Productivity and Safety for Trucks— Pavement Preservation for the Nation's Highways

HELP is on the Way

Current methods of collecting data on the characteristics of heavy trucks on the nation's highway system are costly to both the government and the trucking industry. Despite the high costs and the substantial efforts involved in data collection, such methods are sometimes ineffective and duplicative; the data are inconsistent among states, between sources, and over years; or important elements are often missing. Meanwhile, the nation's heavy vehicle management needs are constantly changing. Demands for greater productivity in the transport industry, safer highways, and preservation of the nation's roadways require (a) tighter industry control of vehicles and their loads, (b) greater understanding of roadway use, and (c) better administration of existing laws and regulations.

Thirteen states, one port authority, and their trucking industry representatives have come together under the Heavy Vehicle Electronic License Plate (HELP) program to examine what lies ahead for improvements in heavy vehicle management technology and to determine the extent to which a cooperative effort between the public and private sectors might be effective.

The major objectives of the HELP program are to investigate the current technologies, cost, and potential benefits associated with various heavy vehicle monitoring systems.

Information for this article was provided by Loyd Henion, Oregon Department of Transportation; Scott Davis, Castle Rock Consultants; and C. Michael Walton, University of Texas, Austin. Additional material was taken from the Northern Association of State Highway and Transportation Officials' Status Report prepared by the Pennsylvania Department of Transportation.

History of HELP

The HELP project began in 1983 with concept papers originating in the Arizona and Oregon Departments of Transportation. The Federal Highway Administration provided grants to the Arizona DOT to undertake a concept feasibility study and to the Oregon DOT to perform a proof-of-concept demonstration. Both the feasibility study and the Oregon concept demonstration provided encouraging results.

In 1985, a core group of western states joined a number of other interested states to form a jointly funded, multistate development and testing program. The project was originally called the Crescent Study because of the shape of the proposed demonstration route along the West Coast and east to Texas (see Figure 1). The name of the overall study was changed to HELP with the inclusion of states outside the crescent. The third phase of the project, which is just beginning, is known as the Crescent Demonstration.

Five Technologies for HELP

Five technologies that can be integrated into a heavy vehicle monitoring and management system are the focus of the HELP project: (a) automatic vehicle identification (AVI); (b) weigh-in-motion (WIM), using low-cost technology; (c) automatic vehicle classification (AVC); (d) satellite data links; and (e) data communication networks. The first three technologies—AVI, WIM, and AVC—are likely to form the basis for the Crescent Demonstration.

AVI systems, which identify vehicles as they pass specific points on the highway as well as calculate their distance traveled, are now both technically and economically feasible. Trucks carrying no more than legal loads and equipped with AVI may eventually be able to bypass weigh stations. The required compliance checks could be made at normal highway speeds.

With WIM equipment, estimates of axle and gross weights of vehicles can be obtained while they are traveling along the

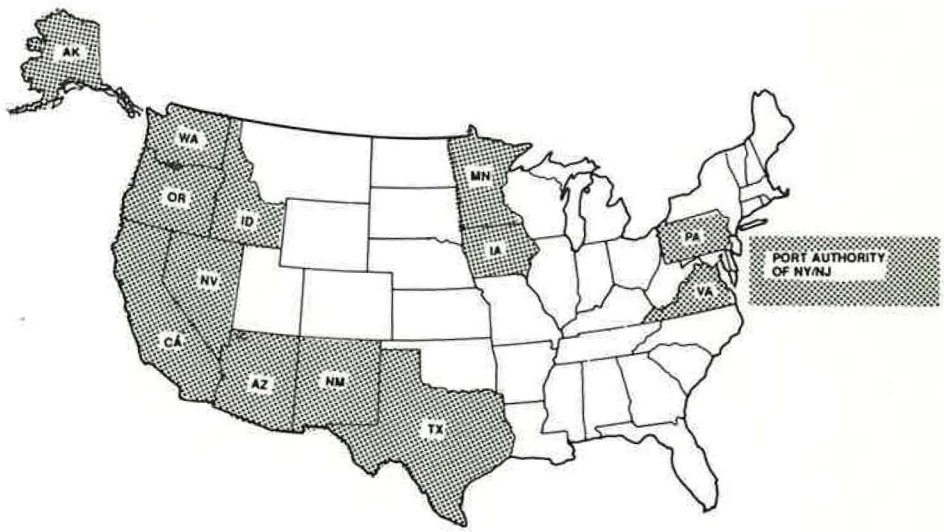

FIGURE 1 *HELP program includes 13 states, 1 port authority, and their trucking representatives.*

highway. Under the HELP program, WIM would provide states with data for highway planning and enforcement screening. Although WIM is not accurate enough at full highway speeds to be used directly for enforcement, it can recognize vehicles operating within allowable limits and permit them to proceed without stopping.

