# Commercial Vehicle Movements in the Sydney Region.

**Samantha Taylor,**
Research Engineer,
Australian Road Research Board

**Ricardo Maldonado,**
Survey Project Officer,
NSW Department of Transport, Study Group

**Ken Ogden,**
Professor, Transport Group
Monash University

**Abstract:**

The NSW Department of Transport, Study Group (formerly Transport Study Group of NSW), and ARRB have undertaken preliminary analysis of the 1991-92 Commercial Vehicle Survey (CVS) of the Greater Sydney Metropolitan Region. The long term aim of the CVS is to provide information on the current patterns and behaviour of commercial vehicles and in particular freight vehicles.

Preliminary analysis of the CVS to date, has found that in the target population:

- 70% of commercial vehicles were light vehicles (i.e. utilities, 4WDs or good vans);
- about 2% of commercial vehicles were articulated vehicles;
- the majority of trips were over short distances (e.g. <20km);
- an average of 65% of registered vehicles were used on an average weekday;
- the majority of the commodities picked-up or delivered were classed as machinery (e g. electrical apparatus, office equipment, machines and telecommunications equipment), but overall the types of commodities moved were very diverse;
- on average there were twice as many deliveries as pick-ups;
- the largest generators of articulated vehicles *per sq km* were Botany, Sydney CAD and Auburn Statistical Local Areas (SLAs);
- in excess of 80% of light and rigid vehicles began their first trip between 6 am and 1 pm;
- no more than about 10% of registered commercial vehicles were on the road at any one time; and
- the number of commercial vehicles on the Greater Sydney Metropolitan network peaked between 10 am and 11 am, but was relatively constant between 7 am and 3 pm.

he views expressed in this paper are the authors' and not necessarily the views of the organisations ıvolved.

**ontact Author:**

ɪmantha Taylor
ɹstralian Road Research Board
Ͻ Box 156
ɹNAWADING VIC 3131

ɪlephone: (03) 881-1572
ıx: (03) 887-8104

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# 1. INTRODUCTION

Achieving total transport reform requires an understanding of the urban road freight transport system, how it operates, and its relationship to other parts of the social system such as the economy and the environment. In broad terms there is a significant relationship between economic activity (e.g. GDP) and the amount of freight moved (Taplin, 1983). While the supply of freight transport is important to maintain a community's standard of living, there are trade-offs between economics, the environment and social issues. As environmental sustainability and economic performance become increasingly important, there is a need to study the trade-offs.

From an institutional perspective, most trade-offs with economic efficiency take the form of regulations, charges and restrictions, which, although they may inhibit the optimal efficiency of goods movement and services, are necessary to increase amenity and reduce social concerns of the community. There are other issues, from an operational perspective, which usually take the form of profit (customer service included) versus operating in congested periods, emissions, vehicle fleet size, number of trips etc. In a competitive environment, customer service and profit (good customer service theoretically leads to greater market share and greater profit) drives an organisation. Generally it is accepted that the amount of freight moved is unresponsive (within limits) to changes in the cost of freight movement, that is, 'there seems to be wide agreement that the price elasticity of demand for the transport of general goods is less elastic than -0.1' (Taplin, 1983). Transport costs for manufactured goods are typically between 2% and 8% of the total cost of production (Ogden, 1992). However, goods with a low ratio of value to bulk e.g. sand, gravel, pre-mixed concrete, etc. have significant freight costs relative to their value and therefore the cost of freight will affect the demand for that product (Friedlaender, 1969).

To assist in the process of identifying freight transport behaviour and the role of urban network planning in freight movement, the Roads and Traffic Authority (RTA) and the NSW Department of Transport, Study Group (formerly Transport Study Group of NSW) undertook a commercial vehicle survey (CVS) in the Greater Metropolitan Sydney Area in 1991-92 (Maldonado and Akers, 1992). The survey was carried out to provide insights into the distribution of freight within the metropolitan region (NSW Government, 1993) and also to provide a basis for future work.

### The Greater Sydney region

Sydney is the largest and most congested city in Australia. It's topography, existing infrastructure, and waterways add extra dimensions to the already challenging task of transport and urban planning. The population forecast for the Greater Metropolitan Sydney Region (see Map, Figure 1) for the year 2011 is 5.2 million, an increase of 800,000 from now, with the majority of growth in Sydney (Department of Planning, 1993). Combined with a forecast GDP growth of about 3.5 % pa over the next 22 years and an estimated 100% increase (from 1991) in the number of commercial vehicles on the network (Roads and Traffic Authority, 1991) there will be increasing pressure on

