



## RESEARCH SERVICES SECTION

# TECHNICAL SUMMARY

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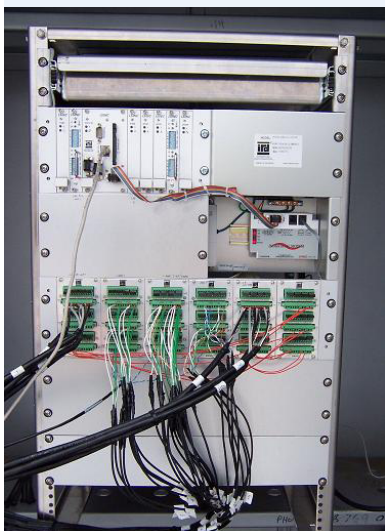
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### Principal Investigator:

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University of Minnesota, Duluth

### PROJECT COST:

\$49,350



This controller is an example of those used at Mn/DOT's WIM sites.

# Development of Data Warehouse and Applications for Continuous Vehicle Class and Weigh-in-Motion Data

## What Was the Need?

Mn/DOT's Office of Transportation Data and Analysis collects, manages and analyzes traffic data from a variety of sources, including 29 continuous vehicle classification sites and 12 weigh-in-motion sites that provide 24-hour traffic information. Mn/DOT uses VC and WIM data for pavement design and commercial vehicle weight enforcement. Monthly Traffic Monitoring Guide submissions to the Federal Highway Administration and traffic forecasting also use this data.

VC data can contain a number of possible combinations of volume (hourly), speed (the number of vehicles within specific speed ranges) and vehicle classification (the number of vehicles of each FHWA-defined type at each hour). WIM data are recorded as a collection of vehicle records, with data elements for lane of vehicle traveled, speed, time, axle spacing, axle weights and error conditions.

Managing the large volume of data generated by the sites and extracting it for reporting and analysis can be challenging. Data are collected in binary formats that can only be read by propriety software packages supplied by specific device manufacturers. This results in a lack of uniformity in reporting and precludes compilation of some historical trend data.

Mn/DOT needed a method to standardize the data from its VC and WIM sites to allow for more effective data management. Because Mn/DOT owns the devices generating VC and WIM data, it owns the data collected from these devices and can develop its own software to read the binary data collected by the devices.

## What Was Our Goal?

The objective of this research was to develop a warehouse for data collected from Mn/DOT's VC and WIM sites that uses a standard format and that can accommodate current volume and expected future expansion of data collection sites. Researchers also aimed to develop data retrieval, statistical analysis and reporting utilities to support Mn/DOT's data reporting needs.

## What Did We Do?

Researchers translated the proprietary binary VC and WIM data into a standardized, unified format using the ASCII character set and comma-separated value data format. ASCII, as the most widely accepted character encoding standard and data format, can be read by any text editor or spreadsheet program. As the raw binary data are decoded, the translated data are organized into a data warehouse with a hierarchical tree structure that provides a single access point for all VC and WIM data queries. Three application reporting software packages were developed to accompany the data warehouse.

## What Did We Learn?

The robust data structure of the warehouse improved on prior VC and WIM data management in a number of ways. Data in the new system are easy to understand and use. The data warehouse produces outputs much more quickly than the proprietary software the new system was designed to replace, makes it easy to distribute and share large amounts of data, and is readily adaptable as data collection devices change. The new system can be installed on an unlimited number of computers without licensing concerns.

*“The new software solves the problem of multiple proprietary WIM systems and data formats, and allows Mn/DOT to manage large volumes of data more efficiently.”*

–Benjamin Timerson,  
Weight Data &  
Engineering  
Coordination,  
Mn/DOT Office of  
Transportation Data  
and Analysis

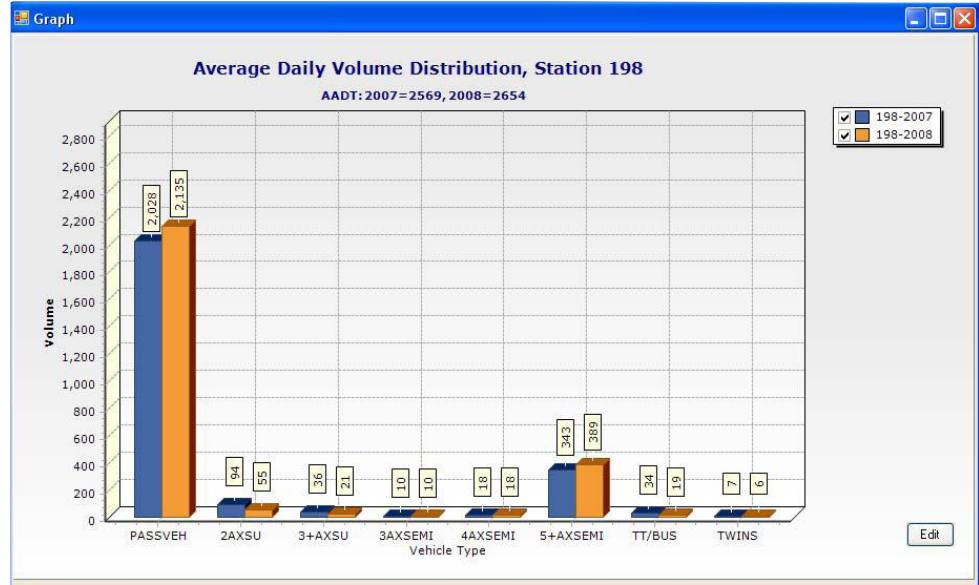
*“The BullPiezo reporting package derives VC-type data such as seasonal adjustment factors from WIM data, providing Mn/DOT with additional VC data without requiring the installation of new VC data collection devices.”*

–Taek Mu Kwon,  
Professor, University  
of Minnesota, Duluth,  
Department of Electrical  
and Computer  
Engineering

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This plot of monthly change in average daily truck volume is an example of a graph generated by the BullPiezo reporting package.

Three reporting applications were developed as stand-alone software packages that can be installed on any computer with network access using a standard Windows installer:

- BullReport. An analysis tool for WIM data, this application includes a load spectra analysis utility for single, tandem, tridem, quadem and steer axles, and generates Traffic Monitoring Guide monthly reporting formatted for submission to FHWA. Once data in this form is produced, it can be used as inputs to other analysis tools and software packages. Summary reporting utilities are available in text, Excel, PDF and XPS Web formats.
- BullGuide. This software package was developed to generate Mechanistic-Empirical Pavement Design Guide input data using data from Mn/DOT’s WIM sites. It generates the same output files as those produced by TrafLoad, a software package that collects and processes traffic data for the MEPDG pavement design software, but produces the files more quickly and easily. BullGuide also includes a data visualization tool for analyzing export data.
- BullPiezo. Developed as a VC data application, this reporting package is capable of generating seasonal adjustment factors for short-count stations (VC sites where the counts are usually 24 to 48 hours in duration), annual average daily traffic counts and monthly average daily traffic. BullPiezo also computes SAF, AADT and MADT using WIM data, which means that Mn/DOT can generate VC-type data without installing additional VC data collection devices.

### What’s Next?

The new software has been implemented in Mn/DOT’s Office of Transportation Data and Analysis. Users report significant time savings in the production of monthly reports and are looking for ways to collaborate with other Minnesota agencies to expand the use of VC and WIM data.

*This Technical Summary pertains to Report 2009-33, “Development of Data Warehouse and Applications for Continuous Vehicle Class and Weigh-in-Motion Data,” published October 2009. The full report can be accessed at <http://www.lrrb.org/PDF/200933.pdf>.*