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Problems in the urban environment: traffic congestion and its effects

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Abstract
Traffic congestion results when there are too many vehicles for the available road space. It may occur on almost any road system but, in general, it Is likely to be experienced with great severity in and around the major employment nodes such" the central business district (Figure 1) during the morning and afternoon peek.

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PROBLEMS IN THE URBAN ENVIRONMENT: TRAFFIC CONGESTION AND ITS EFFECTS

ROSS ROBINSON

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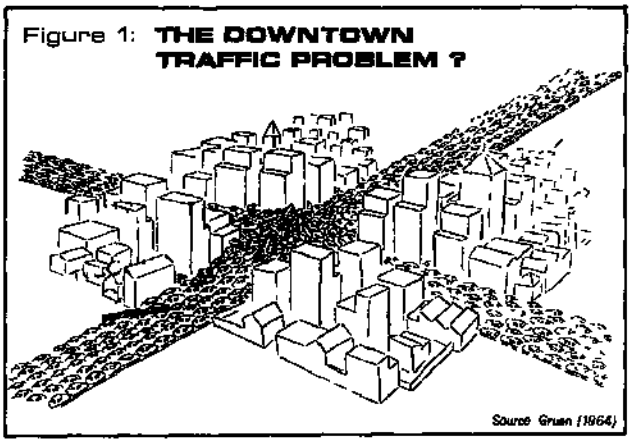
CONGESTION: WHAT IS IT?

Traffic congestion results when there are too many vehicles for the available road space. It may occur on almost any road system but, in general, it is likely to be experienced with greatest severity in and around the major employment nodes such as the central business district (Figure 1) during the morning and afternoon peaks. On the Sydney Harbour Bridge, for example, delays are not uncommon during the two 'rush' periods at the beginning and end of the business day when flows are about twice as heavy as in the middle of the day (Figure 2). Normally, however, such delays are not particularly severe. They become more so when the available road space is temporarily reduced because of accidents and breakdowns, or when flow volumes are raised significantly (as occurs when the commuter rail system is strikebound). In general terms the bridge can handle some 15,000 vehicles per hour without undue disruption to traffic flow, but if such demand were unevenly distributed in time and 500 cars converged on it in one minute (a rate of 30,000 per hour), severe congestion would result (Blunden, 1983).

In 1981 the highest number of trips within the Sydney region for any purpose was begun either between 8 a.m. and 9 a.m. or between 3 p.m. and 4 p.m. (Figure 3). On weekends, the morning peak occurred later and over a longer time period on Saturdays and much later on Sundays! Trips to work, to school and to home clearly helped to create peak traffic conditions (Figure 4) and it is in these peaks that congestion is most likely to occur.

Congestion may be related to one of two sets of conditions - either to inefficiencies within the traffic flow system or to the demand placed on the system (or to a mixture of both).

Figure 1: **THE DOWNTOWN TRAFFIC PROBLEM ?**



Source Gruen (1964)

1) System inefficiencies. These may be due to a variety of causes - when through traffic mixes with local traffic or converges into limited-capacity inner city streets, for example; or when different types and sizes of traffic mix together - coal trucks and heavy vehicles, buses, cyclists and pedestrians. Some inefficiencies relate to the character of the road or street network - when there are many intersections, for example; or when freeways converge on limited-capacity downtown streets. Others result from inadequate controls - poorly coordinated traffic lights, indisciplined pedestrians and drivers and poor street marking.

2) Pressure of demand. There are of course, situations when traffic demand is such that even if a system or part of a system is very efficient, demand is simply too great.

At the end of 1981 there were 2.68 million motor vehicles in New South Wales, almost half a million more than in September