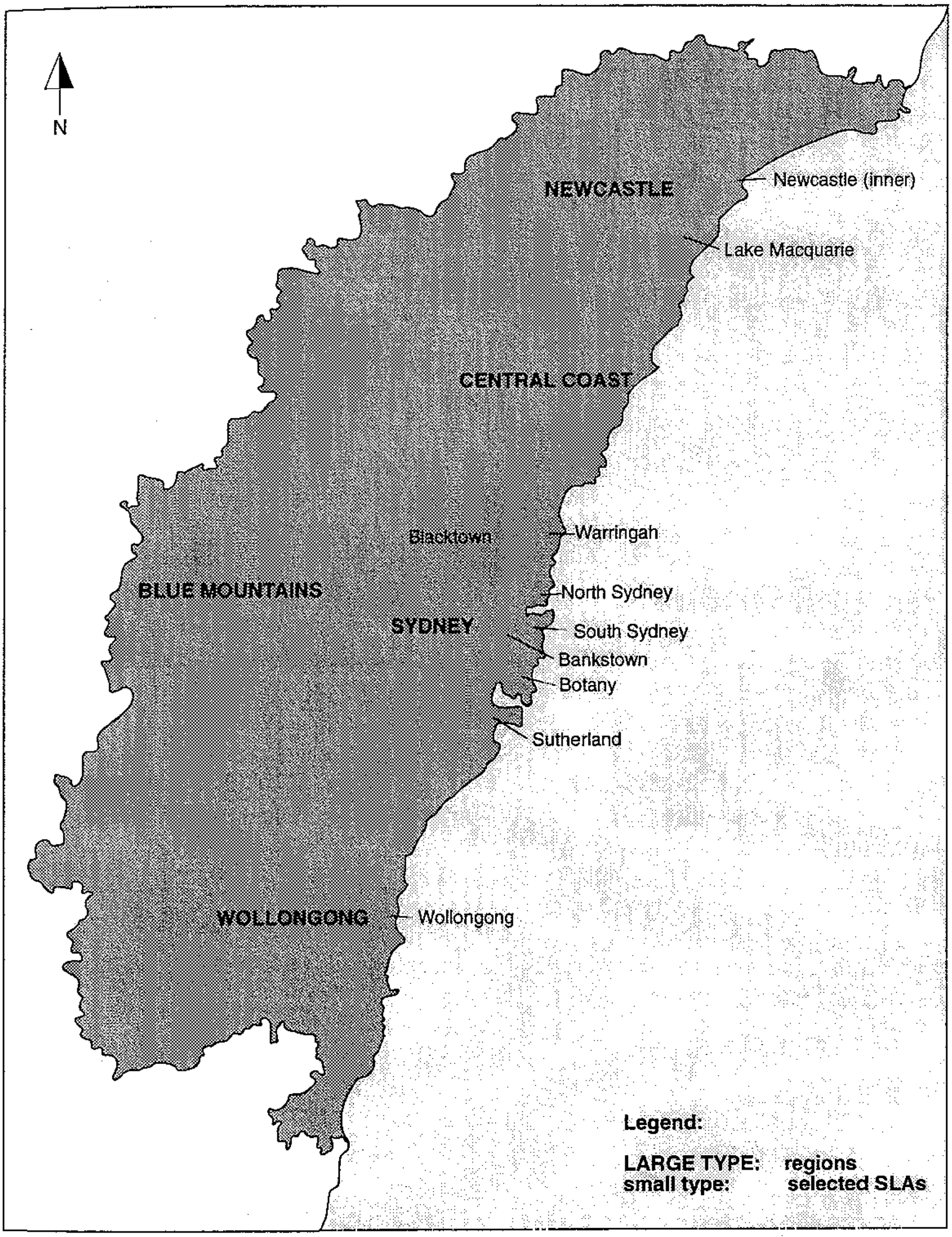



**Figure 1 Greater Sydney Metropolitan Region - CVS study area**

existing infrastructure, congestion, emissions and safety measures. It has been estimated that congestion already costs commercial and business activities in Sydney $1.5 billion pa (Hepburn and Luk, 1993), that trucks are over-represented in fatal urban crashes (Ogden and Tan, 1989), and that Sydney cannot absorb its projected growth and meet national health standards for air quality with the existing rate of emissions (NSW Government, 1993).

The NSW Department of Transport recently published an Integrated Transport Strategy (ITS) (NSW Government, 1993) aiming to deal with these increases in activity, in concert with the RTA's Road Freight Strategy (Roads and Traffic Authority, 1992) and Future Directions on Freight (Roads and Traffic Authority, 1991). The documents all emphasise the need for the CVS to provide insights into freight movement patterns and ultimately assist the development of detailed urban freight policies.

## 2. BACKGROUND

### About the CVS

The CVS was a 12 month study undertaken in 1991-92. Information was requested from a sample of commercial vehicles registered in the Greater Sydney Metropolitan Region (Figure 1), also referred to as the study area: Sydney, Central Coast, Newcastle, Blue Mountains and Wollongong. The survey was in the form of a mail-out mail-back self completion questionnaire with initial contact by telephone. A detailed discussion of the CVS survey is beyond the scope of this report but a description of the CVS methodology can be found in Maldonado and Akers (1992). It should be noted that the CVS was expanded to the registration database using 13 regions (based on Australian Bureau of Statistics Statistical Subdivisions) and the three vehicle stratas.

