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# Session 6-B: Road User Costs and Weigh-In-Motion Technology

*Session chair: Barry E. Prentice, University of Manitoba*



Summary by Session Chair:

The first paper, "Canadian Experience with HDM3 in Road Transportation Management" was prepared by Peter Bein and was presented by William G. Waters II. This paper reports the results of research undertaken to calibrate and test the HDM3 computer model in the Province of Saskatchewan. The HDM3 model was originally developed by the World Bank using data collected in Brazil. It was designed to develop a life-cycle cost analysis for roads based on various design and utilization assumptions.

First, the model is reviewed in terms of its strengths and weaknesses. One notable problem is the absence of any assessment of congestion costs. Subsequently the paper describes the attempt to calibrate the model to the northern temperate zone conditions of Saskatchewan. The paper ends with a discussion of needed research to make the model more useful. In particular, the refinement of impacts of heavy vehicles on pavements, and the relationship between pavement roughness and vehicle operating costs.

The second paper, "Current Status of Weigh-in-Motion Technology in the U.S." was prepared by Fazil T. Najafi. This paper begins with a discussion of the perceived need for Weigh-in-Motion (WIM) technology, and the history of its development. WIM is viewed as superior to existing static weigh scales that involve considerable capital investments, relatively large personnel costs and are easily identified by over-weight trucks. In addition, static scales are time consuming for the trucks being weighed and a hazard to driving because these trucks must exit to the scales and subsequently merge with traffic.

The study is based on a questionnaire that was sent to each state highway authority in the United States. State officials were asked about the type of equipment used, its cost, where it was used and test results to determine the accuracy of WIM technology. A survey response rate of 66 percent was obtained.

Three manufacturers appear to dominate the industry: Street Richardson, Golden River, and Pat/Siemens Allis. The costs of WIM technology varies from as low as $6,000 to the $250,000 range. There appears to be improved accuracy associated with equipment cost, but performance varies widely. Some states noted that smoothness of pavement surface is an important factor in obtaining accurate readings.

Summary by Session Chairman

Both papers were enhanced by audio-visuals that assisted the communication of the research results. Although this session was less well-attended than most, the small size of the group permitted a stimulating discussion in which all present were involved.

Several questions were directed to the first paper regarding the further development of the HDM3. For example, were variables included to address the costs of snow removal, or damage by salting northern roads. Discussion also focused on the value that having such a low cost management tool could have for highway administration. There was a consensus that the HDM3 should be pursued further to help jurisdictions optimize their highway construction/maintenance expenditures.

Questions on the second paper addressed issues that were raised by the survey results. Why have American states not invested more in WIM technology? Why have better technical standards not been developed? How can one account for the large discrepancies in the accuracy of WIM results? What are the political and legal barriers to the use of WIM technology?

It was agreed that more research is needed to track the progress of WIM technology in North American jurisdictions.

## Canadian Experience With HDM3 in Road Transportation Management, by Peter Bein.

Peter Bein is with N.D. Lea International, Ltd.

The HDM3 model is a useful decision-support tool for funds allocation to roads and for regulatory changes in the trucking industry. Its life-cycle economic analysis of road costs integrates: available roadworks options; resulting road geometry and surface quality; and their impact on user costs. The user-cost and pavement deterioration modules are generic and have been adopted in Canada even though the economic system, vehicle technology and operation, road standards and physical environment are different than in the HDM database. Adoption of HDM in North America will spread more widely once the effects of traffic congestion are included into the model. It will then become more relevant to urban roads and to highways with traffic capacity problems.

The slope of total user-cost versus pavement roughness is crucial for road investment decisions and should be verified in a large-scale experiment involving typical North American vehicles and pavements. The effect on VOC of road texture - a major user-safety decision variable - needs to be established. On many of North America's low-volume roads, additional rolling resistance arises due to pavement deflection under wheels, but possible VOC increments are not accounted for by HDM3.

Although the components of VOC are not necessary for accurate calibration of the total VOC, the fuel, tires, maintenance, depreciation and cargo-related cost components need refinement if HDM is to be used in economic analyses of North American commercial fleets.

The HDM3 pavement deterioration module separates environmental effects from traffic loading and can be instrumental in determining North American user charges according to relative damage by various types of vehicles. The module is also structured for implementation in roadway management systems. Its flexibility and reliance on local data should make it attractive to many North American highway agencies. A stand-alone version for a PC would be desirable.

The overall life-cycle analysis model will find use in economic comparisons of alternative routes and geometric standards for new projects or for improvements. In maintenance and rehabilitation, both project and network life-cycle analysis can be done with HDM3. It could also be employed to demonstrate the economic benefits of increased funding for road transportation compared to other sectors of the North American economies. Improved input and report generation functions would enhance the PC use of HDM3.

## Current Status of Weigh-In-Motion Technology in the United States, by Dr. Fazil T. Najafi.

Dr. Fazil T. Najafi is Assistant Professor, Department of Civil Engineering, University of Florida, Gainesville, Florida.

For almost fifty years, truck weight data have been obtained by weighing vehicles statically. The time loss for the owners and operators of trucks, cost of building special weighing sites, personnel and equipment costs are all related problems which forced researchers around the world to develop techniques for weighing trucks while they are in motion. These, among other factors such as highway operations (e.g., planning, design "dynamic versus static theory," pavement management, and law enforcement), triggered the development of prototype weigh-in-motion (WIM) devices.

This paper addresses the current status of WIM technology in the United States. In this country, many states own WIM devices. Some states own bridge WIM systems. All states were asked to respond to a questionnaire regarding their WIM vendor's name, WIM costs, and their field results on: (1) the percent error margin on individual axle weight and (2) the percent error margin on gross vehicle weight. The WIM equipment costs varied from state to state. Measuring the differences between the static weight of a specific vehicle and its dynamic weight has not been standardized in this country. The measurement of the calibration factor is not unique resulting in many different claims as to the accuracy of different devices.

**Low-cost WIM devices are available for as low as $6,000 and are under further development including piezoelectric, bridge, and capacitance strip types. In general, standardization of WIM devices is essential for proper planning, pavement design, law enforcement compliance, benefit-cost of different systems, accuracy, weather standards, calibration, performance specification, site standards and pavement management.**