Introduction References Content

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• "WIMLINK" - THE FULLY INTEGRATED INFORMATION MANAGEMENT SYSTEM FOR WEIGH-IN-MOTION

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ABSTRACT

The collection and processing of Weigh-In-Motion (WIM) data has historically been a restrictive influence on the application of vehicle weights and dimensions to detailed traffic analysis. This is not surprising given the difficulties that WIM data managers have had to face. These difficulties arise through: differences in WIM system outputs; maintaining calibration; changing rules of classification and enforcement; servicing user groups who want different levels of accuracy and data aggregation; handling and limiting the huge volumes of data available; and giving quality assurance.

A new WIM management tool being developed at ARRB Transport Research Ltd. addresses all of these problems, providing a common interface to the WIM data and substantially simplifying the management of multiple WIM sites. The system offers inventive solutions to vehicle classification, storage, reporting, calibration and quality assurance and substantially reduces the workload involved in managing the data whilst making it available to a host of new applications of heavy vehicle information.

BACKGROUND

In the mid 1980s, ARRB Transport Research Ltd. (formally the Australian Road Research Board) and the Department of Main Roads, Western Australia, designed and built a culvert-based Weigh-In-Motion device called "CULWAY" (Peters 1986). This device proved to be extremely popular and within a decade, more than 100 CULWAY systems had been installed in every state in Australia, making it the country's most popular choice of vehicle weighing system.

In the last 5 years, the demand for vehicle mass information has continued to increase and other WIM systems have appeared where there are no suitable culverts for the CULWAY system to operate. The data flowing from all of these systems grows steadily each year (**Figure 1**) and although there exists a keen data user group, the mechanism to convert this data into relevant and timely information is unwieldy and in urgent need of upgrading. The projected trend line in Figure 1 is based on the knowledge that State Road Authorities (SRAs) and private toll road operators are purchasing WIM systems to monitor densely trafficked urban areas whereas in the past, the majority of WIM sites where installed in rural areas.

The cost of simply managing the various systems has grown nation-wide to well over 1 million Australian dollars per annum. Given that the data for around 10 million commercial vehicles are collected each year, this is of the order of 10 cents per vehicle.

The WIMLINK system is designed to reduce the cost of management while greatly increasing the quality, availability and extent of information available.

WIM DATA MANAGEMENT

In Europe and America there is a move towards improving the management and quality of traffic data. In Europe, some countries have developed their own systems, notably the French database PESAGE, which stores 2 million truck records (Jacob 1996). Recently a program to integrate European systems has appeared in the form of the pan-European WAVE (Weigh In Motion of Axle Vehicles and Weights) research project. This states one of its objectives to be the "development of improved pan-European procedures for the checking, processing and storage of WIM data." (Jacob 1996) This is expected to create a common mechanism for describing the quality of WIM data as well as exchanging this data for a variety of purposes across Europe.

In the US State of Pennsylvania, the Department of Transport also developed a system to automatically retrieve, store and report WIM data (Haines 1990). However, the most significant advance in WIM data processing in America has been through the Strategic Highway Research Project (SHRP). This has accumulated a very large database of traffic loads and developed a structured Quality Assurance program in order to establish integrity in the data. This QA program is a benchmark for Quality Assurance in WIM data.

Difficulties Encountered in Data Management

Traffic data has traditionally been quite difficult to manage for a number of reasons.

The data collected has unlimited size and tends to quickly overwhelm the capacity of the data management system. In Australia for example, WIM devices collect information on over ten million commercial vehicles per year, in the order of 10 gigabytes of disk space. The traditional solution to this problem is to limit (or ignore some of) the data collected.

The individual vehicle records are not similar. Although the most common vehicle may have only three axles, the most "interesting" may have more than fifteen, as is the case for the triple road train found in parts of Australia. The approach to solving this problem has been to ignore vehicles longer than a certain length and/or to store only aggregates of the data, ie, not the individual vehicle records or "primary level" data.

Data generated from collection devices are not reported in a common format. Some systems report individual axles, others report axle groups. Some are fixed field format, others are floating field format. A laborious process of conversion often ensues as the data moves through the management system.