### The commercial environment

Before analysing the results of the CVS it is useful to outline the environment in which commercial vehicles operate:

- about two-thirds of the Australia wide urban freight task is carried out by firms using their own trucks (ie. ancillary operation), the remaining one-third by hire and reward (Australian Bureau of Statistics, 1990). As a proportion of the commercial vehicle fleet, ancillary vehicles are probably even larger since it is suggested that most *service* vehicles are ancillary vehicles; and
- the concept of logistics has led to the adoption of Just-In-Time techniques to enable organisations to become more flexible in production by reducing capital investment through storing less raw materials and finished goods. This has led to an increase in timed deliveries.

Like any business, freight transport activities are profit driven. In the Hire and Reward sector freight operations are also customer driven and therefore largely reflect the environment and operations of major customers. On the other hand ancillary fleet operations are often driven by the logistics (e.g. Just-In-Time) and marketing strategies of that particular firm therefore maximising the profit of the entire firm rather than only the transport component.

There are many different industry groups (Fearon et al, 1994) served by the freight transport industry. Some of the major industry groups are as follows: food retailers; consumer product retailers (products other than food); manufacturing; petroleum and oil; construction; express freight including mail and parcels, and waste removal. Each industry has different transport requirements which usually depends on the following: customer operations (e.g. goods receival hours), lead times, operating policies (e.g. JIT) and type of freight being transported (e.g. concrete). Some industries, for example major food retailers, supply their stores through regional distribution centres which enables consolidation of all products at the warehouse and a high level of control over incoming and outgoing stock (Ogden, 1992). On the other hand, some small independent stores still have to rely on direct deliveries from individual suppliers or wholesalers. These two methods of operation necessitate different delivery patterns. The regional distribution centre consolidates a range of goods for one large delivery to a store, whereas the small independent stores may require multiple deliveries: one from each supplier.

## 3. GENERAL ANALYSIS OF THE CVS

The work presented in this paper results from analysis of trips with both origins and destinations within the study area (Figure 1). A trip is defined as the one-way movement of a vehicle from origin to destination with no stops. Many of the explanatory comments expressed are speculative and are included to explain the movement of commercial vehicles. The following is a summary of the general findings.

### Survey information

The commercial vehicles surveyed in the CVS were classified by number of axles and type of carrier, as shown in Table I. Light vehicles (small, two axle) were classed as either goods van, utility or 4WD while rigid (medium) and articulated (large) vehicles were classed by number of axles on the body, and by type of carrier.

The CVS showed that an estimated 65% of commercial vehicles made trips on an average weekday, of these vehicles 2% were articulated vehicles, about 26% were rigid, and about 72% were light vehicles. Of the light vehicles, about 56% were reported to be service vehicles.

**Table I** **CVS vehicle classification**

| Vehicle Class | Number of Axles on Vehicle Body* | Type of Carrier |
|---|---|---|
| Light | 2 | goods van, utility, 4WD |
| Rigid | 2, 3, 4 | ) flat top, livestock transport, ) pantech., car carrier, tanker, |
| Articulated | 3, 4 | ) tipper, refrigeration unit, container ) carrier, dangerous goods |

* the body of an articulated vehicle is the prime mover

## Trip characteristics

### *Lengths, durations and average speeds*

The physical characteristics of internal (both ends within the study area) weekday trips are shown in Figures 2 and 3 and Table II.

The majority of trips were over short distances and of relatively short durations. As vehicle size increased so did the length and duration of trips, which is consistent with results from other studies (Reilly and Hochmuth 1990, Stephens et al 1993, Schlappi et al 1993). This may be partly due to the economies of scale of larger vehicles which only come into play over longer distances. Also, multiple pick-up and/or delivery operations are almost all carried out by smaller vehicles, which lowers the mean and median trip lengths and durations of these vehicles.

Calculated average speeds were higher for articulated vehicles than other vehicles (Table II) which may be related to the finding that these vehicles performed longer trips. Higher average speeds may be a 'by-product' of longer distances and longer durations since as length increases, delays and stops at signals generally become a smaller proportion of the total trip length, thereby increasing the average speed.