Figure 2: **HOURLY TRAFFIC FLOW ACROSS THE SYDNEY HARBOUR BRIDGE, 16 OCTOBER 1981.**

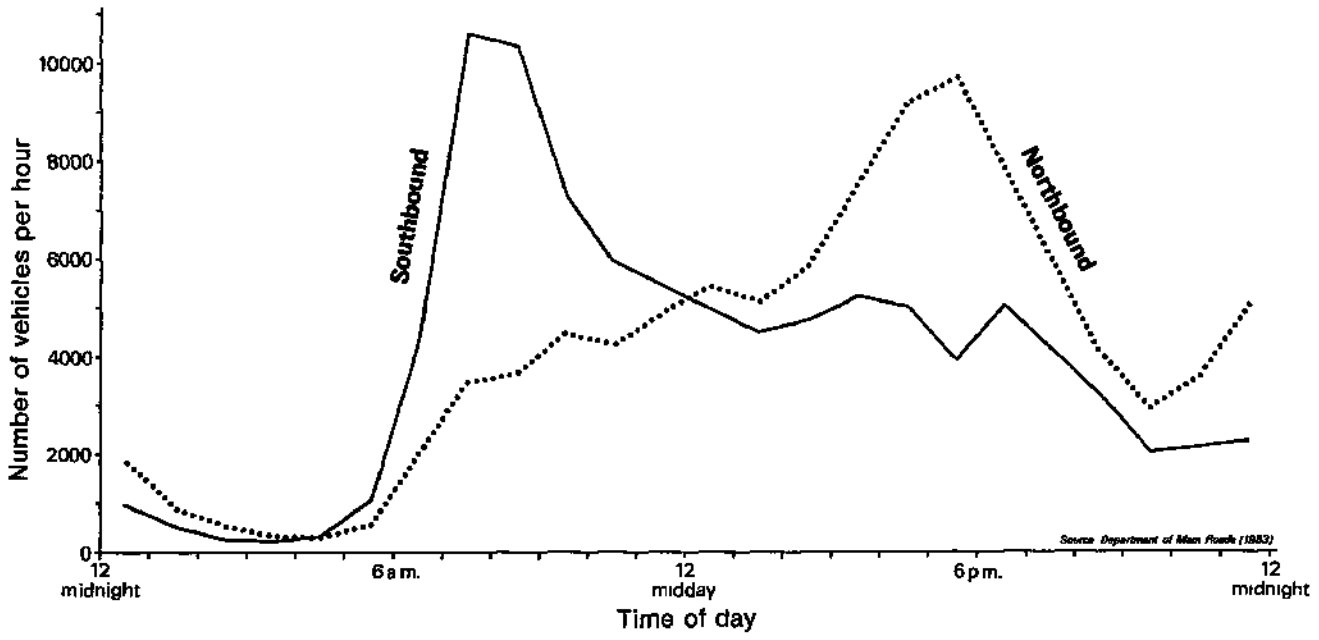
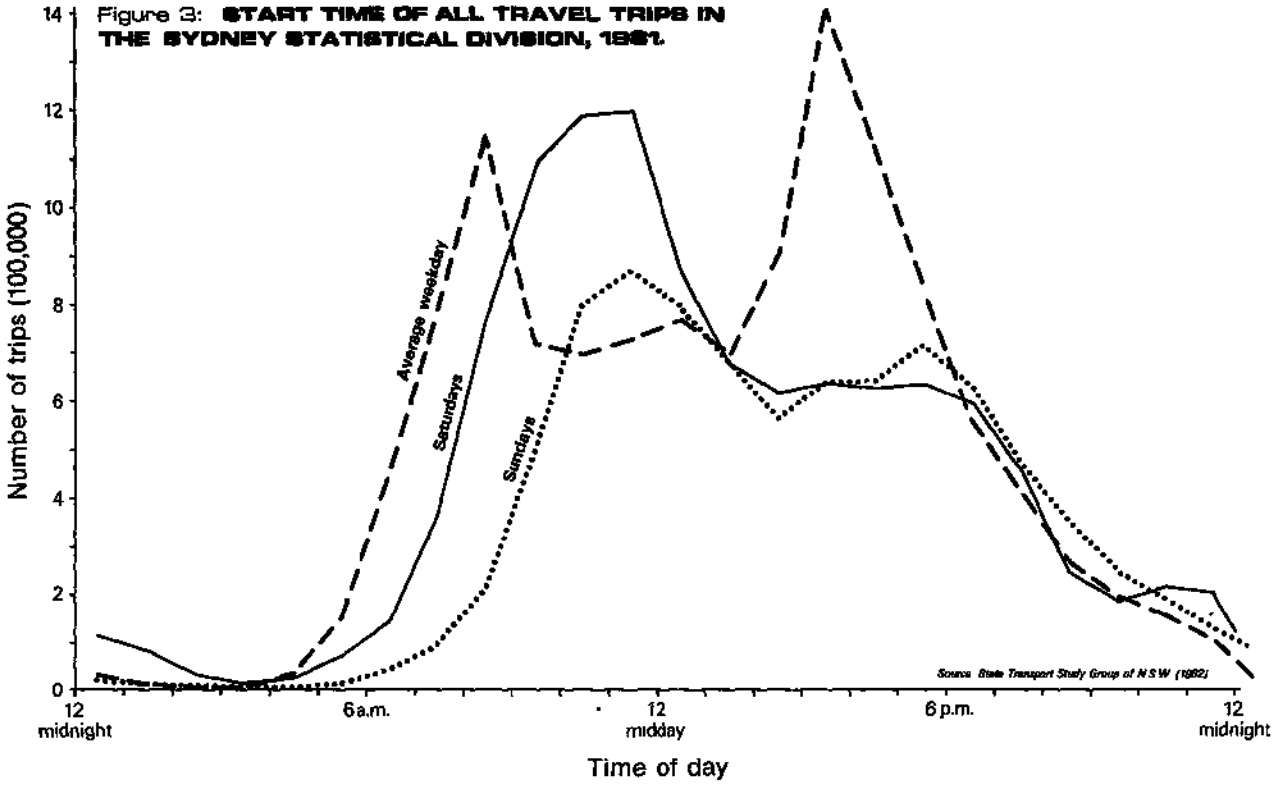
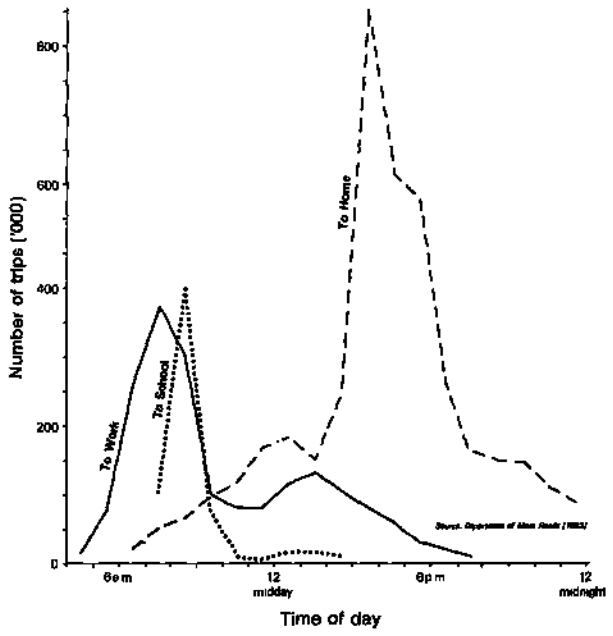


