DIVISION HIGHLIGHTS: TRANSPORTATION PLANNING AND INFORMATION SYSTEMS

STATEWIDE PAVEMENT MANAGEMENT: COORDINATING THE DATA

Project sponsor: Iowa Department of Transportation

IPMP: Absent a mandate, Iowa forges ahead

Iowa's statewide pavement management program was far along in its development when the National Highway System Designation Act of 1995 rendered ISTEA-91's mandate for such systems optional. But by then, with significant resources invested and anticipated benefits yet to be experienced, the Iowa Department of Transportation (Iowa DOT) confidently proceeded to develop a management system for the 40,000 kilometers (23,500 miles) of Iowa's non-National Highway System (NHS) roadways eligible for federal aid. CTRE is providing staff support for the project.

The Iowa Pavement Management Program (IPMP) will be a system for programming pavement maintenance, rehabilitation, and reconstruction. It will help planners and engineers plan road work that is most cost effective in the long term, stretching pavement life to the maximum and making the most of available dollars.

At the heart of such a system are data about Iowa's existing highways. With roadway data collected statewide, state, regional, and local governments will have access to these data to support management systems within their jurisdictions. In addition to an inventory of existing roadways, the IPMP requires specific data for each roadway: When was the roadway constructed? Is it asphalt or portland cement? What maintenance has been performed on it? What is its current condition? How much and what kind of traffic does it serve? The list goes on.

To make the data issues more complex, significant highway data had already been collected before the IPMP was initiated but were stored in a variety of formats, and not all data were accurate or up to date. Much of the data still had to be collected and, once collected, kept current. In addition, existing data support systems do not necessarily interface with pavement management software. Not least important, the database of highway data must be compatible with Iowa's other transportation management systems (e.g., bridge management, safety management, congestion management, etc.); ultimately, the IPMP database will be part of a completely integrated, statewide transportation information system.

Collecting, maintaining, and manipulating pavement data with management software is a complex challenge. The IPMP is being developed to address that challenge under the direction of a task force. CTRE serves as facilitator and technical advisor for the task force. Consisting of representatives from Iowa cities, counties, regional planning agencies, metropolitan planning organizations, the Federal Highway Administration's (FHWA) division office, and the Iowa DOT, the IPMP task force has input from all levels of government.

The following article briefly discusses the issues involved in designing the IPMP

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"The Iowa Pavement Management Program (IPMP) will be a system for programming pavement maintenance, rehabilitation, and reconstruction."

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database; selecting software; collecting data from various sources; storing, managing, and maintaining the data; developing the graphic linear network; integrating the pavement management program with other management systems; and accessing data. end

IPMP: Developing a management database

The IPMP database's basic design focuses on the development of a geographic information system (GIS) database that supports the use of dynamic segmentation (storage methods) and data transformation. Dynamic segmentation provides for more flexible data management without requiring the duplication of network geometry or data. Dynamic segmentation also allows for the use of multiple linear referencing methods, while accommodating statically segmented data sets. GIS for data analysis allows flexibility in displaying and integrating all of the pavement data.

Data sources

Pavement data consist primarily of pavement history information provided by local highway operating agencies (cities and counties), and vendor-collected, pavement condition (distress) data. The database will include information from three sources, each with a different location referencing method. See Figure 1.

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"Dynamic segmentation provides . . . flexible data management . . . (and) allows for the use of multiple linear referencing methods."