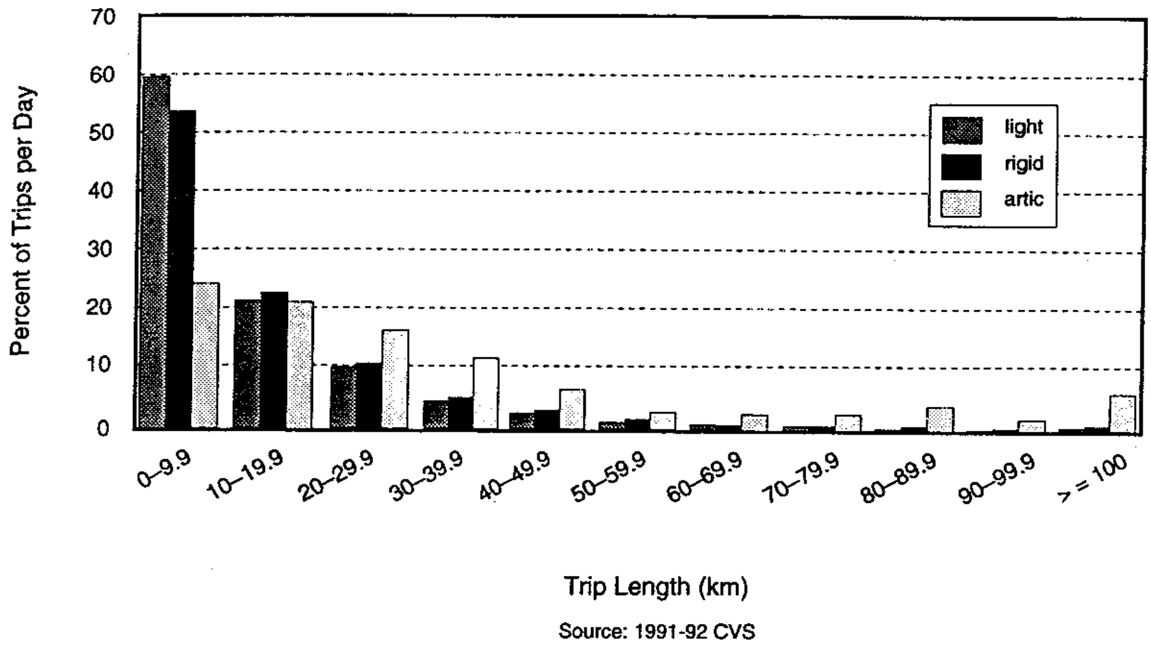



**Figure 2** **Distribution of weekday trip length by vehicle strata**

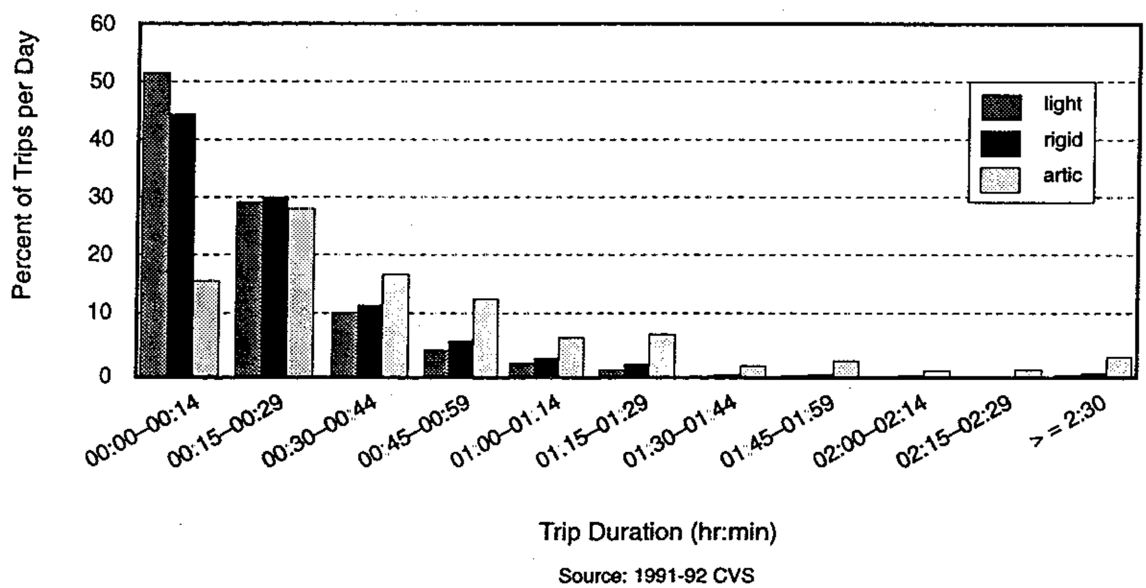



**Figure 3** **Distribution of weekday trip duration by vehicle strata**

**Table II** **Weekday trip characteristics**

| Vehicle Strata | Length (km) | | Duration (min) | | Av. Speed (km/h) | |
|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median |
| Light | 14.1 | 8.2 | 24 | 15 | 34 | 30 |
| Rigid | 16 3 | 10 0 | 29 | 20 | 34 | 30 |
| Artic | 37.7 | 25 0 | 54 | 40 | 39 | 38 |

Source: 1991/92 CVS

### *Spatial patterns*

Commercial vehicle trips were not dispersed over the entire study area but as expected were generally concentrated in the industrial, terminal and commercial areas. The study area was divided into regions: 56 Statistical Local Areas (SLAs) based on local government boundaries It should be noted that SLAs all have different land areas. The following is a summary of the main findings:

- one third of the trips generated in the study area were destined for one of the following SLAs: Wollongong; Newcastle (remainder); Blacktown; Bankstown; Lake Macquarie; Warringah; Sutherland; and South Sydney (Figure 1);
- Botany, Sydney CAD and Auburn respectively, generated the greatest number of articulated vehicle trips per sq km (Figure 1); and
- of the heavy commercial vehicle group (rigid and articulated classes combined), Bankstown, Blacktown and Wollongong attracted the greatest number of heavy vehicles (Figure 1).

The majority of vehicle trips originate from within the same SLA to which they are destined which is supported by the high frequency of short trip lengths (Figure 1).

### *Commodities*

Using the Australian Transport Freight Commodity Classification (ATFCC) commodities were classified into a possible 67 specific categories (2 digit code) and also into 10 broad categories (1 digit code) The five most commonly delivered commodities, using the 1 digit code, in each strata are presented in Table III. The CVS showed that *service* vehicles mainly deliver Machinery or Manufactured Goods (not shown) and no more than one third of deliveries in any vehicle strata accounted for any one commodity classification.