It is difficult to assure quality in the data. Field calibration of systems is an expensive procedure and much has been written on alternative methods of “indirect” calibration.

The data user groups have extremely divergent reporting interests. While pavement engineers are mainly interested in averages and frequencies, enforcement officers and bridge engineers are often interested in masses and spacings of individual “extreme” vehicles.

WIMLINK – A FULLY INTEGERATED APPROACH

WIMLINK confronts these issues through a considered design and an investment in a modern information retrieval, management and reporting system. The top-level design of the WIMLINK Information Management System (**Figure 2**) breaks the data management process into its logical functional components.

The SYSTEM Modules

WIMLINK can automatically dial and download data from any WIM or traffic counter site connected to a modem through the RETRIEVAL module. Once downloaded, the PROCESSOR automatically processes the files to a common database format and inserts them into the WIMLINK DATABASE.

Information about the specific WIM system such as calibration numbers, hardware devices, service details and site performance information is recorded in the SYSTEM DATABASE; the interface to this being the ADMIN module.

CALIBRATION is setup to go beyond the use of calibration trucks or the few vehicles stopped from the traffic stream. These traditional methods have been quite expensive to perform and have meant that calibration is performed very infrequently. Although WIMLINK is able to use the results of these methods, it is much better suited to calibrating using hundreds of different vehicles taken from the traffic stream over months and years. This would be possible through vehicle ‘tagging’.

A suggestion is that accurately weighed vehicles bearing an electronic license plate would pass over the WIM site, transmitting their known load. Some freight haul companies such as petrol companies weigh their cargo to the nearest kilogram and would be ideally suited to this concept. The WIMLINK system would keep the information and update the calibration automatically.

To encourage industry to join the scheme, a payment could be made for each recorded vehicle. Additionally, future WIM systems should be capable of returning mass information to the vehicles passing.

WIMLINK DATABASE

The WIMLINK DATABASE is capable of handling individual vehicle records from trafffic counter devices as well as WIM devices. Although it currently stores over 10 million individual commercial vehicle records (location, date, time, axle masses, axle spacings etc) it has the clear potential to handle a data set which is far greater: closer to 1 billion vehicle records.

All derived information (such as freight carried, ESAs, headway, AADT or percent overloaded indicators) is generated from system tables, making the information specific to the location. For example, a six axle articulated vehicle in WA has a different average tare

QA MANAGER

The issue of quality is of great concern to traffic information consumers. For this reason, WIMLINK has an extensive system of quality checks, based on the experience gained from SHRP, that span from the hardware-specific to the hardware-independent.

WIMLINK is capable of performing any kind of QA check:

1. Range checks on fields such as speed, time or mass. These usually indicate temporary failure of the system due to an unexpected event such as vehicles overtaking on the weighing device.

2. Comparison checks on indicators created through the aggregation of multiple vehicles. These are used to show long-term calibration drift. Common examples are the percentage of vehicles recorded in the hour to midnight compared to that for the hour to midday or the location of the loaded peak of a semi-trailer frequency diagram for the month of June.
3. Pattern changes based on a number of indicators simultaneously (cluster analysis). These are also used to flag long term or short term ‘outlier’ events such as system breakdown over a short period of time.
4. Hardware checks for system specific information such as axle detector failure.

The QA MANAGER automatically generates these reports for inspection.

The VEHICLE REPORTER

The function of the module VEHICLE REPORTER is to periodically and automatically generate prepared queries and to post the results to data users via email.

As described above, the resolution and accessibility of the data can support a very broad range of inquiry. Studies of vehicles can easily range from investigating the individual axle characteristics on individual vehicles, through to changes in data patterns across seasons and regions.

In Australia, end users of vehicle information can be grouped into the following categories: Infrastructure Design and Maintenance; Freight; Detection & Enforcement; and Bridge.

- **Infrastructure Design and Maintenance**

WIMLINK is capable of satisfying the requirements of pavement designers with a number of routines to support the various Australian design methods. Frequency plots of group masses, numbers of ESAs per commercial vehicle and ESAs per axle group are quickly accessible.

WIMLINK is currently being used to create pavement traffic design reports as part of a project aimed at updating the Traffic Chapter of the Australian Pavement Design Guide (Koniditsiotis 1996). One such report is illustrated in **Figure 3**.