Classification of traffic data provides basic information that is widely used in the design, maintenance, and management of the highway network. AVC systems count vehicles and classify them in 13 categories; used in conjunction with WIM, AVC can provide states with an effective means of collecting data for highway planning.

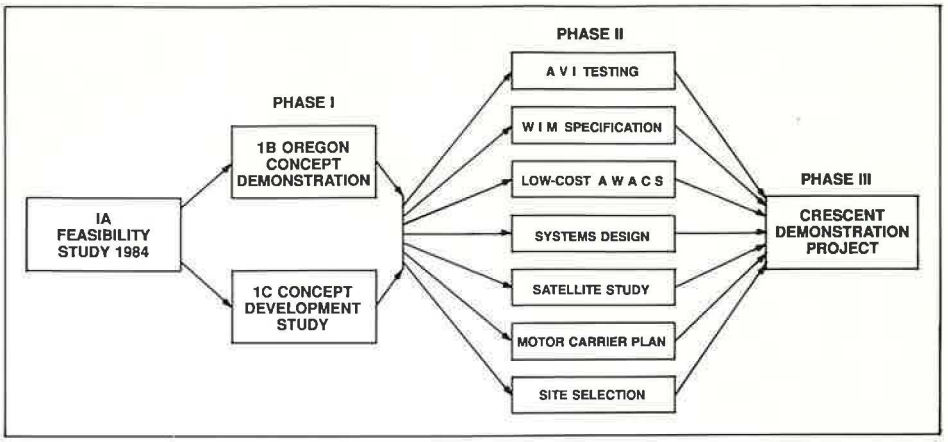

FIGURE 2 *HELP program structure.*

Three Phases of HELP

The HELP program can be divided into three phases (Figure 2). Phase I (1983–1985) involved the early work by the transportation departments of Arizona and Oregon to assess the feasibility of the program concept. Phase II (1985–1988) has consisted of a number of technical studies of each of the technologies; field and laboratory testing; development of equipment performance specifications; and National Cooperative Highway Research Program (NCHRP) Project 3–34, which reviewed the potential for implementation at the national level. Phase III (1988–1991) is the Crescent Demonstration, which will attempt to provide a sufficient number of vehicle-monitoring locations, as well as participating vehicles, to test an integrated system concept in a real-world environment.

Each of the states participating in the HELP program contributes to a pool-funded budget, and each state has equal representation from state government and the trucking industry in the program. The total pooled resources from 1985–1986 through 1989–1990 are expected to exceed $3.5 million.

TRB Committee Studies Data Needs for Improving Truck Safety

In a time of rising concern over the safety of large trucks and buses, existing programs to collect information about truck accidents and travel frequently are unable to help evaluate actions to improve safety. The Transportation Research Board (TRB) Committee on Truck Safety Data Needs is conducting a study to seek ways to close the truck safety information gap. The study is sponsored by the Federal Highway Administration, the Trucking Research Institute of the American Trucking Associations, the Motor Vehicle Manufacturers Association, and the Highway Users Federation. The National Research Council is also providing financial support.

Public awareness of the hazards created by the use of large trucks has never been higher. Truck crashes are often spectacular and severe and frequently receive press attention. Many motorists feel intimidated when driving in truck traffic. The perception is growing that truck safety has deteriorated and that the problem has reached crisis proportions. When government regulators or industry management have tried to respond to these concerns, they have discovered that little information exists about the causes of truck accidents or about the effectiveness of actions to control accident losses. In fact, adequate data are not even available for showing broad trends in truck accidents, so it is difficult to determine whether safety is declining and to direct control efforts to areas where they are most needed.

The truck safety data committee includes experts in managing statistical programs, state government officials, executives in the trucking industry and in truck manufacturing, and researchers in the analysis of truck safety. Wayne Muri, chief administrative officer of the Missouri Highway and Transportation Department and a member of the TRB Executive Committee, is chairman. The committee will define the requirements for nationwide truck safety data collection and processing, develop proposals for reform of current programs to satisfy these requirements, and recommend arrangements for implementing and overseeing the needed data-collection activities. The committee will report on its findings in December 1989.

Status of HELP Technical Studies

The HELP program is a major step forward in the use of information technology in transportation, and considerable progress has occurred since its inception in 1983. The following studies of the various technologies have been completed or are nearing completion.

