a beneficial planning aid, for example, for estimation of productivity gains from capital investment and for verification of results after the investment has been made. Finally, we present our methodology as a general framework for analyses. Our particular choices of output measures, our groupings of labor inputs, and our choice of relationship of certain outputs to certain inputs are unlikely to suit all circumstances or all users. The general framework allows the manager to tailor the features of the model with relatively little effort, however, and this is a major advantage.

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Minnesota's Railroad Information System

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The railroad network in Minnesota has undergone major changes in recent years. Knowing the status of the network and being able to predict future changes and directions depend on having a comprehensive and accessible source of rail information. The implementation of a computerized railroad information system in Minnesota in 1981 is helping to ease the information and decision-making needs of the state's transportation planners. A synopsis is given of the system's computer records, data files, and data elements and of uses of the information.

In the late 1970s, the Minnesota Department of Transportation (Mn/DOT) recognized the need to develop a source of comprehensive and readily accessible information about the state railroad network. Major changes were occurring in the rail system in the state, which made it increasingly important to know the status of the transportation network and to be able to predict future deficiencies. To meet these needs, Minnesota's rail data base was developed in 1981.

Having ready access to information about the state's rail system serves a number of important purposes, among them the annual updating of the state rail plan and providing information for systemwide assessment, eligible branch-line analysis, track inspection, and other surveys arising in rail transportation.

Before a rail data base existed, these needs were satisfied by a time-consuming process. A variety of publications and maps served as sources. Simply finding the right sources was often difficult. Once they were found, understanding the terminology and the format of the data could be difficult.

The data base, which is also called the railroad subsystem, is one of six operational subsystems of Mn/DOT's Transportation Information System (TIS). Roadways, accidents, traffic, bridges, and rail grade crossings are the other five subsystems. Together they are a computerized system of data files and programs for reporting and analyzing transportation data.

SYSTEM DESIGN

At the time that a work program for the development of a data base was being prepared, there were no software packages available for a rail data base. Whatever Mn/DOT would be able to use had to be developed. With no package available, the best development option was a data base that would be similar to the roadway subsystem of TIS, which had been developed for Mn/DOT by Montana State University.

The roadway subsystem is based on mileposts. Computer records describe road sections in terms of surface thickness, number of lanes, and so forth, and physically locate these sections by mileposts. Different points along these sections are also described and located, such as county boundaries or intersections. If further information is needed, subordinate tables or files tied to the physically located data item are supplied. For example, a city table tied to the city number stored in the physical data expands that number so that the city name, population, census year, and so forth, can be accessed.

The rail data base as developed by Montana State University and Mn/DOT follows the same general structure as the roadway subsystem. Railroads originated the milepost concept; their track charts show milepost locations on their lines. Sections of rail lines are described in computer records and located in reference to these mileposts. Points along the lines, such as stations or jurisdictional boundaries, are described and located as well. Another similarity is that subordinate tables or files are used for additional information, such as station details.

Each rail computer record must have a unique identification. This key field format is similar to the roadway key, which consists of a route system code, as for a U.S. or state highway; a route number; and a reference point. The key designed for rail lines consists of a railroad system code, a railroad line number assigned by Mn/DOT, and a reference point calculated in relation to the railroad milepost locations.

Because of the relatively small size of the rail data base (7,000 miles of railroads versus 128,000 miles of roads) and because many rail characteristics rarely change, once the initial data have been stored, management of the system is relatively simple.

DATA ELEMENTS

Data elements were developed after in-depth investigation of rail user needs. Mn/DOT units that would be the principal users of the data base were consulted about their needs and about potential data elements, codes, and other requirements. Primary among their needs was a data base of sufficient detail to be used for system analysis and eligible-line analysis. As development progressed, regular meetings were held with a representative rail user committee to keep the units informed of the status of the project and to resolve problems or questions as they surfaced. User input was especially important in the later stages in the design of reports.

The primary rail data are physical data, or data that describe the physical network of the Minnesota railroad system. All other data are tied to some physical data element. For example, the location of a station along a line is a physical data item. Tied to that data element are a number of secondary items that further describe the station, such as freight and passenger service, whether it is a trailer-on-flatcar (TOFC) facility, and so forth.

The types of secondary data are station data (tied to station locations), railroad data (tied to operating carriers), and jurisdictional data (tied to jurisdictional boundary locations).

Railroads are sources for many of the data items. This causes two problems. The first is that railroad publications, such as track charts and timetables, differ among railroads. Data items may be represented differently or may be lacking. The second problem is confidentiality, especially when traffic data are involved. Some railroads will release more data than others.

These problems are not insurmountable. With physical data, there is a fair amount of consistency among railroads. Occasionally, different conversions may be required to get a data element into the data-base form. Because one railroad may provide more information than another railroad, there must be an understanding that there may be more data stored for one railroad than perhaps for another.

DATA FILES

Four separate data files have been developed. They are the railway, station, rail-point, and true-mileage files. Each contains a particular kind of information.

The railway file contains all segment data for the subsystem. This includes physical data such as weight of rail and number of tracks; operational data such as densities, trackage rights, and speeds; and jurisdictional data such as city and county. Each railway segment is a length of a rail line in which all data are constant. A segment begins at the location of a reference point and terminates at the reference point that initiates the next segment record. A new record is entered into the file whenever one of the data elements changes along the line.

The station file contains information describing railroad stations in Minnesota, such as the presence of an intermodal facility, interchanges with other railroads, a yard, siding, and so forth. One record exists in the file for each station. The station record itself does not contain location information. Rather, the station is located by a point record in the subsystem's rail-point file.