Figure 3: **START TIME OF ALL TRAVEL TRIPS IN THE SYDNEY STATISTICAL DIVISION, 1981.**



1976, representing an annual growth rate over the period of 3.9 percent (Australian Bureau of Statistics, 1982). For Sydney, in the year 1981-82, 139,000 new vehicles were added to the city's streets to make a total of about 1.5 million. If Sydney were to maintain its share of the state's population and motor vehicles and if the general rate of increase were maintained, the city would have about 3 million vehicles by the year 2000 AD — double its 1981 figure! Whatever the actual number of motor vehicles in the year 2000 AD will be, it seems certain that the street network in Sydney will be required to meet much higher levels of traffic demand than at present. Other transport modes must also cope with future increases in traffic -approximately 8.4 million passengers passed through Sydney Airport in 1980 (Department of Transport, 1981) and predictions for the year 2000 vary between a low of 24.5 million and a high of 36.1 million (Bureau of Transport Economics, 1978a).

Figure 4 **START TIME OF WEEKDAY TRAVEL TO WORK, SCHOOL (including university and college) AND HOME, SYDNEY STATISTICAL DIVISION, 1981.**



The important issues are not only those of the size of the demand but also the options available for meeting it. Three possibilities exist:

(a) To make major changes in the transport system itself. This may involve the construction of new roads and entire new networks; and/or new operating rules which ensure greater efficiency - co-ordinated traffic signals, one-way streets, transit lanes, integrated modes and networks, modified timetables and the like. In some cases new technology may increase speeds and carrying capacity. Changes in pricing policies may also 'create' new capacity by rationing road space, for example.