**Table III Commodities most commonly delivered - by vehicle strata.**

| Vehicle Strata | Commodity Classification (ATFCC) | Example Commodities | Percentage of Deliveries |
|---|---|---|---|
| Light | Machinery | office equipment, machines, telecommunications, electrical apparatus | 31% |
| | Manufactured Articles | prefabricated building materials (e.g. lighting, plumbing), clothing, furniture | 16% |
| | Food and Live Animals | food, cereals, animal foods | 16% |
| | Manufactured Materials | paper, iron, steel | 15% |
| | Commodities & Transactions | containers, packages, mail, motor vehs. | 8% |
| Rigid | Manufactured Materials | paper, iron, steel | 27% |
| | Food and Live Animals | food, cereals, animal foods | 19% |
| | Machinery | office equipment, machines, telecommunications, electrical apparatus | 19% |
| | Crude Materials (inedible) | wood, crude fertilisers, waste paper | 10% |
| | Manufactured Articles | prefabricated building materials (e.g. lighting, plumbing), clothing, furniture | 8% |
| Artic. | Crude Materials (inedible) | wood, crude fertilisers, waste paper | 20% |
| | Manufactured Materials | paper, iron, steel, wood | 17% |
| | Mineral Fuels | coal, petroleum, oil, gas | 16% |
| | Commodities & Transactions | containers, packages, mail, motor vehs. | 16% |
| | Food and Live Animals | food, cereals, animal foods | 13% |
| All C.V.s | Machinery | office equipment, machines, telecommunications, electrical apparatus | 27% |
| | Manufactured Materials | paper, iron, steel | 19% |
| | Food and Live Animals | food, cereals, animal foods | 17% |
| | Manufactured Articles | prefabricated building materials (e.g. lighting, plumbing), clothing, furniture | 14% |
| | Commodities & Transactions | containers, mail, packages, motor vehs | 8% |

Source: 1991-92 CVS

*Pick-up versus delivery*

Deliveries were more than twice as frequent as pick-ups, as expected, indicating that there are more receivers of goods than producers of goods (Table IV) This high proportion of deliveries is related to the high number of consumers in urban areas relative to other areas.

When the pick-ups and deliveries are analysed by vehicle strata, the articulated class performed a slightly lower proportion of deliveries (Table IV), suggesting that there are more full truck load (FTL) consignments by articulated vehicles than smaller vehicles. This is probably due to the large proportion of trips by articulated vehicles to terminals and warehouses involving large shipment pick-ups and deliveries, for example delivery of containers to ports.

**Table IV Weekday pick-ups and deliveries of goods**

| Function | Light | Rigid | Articulated |
|---|---|---|---|
| Goods Delivered | 66% | 66% | 58% |
| Goods Picked-Up | 34% | 34% | 42% |

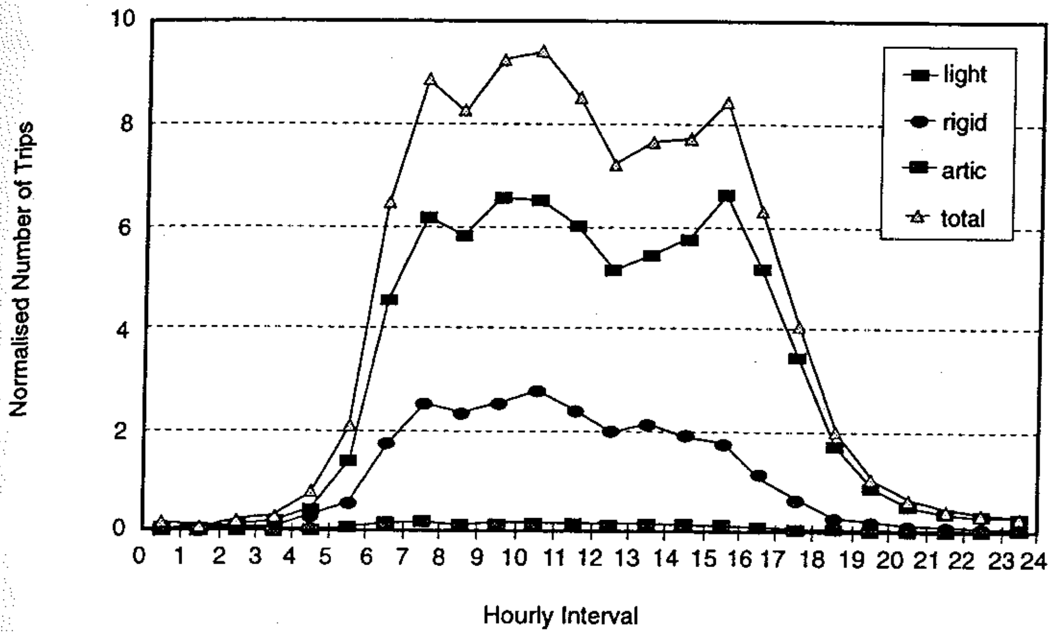
Source: 1991/92 CVS

## 4. TEMPORAL PATTERNS AND COMMERCIAL VEHICLE USE

### Network loading

Figure 4 shows the relative frequencies of commercial vehicle trips on the Greater Sydney network at hourly intervals throughout an average week day. Commercial vehicle movements started increasing at around 6am, and peaked between 10am and 11am before dropping to a day-time low at 12.30pm.