- *AVI testing*: Field and laboratory testing to develop specifications has been completed. Preferred system testing has not yet begun.
- *WIM specification*: Field and laboratory testing of WIM/AVC has been completed to provide performance specifications. A draft final report is under review.
- *Low-cost Automatic Weight and Classification System (AWACS)*: A companion project to evaluate low-cost piezoelectric technology for WIM/AVC undertaken by the Iowa and Minnesota Departments of Transportation has been completed.
- *Systems design*: Definition of communications and processing requirements for public- and private-sector applications has been completed.
- *Satellite reference design*: Investigation of the economic and technical feasibility of a satellite-based monitoring system is complete.
- *Motor carrier plan*: A workshop was held in 1987 to examine how the HELP system may benefit the motor carrier industry.
- *Site selection*: Guidelines have been developed that will enable states to locate HELP stations along the demonstration route. The final report is under review.
- *On-board computers*: Not yet begun, this study will investigate institutional arrangements and changes needed to allow on-board computer logs to be used in the preparation of conventional reports.
- *Crescent Demonstration*: Detailed planning is being handled by the Crescent Implementation Group made up of the affected state government agencies and participating trucking interests. The goals and objectives of the demonstration are to (a) assess the viability of the technology in the highway environment (objective is to test the reliability and accuracy of the technologies); (b) improve institutional arrangements (objectives are one-stop shop-

Weight Watching on a WIM

Determining truck weights for pavement design and enforcement of weight regulations has traditionally been achieved by the use of static scales, which require trucks to come to a full stop. On heavily traveled routes, it is not unusual to see 15 or more trucks waiting in line to be weighed. To speed the weighing process, weigh-in-motion (WIM) systems have been under development for more than 30 years and WIM is now an established technology in the United States and throughout the world.

Clearly, accurate pavement loading data are needed to design and maintain better highway pavements. WIM systems can provide states with needed data for highway planning and weight-enforcement screening. WIM equipment simply weighs a vehicle as it moves across a scale. However, WIM is not yet sufficiently accurate at full highway speeds to be used directly for truck weight enforcement. (The courts expect an accuracy of 2 percent from enforcement scales, and WIM typically yields accuracies of 5 percent at 35 mph and 10 percent at 55 mph for gross vehicle weights.) A wide variety of systems are now available, from slow-speed WIM through a range of full highway speed systems, each with a different methodology. (Under the HELP system, only full highway speed systems will be used because all HELP stations are likely to be located in the mainstream traffic flow.)

The idea of WIM has been around since 1952 when the first WIM device described was a floating, reinforced-concrete platform constructed with its top flush with the pavement surface. The concrete slab measured 12 x 3 x 1 ft and was supported at each corner by a wire strain-gauge load cell. As trucks rolled over the slab, each spring-type load cell shortened slightly, and this change was measured.

In 1955, the Pennsylvania Turnpike Commission installed the first major operational WIM system for revenue collection, which was probably the world's first WIM type of weight-distance-tax program. All the entrances to the 350-mile turnpike were equipped with WIM scales and computers. Trucks were weighed as the driver slowed to get a ticket at the turnpike entrance, and were weighed again at the turnpike exit; tolls were then calculated by computer in real time.

The Ohio Turnpike installed a similar system about the same time except that it weighed trucks at turnpike entrances only. Since these early WIM systems were installed, at least five classes of WIM system sensors are either in use or are being developed:

- A metal plate or platform mounted flush with the highway surface and supported by strain-gauge load cells;
- Strain gauges mounted on the underside of bridge girders;
- A capacitance pad (a sandwich of parallel steel plates encased in a rubber matrix), the electrical properties of which change under load, affixed to the pavement surface;
- A fiber-optic bundle whose fibers transmit a light signal that changes when it is deflected or compressed; and
- A sensor, consisting of two concentric conductors with piezoelectric material in the interstitial space, whose electric field changes when deformed.

In evaluating these five classes of WIM systems, the key considerations are accuracy and cost. Existing WIM installations (using the metal plate or platform, strain gauges, or a capacitance pad) usually cost between $100,000 and $200,000 each. These more accurate, higher-cost systems will be needed for enforcement; the lower-cost systems can be used for traffic counts and vehicle classification, but probably should not be relied on as a primary source of data.

A draft standard specification titled "Highway Weigh-in-Motion Systems with User Requirements and Test Method" is currently under review at the American Society for Testing and Materials (ASTM) with final action expected by early 1989. The proposed standard is intended to provide future users of WIM systems with a convenient means for specifying the type of system needed and bring some uniformity to the system configurations that manufacturers will be asked to develop and produce. Current indications are that ongoing efforts in NCHRP Projects 3–34, 3–36, and 3–39 will provide additional basic research findings necessary for the possible expansion and improvement of this ASTM specification in the early 1990s.

This article is based on "Truck Weight Enforcement on a WIM" by K.A. Godfrey, Civil Engineering, November 1986, and material supplied by Clyde Lee, College of Engineering, University of Texas, Austin.

ping, preclear at weigh stations and ports of entry, and border transparency); (c) measure efficiency and productivity (objectives are improved safety, enforcement, reduced administration, and data-collection technology); and (d) identify additional applications (objective is to determine public- and private-sector applications).