(b) To develop public transport (particularly rail-based transport) as an acceptable alternative to the automobile. In most Australian and North American cities, low residential densities and car-oriented populations have made this move very difficult, however.

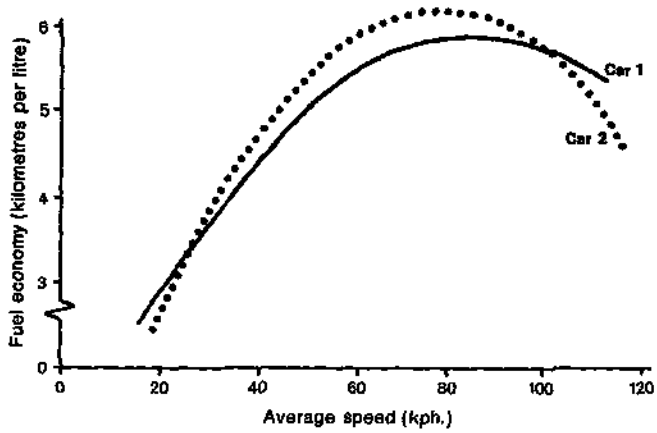
(c) To restructure land use patterns in order to reorient or redirect existing or future flows of traffic. This tends to be a longer term solution.

CONGESTION AS A FUNCTION OF TRAFFIC FLOW AND CAPACITY

Congestion then, is a problem related both to space and to time. It is sometimes defined in terms of the average traffic speeds achievable in downtown areas in the peak hours (New York 16 kph; Paris 17 kph; Singapore 21 kph; Manila 11 kph; (Thomson, 1977)). For Sydney, the Sydney Area Transportation Study (SATS) (1974) was concerned that bus travel time from Central Station to Circular Quay was 13 minutes in 1962 but had increased to 17 minutes by 1970. Congestion may also be defined in terms of actual time spent in a queue; or when 'traffic flow exceeds 80 percent of road capacity'.

It is very useful, however, to think of congestion as a 'transport impedance function' which, for planning purposes, can be dealt with mathematically to predict levels of delays. In this context the function describes the relationship between traffic volumes, delays