Activity increased slightly after the midday period until about 3.30 pm when the number of trips starting began to drop to coincide with the end of the 'trade' working day (n.b. the Transport Workers Award specifies 8 hour Monday to Friday working days between 5.30am and 6.30pm, Noonan, 1993). Light vehicles appear to exhibit slightly different temporal patterns than the other vehicles. After the midday period, light vehicle activity increased again whereas the other vehicles began to taper off until the end of the working day. It can take a long time to unload or load a large vehicle, and sometimes the vehicle is loaded in the afternoon in preparation for the next shift (often the following morning). This means that drivers may need to finish their trips in the early afternoon so that the vehicle can be attended to before the end of the day.



Source: 1991-92 CVS

**Figure 4** **Distribution of trip start times on weekdays**

Light vehicles often rely on short lead-time work (e.g. couriers) and are often involved in small quantities and more regular deliveries. Given the extremely short lead-times involved with, say couriers, their services would be in demand equally in the morning as in the afternoon. On the other hand, larger vehicles could be working their trips in the morning to coincide with customer demand and working hours. Generally, many blue collar workers start their working day around 7 or 8am and finish around 4pm which affects the times when organisations can receive goods. It is not uncommon for organisations not to receive goods after 3pm while the Botany-West Transport Study found that some organisations stopped receiving goods as early as 2pm (Denis Johnston & Associates, 1991).

## Day-time versus night-time operations

For the network loading analysis, the time-of-day operations of commercial vehicles during weekdays was split into day-time and night-time hours where day-time was arbitrarily selected as 6 am to 6 pm and night-time from 6 pm to 6 am. To analyse any variations between morning and afternoon periods during the day, a further breakdown of the day-time period into morning (6 am to 1 pm) and afternoon (1pm to 6 pm) was carried out (Table V). Similarly, the night-time period was split into evening (6pm to 4am) and early morning (4am to 6am).

**Table V Time when vehicles make their first trip (percent)**

| Time Period | Light | Rigid | Articulated |
|---|---|---|---|
| Morning (6am to 1pm) | 86% | 82% | 61% |
| Afternoon (1pm - 6pm) | 3% | 3% | 2% |
| Evening (6pm to 4am) | 2% | 4% | 9% |
| Early Morning (4am to 6am) | 9% | 11% | 28% |

Source: 1991/92 CVS

As vehicle size increased so did the proportion of vehicles which began their first trip in the early morning period (Table V) Twenty-eight percent of articulated vehicles began their first trip in the early morning period while only 9% of light vehicles did This relatively high proportion of articulated vehicles that began their first trip in the early morning may be partly attributed to the following:

- articulated vehicles make longer trips, therefore by starting early in the morning they arrive at their destination at the beginning of the working day; and
- a high percentage of pick-ups and deliveries were minerals and fuels which can be delivered outside normal working hours.

Light vehicles have similar performance characteristics to cars, and although congestion would increase travel times, some (light) hire and reward vehicles (e.g. couriers) rely more on the normal working day (as opposed to trade working day) for their customers. It is hypothesised that the normal working day coincides with office and retail hours (approximately 9am to 5pm) rather than traditional trade hours (e.g. 7 or 8am to 3 or 4pm).

**Table VI Characteristics of trips in day-time period**

| | Length (km) | | Duration (min) | | Av. Speed (km/h) | |
|---|---|---|---|---|---|---|
| Vehicle Strata | Mean | Median | Mean | Median | Mean | Median |
| Light | 13.5 | 8.0 | 22 | 15 | 34 | 30 |
| Rigid | 15.1 | 10.0 | 26 | 20 | 33 | 30 |
| Artic | 33.1 | 24.0 | 48 | 39 | 38 | 36 |

Source: 1991/92 CVS

**Table VII Characteristics of trips in night-time period**

| Vehicle Strata | Length (km) Mean | Length (km) Median | Duration (min) Mean | Duration (min) Median | Av. Speed (km/h) Mean | Av. Speed (km/h) Median |
|---|---|---|---|---|---|---|
| Light | 13.3 | 9 8 | 20 | 15 | 38 | 36 |
| Rigid | 22 0 | 12.0 | 29 | 20 | 41 | 36 |
| Artic | 54.2 | 33 0 | 59 | 40 | 50 | 48 |

Source: 1991/92 CVS

Less than 3% of vehicles made their first trip in the 1pm to 6pm period and it is suggested that the vehicles that did were specialist vehicles, for example horse carriers (for horse trainers), tow trucks, special equipment vehicles, and earth moving trucks. It is hypothesised that many of these vehicles are thought to be ancillary vehicles, and their operators often have greater flexibility in deciding when to make trips.

