411551 LAST OVERLAY DATE 8/79

	BINDER	SURFACE
THICKNESS	4.5 IN	1.5 IN
PRODUCER CODE	1742.15	1742.15
MATERIAL CODE	101.06	101.07
MARSHALL STABILITY-LBS	2132	1915
FLOW	10.6	11.1
AVERAGE BIG 'D'-PCF	159.5	157.5
AVERAGE DENSITY	97.8	97.2

YEAR	--81--	--82--	--83--	--84--	--85--
RUTTING LEFT LANE	***	***	0.05	0.12	0.16
ADT LEFT LANE	***	***	10800	11100	11500
CUM ESAL LEFT LANE	***	***	1.0	2.1	3.3
RUTTING RIGHT LANE	***	***	0.04	0.05	0.05
ADT RIGHT LANE	***	***	1750	1800	1900
CUM ESAL RT LANE	***	***	0.02	0.04	0.6

PROJECT ID	LAST OL DATE	BINDER THICK	SURFACE THICK	BINDER MATERIAL	SURFACE CODE	ADT SINCE	ESAL'S LAST O.L.	RUTTING INSIDE	RUTTING OUTSIDE LN
03108011101	8/79	3.0	1.5	101.06	101.08	13200	9.3	0.12	0.47
03108011151	8/79	3.0	1.5	101.06	101.08	13200	9.3	0.18	0.14
03107411551	10/82	4.5	1.5	101.06	101.07	11500	3.3	0.05	0.16
03107412101	9/81	4.5	1.5	101.04	101.07	11500	3.3	0.05	0.18
03107412151	9/82	4.5	1.5	101.04	101.07	11500	3.3	0.06	0.19
04108011501	7/78	3.0	1.5	101.06	101.08	12700	10.1	0.23	0.51
04108011551	7/78	3.0	1.5	101.06	101.08	12800	10.1	0.27	0.51
04105719701	6/83	3.0	0	101.06	****	9800	1.2	0.09	0.12
04105719751	6/83	3.0	0	101.06	****	9800	1.2	0.07	0.11
04105725601	7/80	5.0	2.5	101.03	101.09	14600	3.8	0.10	0.22
04105725651	7/80	5.0	2.5	101.03	101.09	14600	3.8	0.11	0.29
05107207801	9/84	2.0	1.5	101.06	101.08	7100	0.7	0.02	0.08
05107207851	9/84	2.0	1.5	101.06	101.08	7100	0.7	0.02	0.06

FIGURE 5 Example of Rutting Asphalt Concrete Overlays Report.

ILLINOIS DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITION SUMMARY-JUNE 12, 1985

PROJECT IDENTIFICATION DATA

PROJECT ID	03108011551	TRAFFIC DIRECTION	WESTBOUND
CONTRACT NUMBER	25408	NO.LANES ONE DIRECTION	2 AT 12 FT
ROUTE	I-80	INSIDE SHOULDER WIDTH	4 FT
CONSTRUCTION SECTION	****	OUTSIDE SHOULDER WIDTH	12 FT
LAST CONDITION SURVEY	5/85	START MILEPOST	115.10
		END MILEPOST	116.90
		PROJECT LENGTH	1.8 MILES

ORIGINAL DESIGN DATA		OVERLAY DESIGN DATA		
ORIGINAL PAVEMENT TYPE	JRCP	OVERLAY NUMBER	1	2
SUBGRADE AASHTO CLASS	A-7-6	DATE OF OVERLAY	05/83	
ORIGINAL SURFACE/SLAB THICKNESS	10 IN	A.C. THICKNESS	3.0	
ORIGINAL JOINT SPACING	100 FT			
DATE OPENED TO TRAFFIC	11/62			
UNDERDRAINS INSTALLED	5/83			

YEAR	79	80	81	82	83	84	85
CRS	5.0	4.7	4.2	3.9	9.0	8.4	8.1
ROUGHNESS INDEX	115	122	128	135	34	40	***
SKID NUMBER	32	30	28	27	45	44	***
AGE	17	18	19	20	1	2	3
CUMULATIVE ESAL'S $(*10^6)$	17.0	18.4	19.9	21.5	23.0	24.6	26.3

DISTRESS TYPE	SEV	UNIT	79	80	81	82	83	84	85
CORNER BREAD	L	SLABS/MILE	1.1	1.7	1.7	2.2			
	M	SLABS/MILE	0.0	0.0	0.6	0.0			
	H	SLABS/MILE	0.0	0.0	0.0	0.6			
TRANSV CRACK	L	CRACKS/MILE	139	120	130	95			
	M	CRACKS/MILE	172	188	212	217			
	H	CRACKS/MILE	19	26	35	45			
SPALLING	L	JOINTS/MILE	15.8	12.8	9.8	5.8			
	M	JOINTS/MILE	28.8	27.6	28.0	28.2			
	H	JOINTS/MILE	9.2	12.4	15.0	18.8			
JOINT REFL CR	L	CRACKS/MILE					0.0	16.9	43.3
(OL)	M	CRACKS/MILE					0.0	0.0	2.6
	H	CRACKS/MILE					0.0	0.0	0.0
CENTERLINE CR	L	L.F./MILE					0	2200	4600
(OL)	M	L.F./MILE					0	0200	500
	H	L.F./MILE					0	0	100
PATCH REFL CR	L	CRACKS/MILE					0	13.3	69.4
(OL)	M	CRACKS/MILE					0	0	16.7
	H	CRACKS/MILE					0	0	4.2