Long-term issues such as accumulated damage or traffic growth can be assessed for strategic road planning and budget forecasting

- **Freight**

WIMLINK has recently provided the information for a study into the amount of freight carried on certain roads in Western Australia. Freight carried was determined by subtracting the average tare mass of the vehicle’s class for WA from the vehicle’s measured weight. The study reported freight carried per hour, per lane for each hour of the day.

- **Detection & Enforcement**

Enforcement agencies tend to require a great deal out of WIM data, both in terms of hardware accuracy and the level of vehicle information detail that is recorded.

The WIMLINK information management system will be capable of delivering the most relevant information available to them. **Figure 4** shows one possible form of output in an example of the extremity of overloads by vehicle class. Of note is the sample size reported: nearly 6 million vehicles.

WIMLINK will be just as capable of informing the officers where and when they should locate themselves in order to intercept the most overloaded vehicles as it is in quickly sifting through hundreds of thousands of vehicle records to identify the travelling patterns of a consistently overloaded vehicle.

- **Bridge**

Recently the WIMLINK database was used to investigate headway distributions between different types of vehicles. A procedure was written to select and calculate the frequency of headways between vehicles of different classes, speeds and masses. This is akin to removing all the other vehicles from the traffic stream and recalculating the headways between the vehicles remaining. Percentile figures were also reported. An example of this output is presented in **Figure 5**.

WIM data could be applied to the evaluation of bridges, legal limit settings, bridge load limit postings, cumulative fatigue damage indicators and the granting of permits. This is all made possible through the storage and fast retrieval of individual vehicle records.

• CONCLUSION

The primary stage of the WIMLINK vehicle information management system is completed, and has been used in a number of studies. It is proposed that further improvements to the WIMLINK reporting capabilities will be to have data accessible via the World Wide Web.

However information immediately available from the system will give the Weigh-In-Motion and traffic data collection business in Australia a flying start to the next century.

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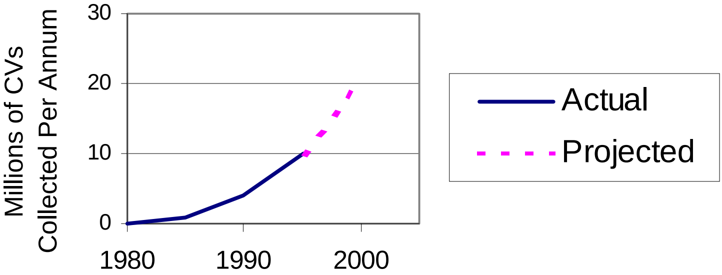

Figure 1. Trend in Australian WIM Data Collection

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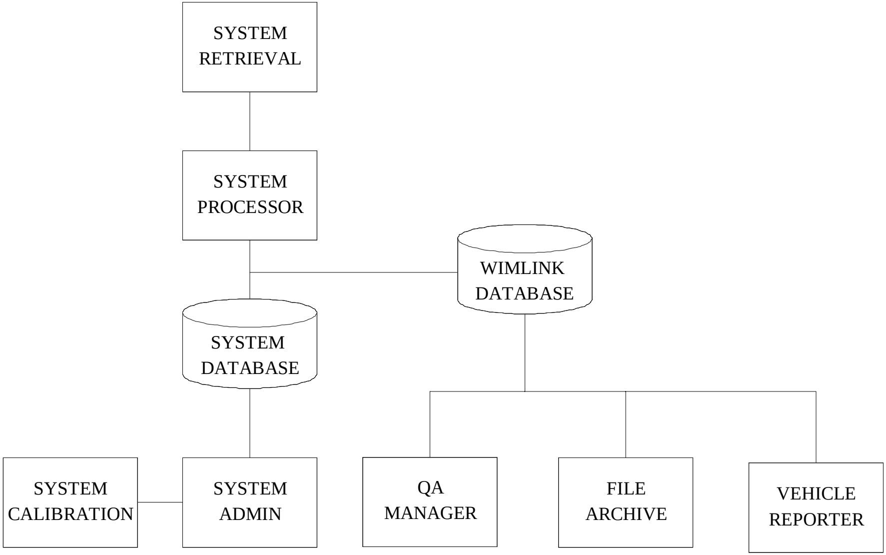