Given a vehicle made its first trip in a particular time period (ie. day-time or night-time) there are only subtle differences in physical trip characteristics (Tables VI and VII). These differences are likely to be a result of reduced congestion. In summary, in the night-time period (6pm to 6am) the differences were as follows:

- small increases in average speeds by light vehicles without changes in trip length;
- marginal increases in trip length and duration and average speed for rigid vehicles; and
- significant increases in trip lengths, durations and average speeds by articulated vehicles.

## Vehicle use

The average daily use of commercial vehicles as a percentage of registered commercial vehicles is shown in Table VIII, together with corresponding trip frequencies.

The apparently low number of working vehicles is comparable with the Chicago commercial vehicle survey which reported that between 50% and 60% of registered vehicles were used on an average day (Reilly and Hochmuth, 1990). However, this low number of working vehicles (Table VIII) could be due to any of the following reasons:

- light vehicles also being used as passenger vehicles, this could be particularly so with service vehicles;
- vehicles being repaired;

- no work available for the vehicle, for example specialist vehicles such as tow trucks, earth moving or special equipment/apparatus vehicles, and ancillary vehicles like fruit and vegetable trucks; and
- large vehicles being older vehicles (e.g. no longer used for line-haul but adequate for urban goods movement) and therefore not representing the same degree of investment as new large vehicles. Also, since they are used for larger quantities, the customer may require deliveries or pick-ups less frequently than daily. A good example of this is the ports where truck travel to the ports depends on the frequency and cargo of ships arriving and departing (Maritime Services Board, 1993)

The full extent of this under utilisation is difficult to assess without knowledge of how organisations run their fleets, fluctuations in customer demand (for example, higher demand in the morning), and the split between vehicles operating under hire and reward conditions and those operating under ancillary conditions.

**Table VIII Weekday vehicle use**

| | | **Trip Frequency**** | |
|---|---|---|---|
| **Vehicle Strata** | **Working Vehicles*** | Mean | Median |
| Light | 69 % | 4.7 | 3 |
| Rigid | 63 % | 4.5 | 3 |
| Articulated | 66 % | 4.4 | 4 |

Source: 1991/92 CVS
* Working vehicles are the average proportion of registered vehicles that make at least one trip on an average day.
** Trip frequency is related to the number of trips a working vehicle makes in an average day.

### *Trip frequency*

The low median number of trips reported by the light vehicles may be due to a high proportion of service vehicles that made a low number of trips, or the possibility that light vehicles can be dual purpose. That is, they may also be used as passenger vehicles when not used as goods or service vehicles, thus justifying their investment and also providing tax benefits. On the other hand light courier vehicles made a large number of trips which could account for the skewed distribution evident from the variation between median and mean trip frequency (Table VIII).

Vehicles in the rigid class range from small two axle two tonne vehicles, to large four axle trucks. Given the wide range of vehicle sizes in this class, some small rigids may be involved in high frequency work (e.g. Australia Post). However, it is expected that most specialty vehicles are in this category which would contribute to the low number of working vehicles and also the low number of trips reported. This high heterogeneity would account for the skewed distribution (Table VIII).

Even though the articulated vehicle class had only two-thirds of registered vehicles working on an average day, the two-thirds reportedly made a relatively high number of trips (Table VIII). This indicates a more efficient use of *working* vehicles particularly given the longer distances and travel times involved (Table II).

## 5. TRADE-OFFS WITH OPTIMALLY EFFICIENT MOVEMENT

Given that the 'demand for freight arises from the economic process of production and consumption' (Ogden, 1992) it is logical that methodology changes in this process at any level will result in certain social, environmental or economic impacts. These impacts result from decisions made, and policies developed, in both the private and public sectors. The private sector is mainly concerned with the operations of freight transport, while the public sector is generally concerned with regulation and the provision of road infrastructure.

From an operations perspective, profit, logistics and customer service generally drive decisions on freight transport. For example, travelling in congested periods and maintaining a large fleet with low vehicle use may be necessary to meet customers' demands which could be high in the am period and lower in the pm period. From an institutional (public/government) perspective, issues are not so clearly driven. For example, typical trade-offs are between infrastructure investment, economic performance, regulations, environment, safety, social concerns, capital expenditure, and desired urban structure (Ogden, 1992), which can be driven by politics, government policies and successful lobbying.

### Operational perspective

Logistics is the overall management of a chain of activities (including transport) concerned with planning, implementing and controlling the flow of goods from origin to destination (Gilmour, 1987, Ogden, 1992). This means that decisions about freight transport are made not only on the basis of transport variables but also on how individual components of the chain (e.g. manufacturing) affect the overall cost structure. Trade-offs may include ancillary versus hire and reward transport, one centralised warehouse versus multiple local warehouses, or composition of the fleet (large versus small trucks).

#### *Large versus small trucks*

Larger vehicles are more productive and therefore more cost effective than smaller vehicles. All things being equal, smaller vehicles are usually only used if the economies of scale of larger vehicles can not be achieved. This is supported by the high productivity of the *working* articulated vehicles (Table VIII) which shows that once these vehicles are on the road they are making a high number of trips per day. The factors which determine vehicle size are primarily related to the customer, however in some instances road infrastructure, loading/unloading provisions or regulation may prevent the use of large vehicles (Ogden, 1992).