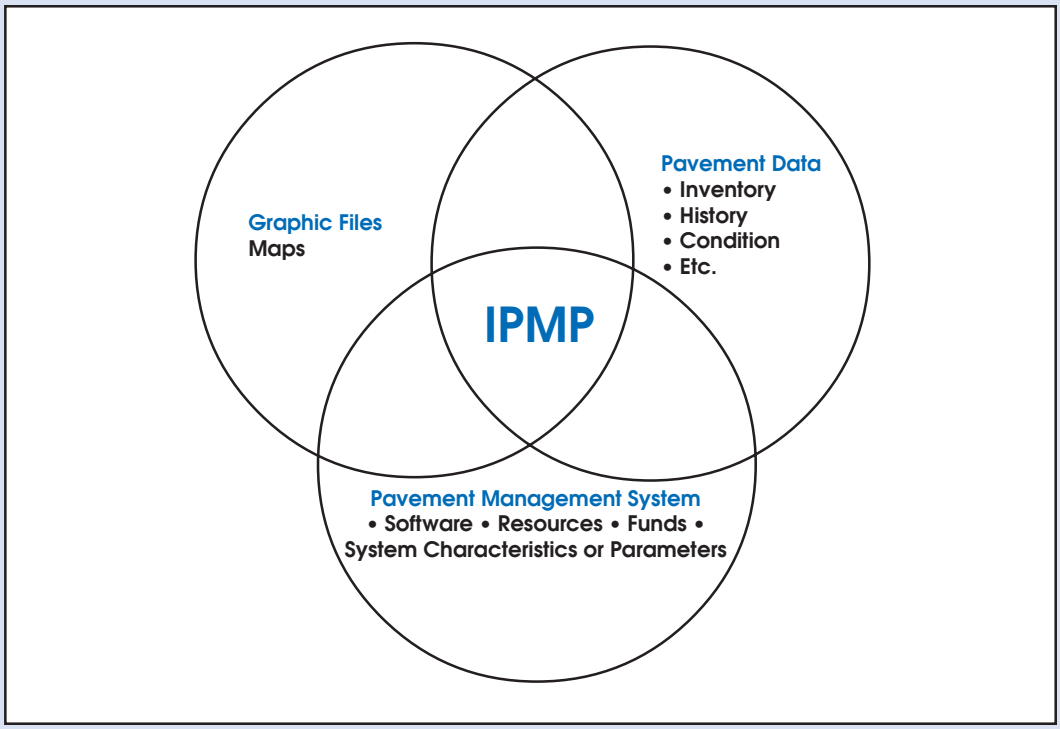

Figure 1. The basic components of the IPMP are data, maps, and management software.

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(1) The first source is the Iowa DOT base record information. These inventory data are based on a kilometer point (km.pt) referencing system. Attribute data are stored using variable-length static segments. Each record is identified by a route name, a begin km.pt, and length. Base record section lengths vary from 0.01 to 1 mile.

(2) Local agencies provide history data and updated inventory data of pavement sections. These data are also stored using variable-length static segmentation, but the information is referenced from point x to point y. Each record contains the surface type, maintenance and rehabilitation history, and cost information. Pavement management section lengths vary, with no length limitations.

(3) Finally, a vendor is electronically collecting and providing current condition, or distress, data, which are stored using fixed-length static segmentation and referenced by geographic latitude/longitude coordinates using global positioning systems (GPS). Data collection sections are constant in length, each covering 0.1 kilometer. Examples of condition data include cracks, potholes, patches, rutting, and ride.

The only commonality among these data sets is that each describes a linear portion of the roadway network. Although both the inventory and history data are stored using variable-length static segmentation, these limits rarely coincide.

Furthermore, each data set uses a different linear referencing method, making their integration difficult and significantly complicating database design and development. To accommodate the different kinds of data sets, the IPMP task force selected a database that supports dynamic segmentation for its pavement management program.

Developing the graphic linear network

A base map of the entire state network of roadways involved in the management program is being created using data provided by the Iowa DOT. These data are the product of a cartography attribution procedure the department has initiated, and as such they do not satisfy all the requirements of the IPMP database.

One problem is incorrect or missing attribution of graphic elements. Another problem is that individual or multiple base record sections may not be represented in cartography at all, so no data exist for these sections.

Both of these coding errors result in an incomplete or incorrect transportation network. Correcting these problems will require significant time and effort. Another solution is to recognize and accept that the transportation network is not entirely complete or correct and to gradually work on completing it.

Storing and managing data

To facilitate data analysis, data are stored and managed according to regional planning affiliation (RPA: a planning organization of several cities and counties that serves a rural area just as a metropolitan planning organization serves an urban area). Individual data sets within each RPA are aggregated by county or city jurisdiction.

Data for all cities within an RPA are maintained together, and data for all counties are maintained together. Although this process decreases the data

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processing overhead, it has two drawbacks: (1) statewide analyses require multiple queries, and (2) city and county data must be analyzed separately.

Maintaining data

The attribute data associated with the graphic linear network must be updated whenever highway alignments or route (street) names change. Alignment changes may entail recalibrating all the distance attributes along the routes that have changed. The cartographic data (graphic elements) must also be modified to represent any changes in highway alignment.

The primary data maintenance issue is not how to implement route changes but how to identify them. Also, dynamic segmentation requires that each route be uniquely identifiable. Two attributes, route (street) name and jurisdiction (specific county or city), can uniquely identify a route.

But not all base record sections are uniquely identifiable. For example, several streets in the same county may have the same name.

While the base linear network is being developed, an attempt is being made to assign a unique name to these routes and then update the route names in the database. The changes must also be made in the Iowa DOT's base record inventory. If not, the base record inventory will contain old route names, and then the Iowa DOT's yearly updates of inventory data for these routes cannot be overlaid onto the base linear network.

Integrating data with other management systems

The IPMP task force is not trying to develop one huge database system for all of Iowa's transportation management systems. Rather, the task force is designing a database for each management system (as needed) and making information sharing among these databases an easy task. The IPMP database is just one of the databases Iowa may develop for its management systems, and it will be compatible with the others in that they will be able to share information easily. See Figure 2.

In addition, however, Iowa is developing a single database containing all the crucial information from each of the transportation management systems that can be accessed by all the systems on a regular basis. See Figure 3.

