

## WHY AUTOMATION SYSTEMS IN HIGHWAY DEPARTMENTS?

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In reviewing Wisconsin's electronic data processing and management information systems, which are among the best, I found a consistent failure on the part of top management to manage data processing applications. If we are to be administrators, we must define management and engineering objectives so that system analysts can use the computer to help us achieve our objectives. To gain an understanding of the automated systems and to properly structure them within the highway department, we must provide frequent, tough-minded reviews of the operation. We must insist on quality-oriented performance and, above all, staff our divisions with outstanding business-oriented people to operate our automated applications.

I believe the following factors determine the course of automated systems: return on investment, managing by objective, and exceptional people. The highway department that fails to control costs, to set goals and use them to evaluate performance, and to employ outstanding people is headed for trouble when it automates its systems.

One of the most dangerous developments in our history has been the effort to produce automated systems that replace managerial or engineering judgments. Certainly processing of large amounts of rapidly changing data, the use of mathematical simulation formulas, and the development of rapid reporting techniques have served to provide the manager with a better set of data on which to base decisions. However, technocrats who propose to develop machinery to replace the judgment of the administrator are proposing trouble.

Why, then, automated systems in highway departments?

At first, the main function of highway departments was to "get the farmer out of the mud." From this, departments have evolved into organizations charged with the responsibility of providing safe, functional transportation networks compatible with the environment at a reasonable cost. This means that a myriad of information and alternatives must be considered by engineers and management to ensure that transportation facilities meet these objectives. To analyze this information, most departments are, or will be, utilizing computer-oriented processing for accident location and characteristics studies, area traffic projections, land use studies, network traverse adjustments, geometric calculations, earthwork design, topographic and perspective views of proposed facilities, and financial systems to provide direction and control. Highway departments must continue to utilize computers to automate such information systems in order to give the public a safe, functional transportation facility at a reasonable cost.

One of the significant aspects in the operation of state highway departments during the 1960s has been the initial attempt to solve numerous and complex problems with the systems approach. The mere fact that we now use and recognize the term systems approach represents a significant shift in our approach to problem-solving and decision-making. Probably for the first time we are looking at broad problems and determining requirements and designing solutions without regard to traditional constraints such as jurisdictional boundaries, organizational structures, and local political pressures.

This trend toward solutions in terms of systems applies to all the problem areas that beset the highway environment: urban renewal safety, pollution of natural resources, transportation, and land use. These systems have required automation through use of the computer.

The world of automation has been characterized by data processing thresholds. In the earliest days of punched cards, the first major threshold was the ability to print as well as to tabulate. Recent thresholds that are opening up new applications are those of mass storage and remote terminals. In particular, problems of urban and rural highway management are becoming much more accessible to data processing through the use of mass storage and remote terminals.

The most serious problem area within the highway department is the need for emphasis on planning. Before the advent of the systems approach, government agencies did not consider the effects of their projects on other units of government or on society in general. They usually implemented their projects without any formal planning; in many cases the only plan that existed was the engineer's drawing and specification.

The key to the development of a plan is, of course, information or data. The collection, organization, and analysis of valid data are the basis for decisions concerning plan development and refinement and expenditure of funds. The range of highway data that can be collected is potentially limitless. Consider the multiplicity of situations, environments, and conditions we all have experienced while driving a vehicle. It takes relatively little imagination to speculate on a broad range of detailed and general questions concerning the basic categories of highway data—accidents, traffic, physical characteristics of the road, design characteristics, land use, and soil condition.

One of the principal problems in organizing highway data is the numerous categories of data in which planners are interested. Each data category has a large number of separate data elements. However, it is not the amount of data alone that presents difficulties; the problem is complex because we must be able to use three types of data—point, length, and area data—individually and collectively. Without the capability to cross-reference data we would not be able to ask a series of sequential questions that are essential to making a value judgment.

There are several major reasons why an automated system for maintaining highway data is needed. One of the principal limitations of manual systems is their inability to respond rapidly and accurately to a wide variety of unstructured user requests; i. e., the manual system does not lend itself to a flexible response, but rather all outputs are strictly formulated and produced by special problems. Therefore, if a change in the output is desired, or a totally new output is requested, considerable time and expense are required to respond to the new request.

A second deficiency of manual systems is their inability to process and type retrievals that determine where conditions overlap. A condition or information on one highway project may affect two or more other projects. This ability to determine overlap conditions for two or more problems is an absolute requirement for decision-making.

A third deficiency of the current systems, which ties directly to the first two points, is the manner in which the data variables are organized and stored. Our methods of computer file creation and maintenance must be modernized and improved.

There are also new data processing capabilities and technologies that are attractive to management. Foremost of these new capabilities is graphic plotting. Why must we read a printed report when a graph would be better? This capability not only would support a plot or mapping requirement but also would be especially useful in showing alternative designs and their relationships to one another and to existing roadway networks. The advantages of being able to show meaningful geographic relationships graphically during the planning and design stages is extremely effective, especially when one considers that the users are almost exclusively engineers.

A second new technology to be utilized is remote-inquiry terminals. Wisconsin is organized into nine separate highway districts with their respective operations scattered throughout the state. Most information requests are unstructured one-time requests that originate at the district offices. The use of remote terminals should increase availability of information. Even if quick response time is not an absolute requirement, accessibility and convenience of the information will provide engineer-computer interaction and improve the alternative problem-solving analysis. Improved highway designs can be achieved by providing direct engineer-computer interaction.

In addition to its engineering applications, advanced data processing can improve statewide data files. The use of remote terminals to satisfy queries, make corrections

to the files, and provide transaction confirmation will also assist users in the outlying districts by providing a direct communication line with the data files located in the central office. In addition to the districts, the various functional groups (design, planning, maintenance, and traffic) located at central headquarters will utilize terminals to process their queries.

I do not know of any computer installation that is cheaper to operate than a "human" one. We should not expect to reduce costs by using computers; however, we should expect and demand quantitative data that are timely and useful. We should expect to reach "the ultimate" in terms of the best design—which is a "savings." We should expect and demand that the highway designer do more creative design work with the automated system and leave the labor of hand calculations to the computer. We should expect to automate applications previously considered impracticable because of the need for extensive hand calculations.

Each automated system should be designed as an integrated subsystem within the framework of the larger overall integrated operations system. Wisconsin has conceived and is implementing such an overall system as a long-range objective. The Wisconsin integrated operations system (IOS) consists conceptually of a number of management and computer-based subsystems that will ultimately form a total system of procedures and information processing for the operations of the department.

The project development system, as a management or procedural system, includes functions of highway planning and design that will both require and produce technical and financial information. The highway engineer system constitutes the technical engineering information component of IOS and, as a computer-based design tool, will act largely as a generator of data during the actual physical design phases of highway improvement projects. The program budget system and financial operating system are the procedural and computer-based components of IOS directed toward the budgeting, resources, and financial information aspects of the department's operations. The highway network data and information system is to act as the central repository of technical information and provide for the storage, processing, and output presentation of such information in support of the planning function and accomplishment of improvement projects. This system must also support the routine federal reporting requirements imposed on the divisions.

The functional areas that the IOS is designed to support include the full spectrum of planning, design, land acquisition, construction, operation, and maintenance. Although the system conceptually can provide support in all these areas, it has been designed as a series of modular packages intended for continuing evolutionary implementation over a long period of time. The concept of evolutionary development and implementation advocated by the Wisconsin Division of Highways for IOS is the most desirable approach to such an automated system.