The rail-point file contains location information for point data in the subsystem. A rail-point record is actually a reference-point location indicating the existence of a station, a rail grade crossing, a bridge, or any other feature (in the verbal description field) along the rail line. These fields (station, grade crossing, and so on) are cross-referenced to the railroad station file and two TIS subsystems, bridges and rail grade crossings.

The true-mileage file defines segment lengths and distances between points in the railroad subsystem. It contains one record for each reference post of every rail line and provides the distance from the beginning of the line to the reference post, i.e., the post location. It is post location that determines the exact physical location of any reference point in the railway or rail-point file. Thus, distances can only be defined from true-mileage data.

Following is a list of data elements in the data base, grouped by file:

1. Railway file

    - Railroad system
    - Railroad line number
    - Reference point
    - Ownership of segment
    - Abandonment status
    - Total density (3 most current years)
    - Directional density toward increasing mileposts (3 most current years)
    - Directional density toward decreasing mileposts (3 most current years)
    - Division
    - Subdivision
    - FRA line indentification code
    - Trackage rights
    - FRA track class
    - Maximum weight on rail
    - Maximum allowable height and corresponding maximum width
    - Maximum allowable width and corresponding maximum height
    - Number of tracks
    - Signal type on track 1, on track 2
    - Maximum freight speed toward increasing mileposts on track 1, on track 2
    - Maximum freight speed toward decreasing mileposts on track 1, on track 2
    - Weight of rail on track 1, on track 2
    - State legislative district
    - Federal congressional district
    - City number
    - Population (generated from CITY program)
    - Rural or urban code (generated from CITY)
    - Population group (generated from CITY)
    - Census year of population (generated from CITY)
    - County number
    - Construction district (generated from COUNTY)
    - Regional development commission (generated from COUNTY)
    - Functional class
    - Verbal description
    - Date record added to file or revised

2. Station file

    - Railroad system
    - Freight station accounting code
    - Standard point location code
    - Station name
    - Freight or passenger service at station
    - Intermodal transfer
        - TOFC facility at station
        - Side-loading device
        - Crane only
        - Crane and ramp
        - Containers handled
        - Limited to cars not more than 60 ft long
    - Interchanges with other railroads
    - Yard at station
    - Agent or operator at station
    - Length of siding at station
    - Date record added to file or revised

3. Rail-point file

    - Railroad system
    - Railroad line number
    - Reference point
    - Freight station accounting code
    - Railroad grade crossing number
    - Bridge number
    - Verbal description
    - Date record added to file or revised

4. True-mileage file

   Railroad system
   Railroad line number
   Reference post
   True mileage, i.e., location of reference post on line
   Estimated or actual true-mileage code
   Date of true-mileage source
   Date record added to file or revised

DATA-BASE USE

The railroad subsystem allows users to quickly identify lines and their characteristics. The main outputs of the rail data base are inquiries, and the software is specially designed for this type of output. It provides a powerful user-oriented language that allows those unfamiliar with data processing to access information.

The whole of TIS can be accessed by using dialed data communications service that connects the user to the data base by means of the telephone and a terminal. This allows users at off-site locations to submit computer runs and obtain results at places near their own offices. A command structure is provided that allows many users to submit runs without help from computer specialists. For example, the user who wants a listing of all data elements in the railway file for Soo Line Railroad line number 9 would type in the following command:

```
:LIST-RAILWAY-FILE
+ROUTES
RAIL-SYS=SOO, RAIL-LINE=09
```

Specific capabilities of the subsystem are generation of data listings and data summaries, generation of special reports, and data maintenance.

Data listings can be requested from any of the four subsystem files. The user specifies through selection criteria which records are to be included in the listing. For each record selected, all of the data elements stored in the file are shown.

Data summaries are available from the railway and station files. The user can summarize on one, two, or three data elements from the file chosen. Data criteria are applied by the user to select records for inclusion in the summary.

In addition, special reports that combine list and summary capabilities are available from the subsystem.

Data maintenance entails updating the contents of the four data files. Various maintenance commands are used to add, delete, or rewrite records in the files.

The information in the subsystem is used for systemwide assessment, eligible branch-line analysis, track inspection, consultant studies, and other surveys arising in rail transportation. In the area of systemwide assessment, rail planners need to ascertain the status of the entire rail system in order to assess program needs. Use of the data base allows them to determine the percentage of rail lines in the state that are light rail or fall in track classes 1 or 2. This kind of information informs them about the rehabilitation needs of the system and about possible abandonments.

In eligible branch-line analysis, rail lines are identified for possible rehabilitation on the basis of the physical condition of the line as indicated by the track class, on traffic density, and on weight of rail. By using these criteria in the railway file, Mn/DOT rail planners can quickly identify rail segments that are prospective rehabilitation projects.

The data base also provides a foundation for future applications in systems planning, automated mapping, financial and market analysis, and rail and highway accident analysis.

CONCLUSION

Improved retrieval of information was directly related to the development of the data base. With its implementation, updating the state rail plan is easier because of information on traffic densities, TOFC facilities, clearances, and so forth, stored in the computer. Day-to-day questions from Mn/DOT units, other governmental agencies, and also nongovernmental units are quickly answered, especially with the user-oriented TIS commands.

In addition, the ready availability of data improves analysis and decision making. With budgetary cutbacks affecting Mn/DOT, it is increasingly important to know the current status of the transportation network and what deficiencies might occur in the future. Railroads in particular are volatile. Major changes are expected to occur in the rail system serving Minnesota. The rail data base is helping to ease the information and decision-making needs of the state's rail planners.

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