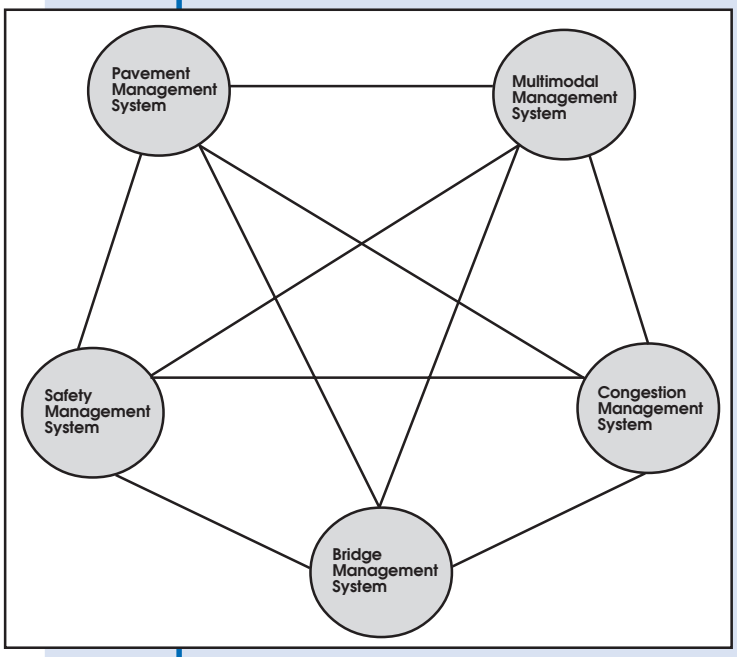

Figure 2. Each of Iowa's management systems will have its own database, and all the management databases will be able to share data easily.

Accessing data

The pavement management database, with its use of a relational database and

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GIS, is quite complex. An inexperienced user may find it difficult to perform a simple analysis of the data. Access to the system is also somewhat limited.

To develop a more user-friendly, accessible system, the following questions should be addressed:

- Who should have access to the data?
- How should users access the data?
- How much experience should users have?
- How will they be trained?
- What types of analyses are necessary?

The answers to these questions will dictate the approach the IPMP task force will take to improving access and simplifying analyses during 1997.

Implementing the system

Most database issues have been or are in the process of being resolved. However, the IPMP task force is still in the process of selecting pavement management software.

Distress data for half of the roadway network have been collected and were distributed to the appropriate local agencies by the end of 1996 to use with their own management systems and/or planning tools.

Distress data for the remainder of the network will be collected in 1997, and the task force anticipates the statewide management system will be operating by the end of 1997. end

"The statewide management system will be operating by the end of 1997."

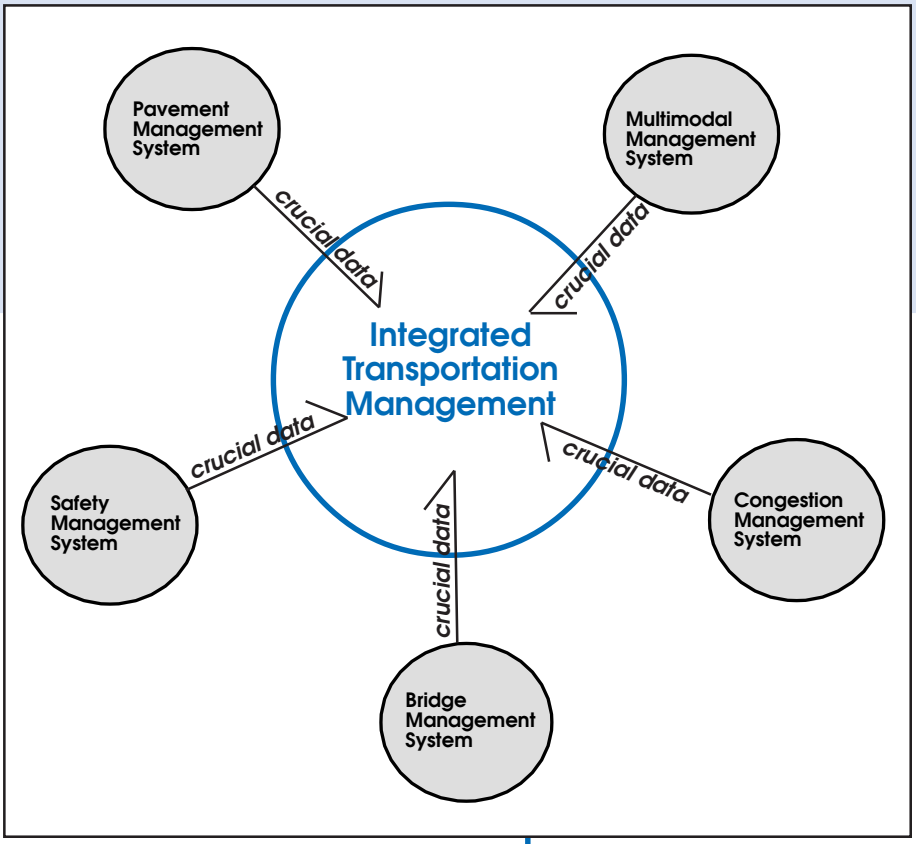

Figure 3. Iowa's integrated transportation management database contains crucial information from each transportation management system.