Figure 6: **FUEL ECONOMY AND CAR SPEED**



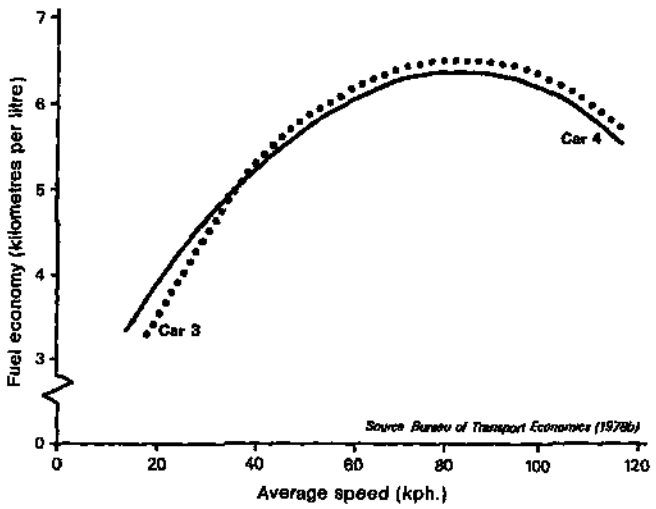


Figure 7: **FUEL CONSUMPTION, CAR SPEED AND ROAD TYPE (MELBOURNE)**

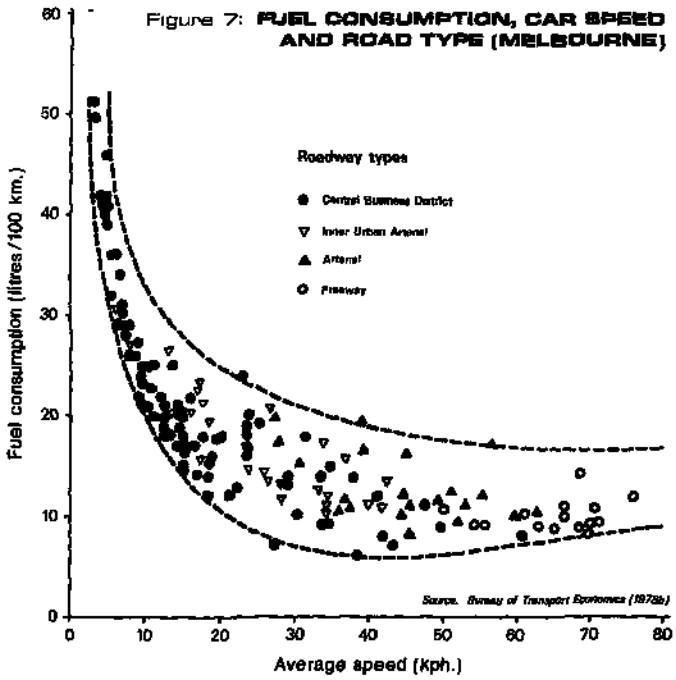


Figure 8: **VARIATION IN CARBON MONOXIDE EMISSION AT DIFFERENT SPEEDS**

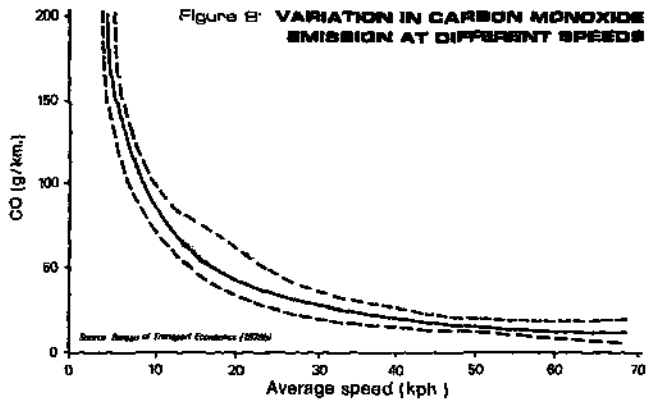
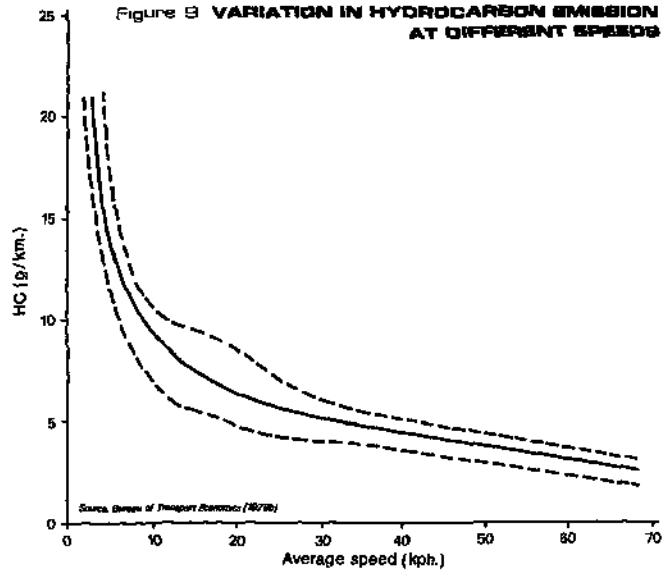
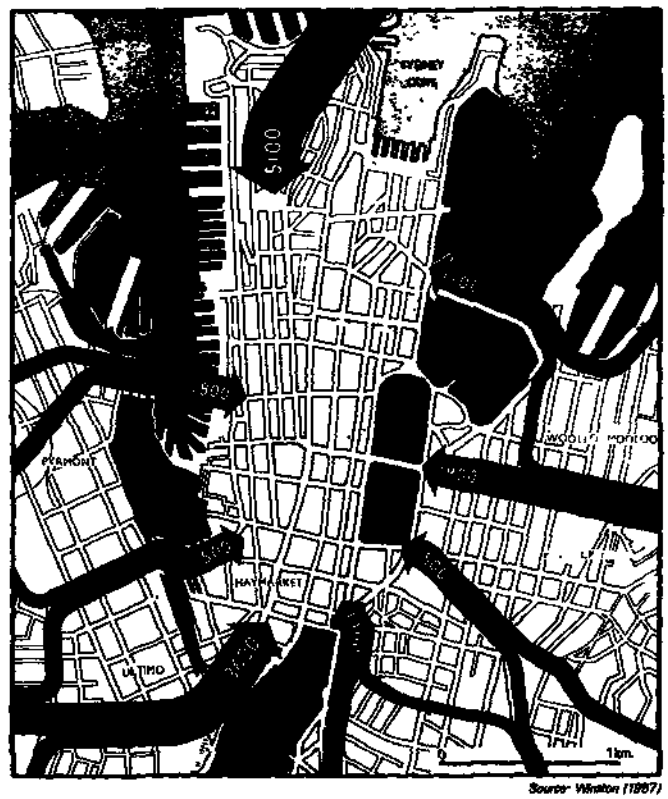