Figure 2. Top Level Design of WIMLINK

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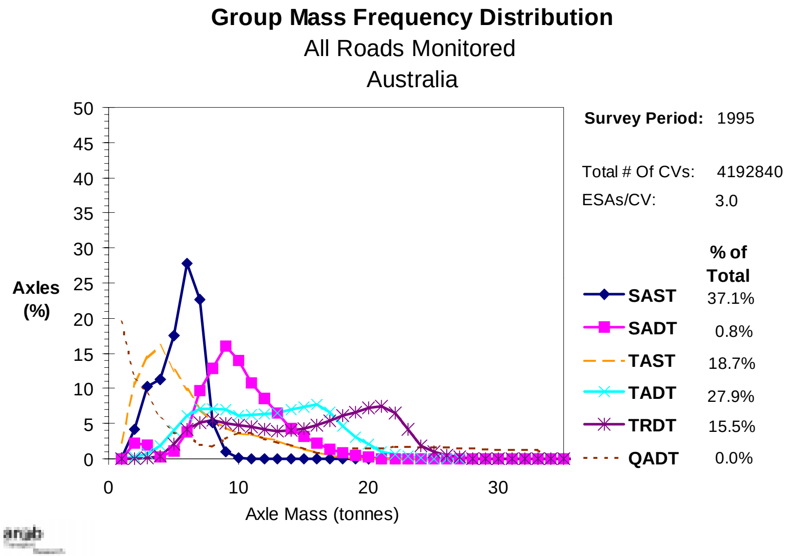

Figure 3. Example of Pavement Report from WIMLINK

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Distribution of Overloads

All Australian Roads

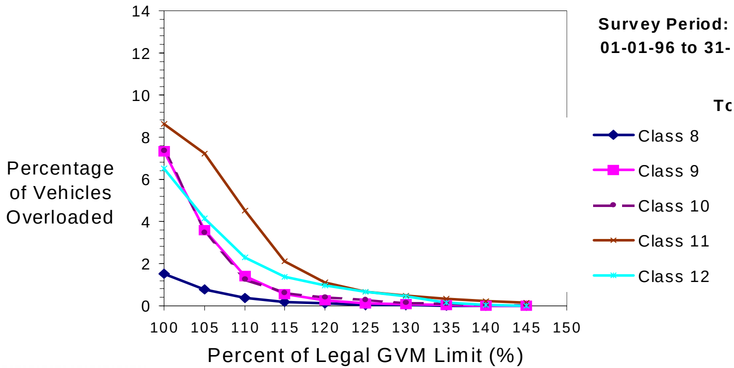

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Figure 4. Example of Overload Data Output from WIMLINK

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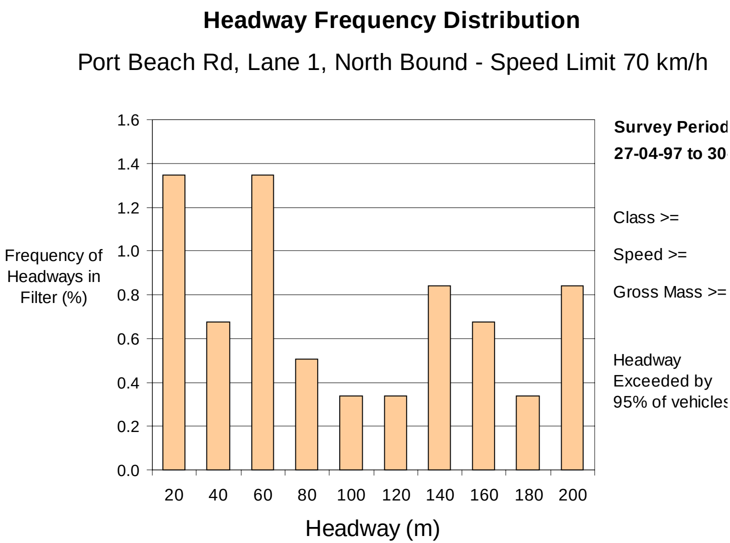

Figure 5. Example of Headway Data Output from WIMLINK

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