FIGURE 6 Example of a Pavement Condition Summary Report.

both analysis applications and graphic applications. Application programs will be able to make direct use of data retrieved from the data base. The following are examples of general pavement feedback applications:

- Summary of design and performance information for a specific pavement section;
- Summary of pavement network information (some information from all sections);
- Prediction of future performance of each section and of the network;
- Evaluation of IDOT pavement policies, design procedures, and standards;
- Evaluation of IDOT specifications and quality control;
- Evaluation of rehabilitation strategies for policy and design development;
- Special pavement studies and research;
- Computation of life-cycle costs for various pavement types; and
- Improvement of network pavement management strategies by addressing management's "what-if" questions.

This is just a partial list of general pavement feedback system applications and uses. Several specific applications have been identified (11) and as the system is developed and implemented, new applications will be identified.

Several specific major output reports to address the above applications were identified by the IDOT project participants. Some of these include:

- The Network Pavement Condition Summary Report,
- The Project Level Pavement Condition Summary Report,
- The Existing Pavement Design/Materials/Construction Report,
- The Summary of Pavement Materials Properties (Original Construction and Overlays) Report,
- The Traffic Loading History Report (Network and Project Level),
- The Report of Annual Mean Roughness Index for New Pavements, and
- Others.

SYSTEM DEVELOPMENT AND IMPLEMENTATION

Work on the complete development and implementation of this system is fully under way by the joint University of Illinois-IDOT staff. The remaining work tasks include the following:

• Logical Design--Phase III. Work tasks include completing the definition of the data base. This will include defining all specific inputs, input sources, output and report formats, the information flow required to provide the required data and outputs, and a more detailed documentation of the requirements of the proposed IPFS.

• Physical Design--Phase IV. Work to be completed centers around the physical design of the system. This includes acquisition of remaining hardware and equipment, physical design of the data base and operational software, development of data base loading and data conversion procedures, initiation of data collection for testing the IPFS, and development of system parts packages (e.g., procedures, programs, and files).

• Implementation--Phase V. Full-scale implementation consists of development of the system test plan, coding, walk-through, documentation and testing of all system programs, creation of development-production documentation, creation of user documentation (e.g., user manuals), and the collection of an initial set of inventory and monitoring data.

• System Adjustment--Phase VI. A thorough review and further refinement of the system will be completed. At the end of this phase, the system will be fully operational.

BENEFITS OF IPFS

Overall benefits to IDOT and the public include the following:

1. Availability of factual data on pavement life-costs-design and policy effects and enhanced distress-performance prediction capability.
2. Improved understanding of pavement performance will have an important positive impact on the total cost of replacing and rehabilitating the Illinois highway infrastructure.
3. Increased pavement life overall as a result of improved design techniques.
4. Improved decision- and policy-making capabilities.
5. Improved credibility with legislature and public.
6. Reduced road user costs as a result of smoother pavements and less lane closure time.
7. Reduced future maintenance funding problems through better planning and analysis of past performance.

The Illinois highway network represents a tremendous capital investment. The implementation of an improved pavement feedback data system will provide pavement managers with a valuable resource to assist in making better decisions.

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REFERENCES

1. Pavement Management System. A Review by Joint FHWA-IDOT Task Force, FHWA, U.S. Department of Transportation, May 1981.
2. Pavement Management in the Illinois Department of Transportation. Bureau of Materials and Physical Research, Illinois Department of Transportation, Springfield, 1981.
3. Illinois Highway Inventory Data Collection and Coding Manual. Illinois Department of Transportation, Springfield, 1981.
4. Materials Integrated System for Test Information and Communication (MISTIC). Illinois Department of Transportation, Springfield, 1981.
5. M.I. Darter, J.M. Becker, M.B. Snyder, and R.E. Smith. PCC Pavement Evaluation System--COPES. NCHRP Report No. 277, TRB, National Research Council, Washington, D.C., 1985, 174 pp.
6. M.Y. Shahin and S.D. Kohn. Pavement Maintenance Management for Roads and Parking Lots. Report M-294. Construction Engineering Research Laboratory, U.S. Army Corps of Engineers, Champaign, Ill., 1981.
7. F.L. Mannering, W.P. Kilareski, D.R. Luhr, and S.A. Kutz. Interactive Data Base for Pavement Management. Proc., North American Pavement Management Conference, Vol. 1, Toronto, Ontario, Canada, 1985.
8. W. Kilareski. Transportation Facilities Information System. Pennsylvania Transportation Institute, University Park, Pa., 1985.
9. W.G. Tuel. A System for Building Geo-Facility Data Bases. Paper presented at 2nd International Conference on Computers in Civil Engineering. Hangchow, China, June 1985.
10. MISTIC EZtrieve Report Availability List. Illinois Department of Transportation, Springfield, Oct. 1982.
11. R.J. Roman, M.B. Snyder, M.I. Darter, and M.R. Broten. An Illinois Pavement Feedback System: Feasibility and System Requirements. Interim Report, Department of Civil Engineering, University of Illinois, Champaign, Aug. 1985.

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