Figure 9 **VARIATION IN HYDROCARBON EMISSION AT DIFFERENT SPEEDS**





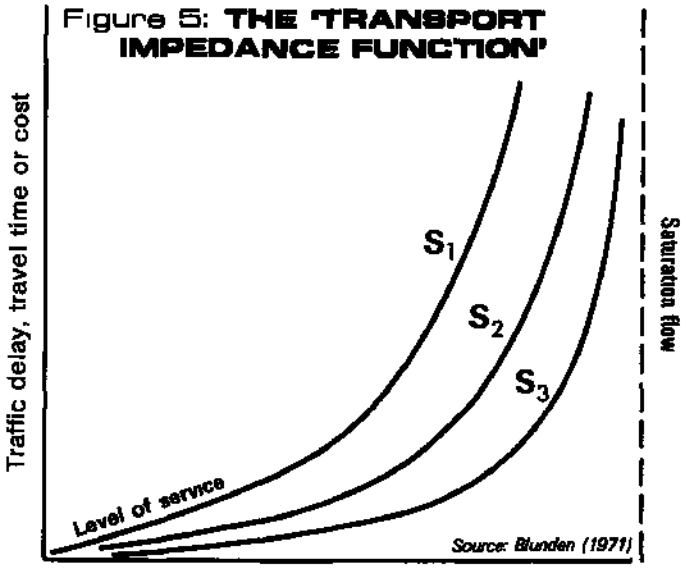
Source: Winston (1987)

Figure 11: **COUNTY OF CUMBERLAND PLANNING SCHEME FREEWAY PROPOSALS**

Source: Winston (1957)

and the standard of the traffic route or facility Figure 5 shows the relationship between traffic volumes or flows (whether defined as cars on a road, aircraft arriving at an airport, ships arriving at a port, or customers arriving at a baggage check-in) and the amount of delay incurred at different levels of service (S1 may represent a two-lane highway, S2 and S3 three and four-lane highways respectively; or different numbers of berths in a port, etc.) At low volumes of flow, delays are small, but as flows increase delays increase and increase more rapidly (though delays are less with better facilities) until the facility reaches saturation and nothing moves! To some extent the system will be self-adjusting for when this limit is reached, other means of travel will be sought.

Figure 5: **THE 'TRANSPORT IMPEDANCE FUNCTION'**



THE EFFECTS OF CONGESTION

Nobody enjoys being caught in a traffic jam: it is likely to make the blood pressure jump a few notches and induce the unlikeliest people to 'use language that would make a sailor blush' But there are rather more serious social diseconomies which arise from congestion; and some quite significant spatial effects as well.

1) The social diseconomies of congestion

(a) Congestion means wasted time or time lost for passengers, crew (or drivers) and for the vehicle itself. It is time which otherwise could be used productively and there is an economic cost attached to it which, although difficult to measure, can be significant

(b) The stop-go, acceleration-deceleration driving pattern and the slow vehicle speeds of congested city driving increase fuel consumption It has been estimated that the minimum fuel consumption rate of a typical car is not reached until it has travelled a distance of 60 kms (or its equivalent in terms of engine temperature, or its thermal equilibrium) Figure 6 shows, for four test vehicles, the relationship between fuel consumption and average speeds. Figure 7 indicates similar relationships established in a Melbourne study, with high fuel consumption at low speeds in downtown locations.

(c) Slow speeds also mean the emission of relatively high levels of hydrocarbons and oxides of nitrogen - the culprits in photochemical smog - from car exhaust systems Figures 8 and 9 indicate that much higher levels of carbon monoxide and hydrocarbons are emitted at speeds of less than 20 kph than at higher speeds

(d) Heavy traffic streams also create high noise levels (about 90 dB) and prolonged stop-start traffic, particularly in uphill-downhill patterns, creates unpleasant environments Noise may be further intensified in inner city streets enclosed by high rise buildings. This is the so-called 'canyon effect'.