Crescent Demonstration Plans

The status of the Crescent Demonstration is as follows:

- The planned demonstration corridor is I–5 and I–10 from Washington State to New Mexico.
- Approximately 40 equipped sites are now anticipated to be included in the demonstration. A minimum of 5,000 trucks are expected to be equipped with transponders. Not all applications will be tested at each site.
- The current schedule calls for all equipment and systems to be in place by the fall of 1989. The actual demonstration will then run for 1 year, through the fall of 1990, and will be evaluated throughout and again after its completion.
- As many applications of the HELP technologies as possible will be tested within budget constraints. The results of the demonstration, how well each of the four HELP goals was achieved, and the possible national implications of the project will be documented.

If the Crescent Demonstration is successful, it could pave the way for implementation of a HELP system in other areas, which may provide far-reaching benefits to both state and federal governments as well as to the trucking industry.

Truck approaches slow-speed weigh-in-motion and automatic vehicle identification site at Woodburn, Oregon, weigh station.

One of Oregon's 350 transponder-equipped heavy vehicles crossing a fast-speed weigh-in-motion and automatic vehicle classification station. Data collected for planning purposes include time, vehicle weight, and speed.

NCHRP Helps HELP

While the western states were developing the HELP project, the states of Arizona, Oregon, and Iowa were submitting problem statements to the National Cooperative Highway Research Program (NCHRP) to conduct research that would complement the HELP studies. The American Association of State Highway and Transportation Officials (AASHTO) Select Committee on Research approved four projects (one project was canceled) to be carried out by NCHRP at a total cost of $1,800,000. A summary of each project follows. Bill McCall, Director, Office of Transportation Research, Iowa Department of Transportation, currently chairs the NCHRP panels that oversee these projects.

Project 3–34

Feasibility of a National Heavy Vehicle Monitoring System

Arthur D. Little, Inc.

This study is being conducted to identify and evaluate the needs, issues, requirements, and feasibility of using an automated system [automatic vehicle identification (AVI), automatic vehicle classification (AVC), weigh-in-motion (WIM)] as a cost-effective, statistically sound replacement for, or supplement to, existing heavy vehicle data collection systems. The research encompassed the (a) identification of different system design configurations for the integration of AVI, AVC, and WIM to provide appropriate levels of monitoring and related confidence levels; (b) amount of equipment and automation needed to achieve different objectives; (c) site location criteria on a state, regional, and nationwide scale; (d) economic analysis of the alternative levels of monitoring; and (e) issues associated with implementation and operation.

The consensus of the panel and the research team at the conclusion was that implementation of a single, national heavy vehicle monitoring (HVM) system was not feasible at this time; therefore, the remaining work was oriented toward developing guidelines for individual states or regions as they deploy various levels of HVM systems to meet their specific needs. A detailed cost-benefit analysis of a voluntary state system, which covers different levels of deployment, system designs, and types of data, has been completed.

The final draft report is currently being reviewed by the NCHRP Project Panel and should be available in the fall of 1988.

Project 3–36

Development of a Low-Cost Bridge Weigh-in-Motion System

Bridge Weighing Systems, Inc.

Development of a low-cost bridge WIM system capable of providing the traffic data that are used in the design and maintenance of highways and bridges is the principal objective of this research. This system will be able to (a) record gross vehicle weights, (b) classify vehicles, and (c) record individual axle weights within the limits of the specific bridge and site characteristics. The system will use state-of-the-art technology and will have the following characteristics: (a) target purchase price of $5,000 to $10,000 per unit, (b) low life-cyle cost, (c) capability to interface with automatic vehicle identification equipment, and (d) capability to be deployed on bridges and large culverts. The researchers have fabricated an operational model and have completed the laboratory testing requirements. During the summer and fall of 1988, a prototype of a turnkey will be built and field tests will be conducted. The research will be completed in August 1989.

Project 3–39

Evaluation and Calibration Procedures for Weigh-in-Motion Systems

Texas A&M Research Foundation

Various WIM systems are available to collect truck data more efficiently than is the case with conventional methods. A number of states are currently installing WIM systems and are specifying and conducting independent acceptance and validation procedures. However, nationally recognized procedures for acceptance testing and on-site calibration of WIM systems do not exist. Such procedures need to be developed and validated by statistically designed field experiments so that WIM users can be confident that WIM-estimated weight will meet specified tolerances. Widely accepted procedures will also benefit the manufacturers by providing more consistent testing requirements among their customers.

The objective of this research is to develop procedures that cover all WIM system applications for acceptance testing, on-site calibration, and periodic verification of system performance. Research is expected to be completed in November 1990.

Detailed information on each research project can be obtained from

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