**Institutional perspective**

As mentioned above, the government provides the environment in which the transport industry operates. Standards for emissions, mass limits and safety are set by regulatory bodies and the road network infrastructure is provided using funds from taxes and charges.

***The economy***

Recent research has found that urban freight movement contributes significantly to the economic development of a region (and therefore to improving social values), in particular:

- a study undertaken by the Road Construction Authority (1987) in Victoria, found that reduced urban freight costs resulting from either travel time savings, or more reliable delivery times, directly affected the profitability and competitiveness of manufacturers in Melbourne;
- cities with strong road networks, particularly those which facilitate industrial activity, attract investment and economic growth (Hussain 1990); and
- a strong link exists between transport infrastructure investment and economic development, in particular there is a positive influence of road investment on urban fringe areas (Cox 1992).

***The environment***

On the other hand, like most motorised transport there are adverse effects to the environment through the use of commercial vehicles, these include noise, vibration, emissions, intrusion and safety. Preliminary analysis of the CVS to date has not included specific environmental effects except those caused by congestion which are reported elsewhere in this paper. However, it should be noted that optimum fuel consumption occurs at speeds of around 50km/h to 70km/h (Bowyer et al, 1985) which can only be achieved with reduced congestion levels. The average speeds calculated using the CVS for weekdays are between 30 and 40 km/h (Tables VI and VII respectively).

***Transport and urban planning***

Even though freight movement allows the community to achieve goals (Ogden, 1992), the road network was designed primarily for the movement of people and not for the movement of goods (which allows people to live). In the absence of freight and commercial vehicle data, urban planners and transport planners have used passenger vehicles and peak commuter traffic to plan the network and forecast traffic growths. Freight traffic has usually been incorporated as a factor of between 5% and 15% of passenger car traffic (Schlappi et al, 1993). This has the effect of the freight movement industry adapting to a network designed primarily for commuters. In some cases, this has led to residential areas being used as freight movement routes, resulting in the need to restrict the network, to reduce residential intrusion. Reilly and Hochmuth (1990) estimated the cost in travel time through restrictions to the network. They found that a truck travelling between two zones in Chicago increases its distance travelled by an average of 1.4% on a restricted network and takes an average of 10.3% more time.

Work on the CVS to date has not been able to contribute quantitatively to these findings, but in future, there are possibilities of using the CVS to do a study similar to that done in Chicago.

Work done in the USA (Grenzeback et al, 1990) suggested that large trucks on *freeways* do not significantly affect peak-period congestion, and that it is truck involvement in accidents and incidents that impacts on congestion. The report suggested that reducing truck travel in the am commuter period is of greater benefit to the truck operators than to reducing overall vehicle congestion. It also implied that a network could be more effectively used through improved incident and traffic management (e.g. by reducing stop-start conditions, minimising hazardous traffic situations, and reducing delay from truck-involved incidents/accidents), rather than through area-wide bans on trucks. Although this study relates specifically to freeways it emphasises the fact that the majority of congestion is caused by commuter traffic

***Road versus rail***

Many people think that adverse effects from urban road freight can be solved by moving some of the task to rail. There are many reasons why this is generally not a realistic option for the movement of freight within urban areas.

Due to the nature of freight movement in urban areas (e.g. short distances, short lead-times), road offers greater flexibility than rail. Rail almost always requires a road vehicle 'leg' since train routes are set by the track infrastructure, and extra time is required to unload and load goods (usually 25-30 minutes each end, Brew, 1994). Also, freight trains by nature carry large loads, are often restricted by timetables (paths through commuter train routes), are noisy (freight trains often have two or three locomotives), and are economically viable only for medium to long distance transport of large tonnages (Brew, 1994).

## 6. CONCLUSION

The low use (65%) (Table VIII) of the commercial vehicle fleet indicates that there is room for improvements in vehicle utilisations. This will be driven by both customer requirements and the need for industry to work its capital investment more, which may eventually lead to the replacement of ancillary vehicles with hire and reward. Organisations which remain ancillary operators may have increasing pressure to have more efficient logistics to optimise their production chain.

Work practices seem to reflect the temporal patterns of commercial vehicle movements. While extended receival hours will enable deliveries to be performed over a greater proportion of the day, if industry chooses to take advantage of this, it may have the effect of generating:

- longer periods (although probably less intense) of noise, vibration and intrusion;
- possible reductions in emissions due to lower peaks in congestion (this also depends on other factors such as number of vehicles and the fuel efficiency of vehicles);
- increases in productivity and vehicle utilisation through fewer restrictions on delivery and pick-up times through extended receival hours;
- reduced number of vehicles in the fleet (e.g. working the one vehicle over a longer period rather than two vehicles over a short period); and
- decreases number of heavy vehicles travelling in the am commuter period.

Finally, every urban area is unique with its own pattern of industrial activity, imports, and exports, and therefore cannot be transferred to another place (Ogden, 1992). So, while the information from the CVS presented here gives an indication of goods movement in urban areas it is specific to the Greater Sydney Metropolitan Region.

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