(e) There are numerous other diseconomies of traffic congestion. Vibration caused by constant and heavy traffic loads is creating foundation problems for older buildings in European cities and elsewhere, road maintenance costs may be higher under congested traffic conditions, and the number of accidents, as well as their disruptive effects, are likely to be greater in congested conditions.

2) The spatial impact of congestion. When queues grow longer and travel time exceeds acceptable levels it is likely that commuters and travellers will seek alternative solutions and that planners must take action to establish more efficient movement patterns. In the short term, car commuters are likely to try and find 'back street' alternatives which often cause local residents great distress and may result in reclassification of streets or their closure to through traffic.

RESPONSES TO CONGESTION

In the longer term, however, the spatial responses to congestion are likely to result in significant infrastructural changes and to new patterns of traffic and functional linkages. There are many examples of such changes though we will mention only a few.

Freeways: the County of Cumberland Plan for Sydney. By the late 1940s Sydney, recovering from the traumas and neglect related to World War 2, was suffering from severe traffic problems and congestion and the County of Cumberland Planning Scheme in 1951 proposed some remedies. The problem was seen in the following terms

"At the 1954 census the county population was 1,941,220. apart from a few settlements away from a main road, the whole of this population, if it got up reasonably early in the morning, could arrive by car and train, bus and tram at the centre of Sydney by nine o'clock: that is to say, they could all arrive if the centre was big enough to hold them: but, of course, the centre remains the old geographical centre of Governor Macquarie's time, stretching less than two miles from the Quay to Railway Square and only half a mile across from Darling Harbour to the Domain and Hyde Park Here lies the essence of Sydney's famous traffic problem - which can never be cured by new roads or bridges or tunnels alone because it is not really a traffic problem at all but a problem of the distribution of employment ..." (Winston, 1957, 18-19).

Figure 10 illustrates the volume of the morning peak hour traffic flows during the early fifties and Figure 11 indicates the proposed 'city ring road' Check a current map of the city and compare proposals of the early fifties with what has actually occurred since that time) Hundreds of hectares of land were involved, many buildings demolished and new patterns of land use emerged.

Freeways: the 1974 SATS proposals for Sydney. It is now a well-established principle that there is 'never enough' road space; build a freeway of four lanes and within a short time it is likely that extra lanes are needed. In 1974, despite the earlier expansion of roads noted above, the SATS study proposed a new highway system with 547 km of new freeways and expressways, 240 km of new major regional roads and 385 km of improved regional roads - at a cost of $2,252 million at 1971 prices. These proposals were not implemented for a number of reasons, one of which was the likely destruction of large parts of the historically significant inner city. Another is the tendency for freeways to generate more traffic, so that the problem of congestion remains unresolved.

The development of freeways as a response to traffic congestion, though not always a very good one, is clearly illustrated on a large scale in Sydney But the general principles are readily seen in smaller urban areas such as Wollongong Through traffic, until the 1960s, made its way through suburban and 'village' streets creating delays and environmental and social problems. Now the F6 freeway diverts the traffic around residential areas.

Inner city pedestrian malls. During the 1960s, increasing traffic congestion in downtown commercial areas was one important factor aiding the decentralisation of retailing to regional shopping centres But a counter trend - the development of downtown pedestrian shopping malls - began to develop and though it could not stop the progressive suburbanisation of retailing, it was an important factor in helping to revitalise dying city centres. The separation of people and traffic (an important principle in this development) is now a well-accepted part of planning practice even in smaller towns and suburban shopping centres. There are numerous examples in Sydney - the Martin Place Plaza and maybe eventually the long-proposed Pitt Street Mall - and a mall will soon replace part of the old, traditional main street of Wollongong.

The spatial effects of congestion in other transport modes. Congestion in other transport modes may also have drastic effects on urban

space. What spatial changes have resulted and will result, for example, from increasing congestion at Sydney Airport? Is new runway capacity needed? Can the present site be expanded? And if not, where will a new site be found? Is passenger terminal capacity adequate? Can the present road network near the airport handle increased traffic?

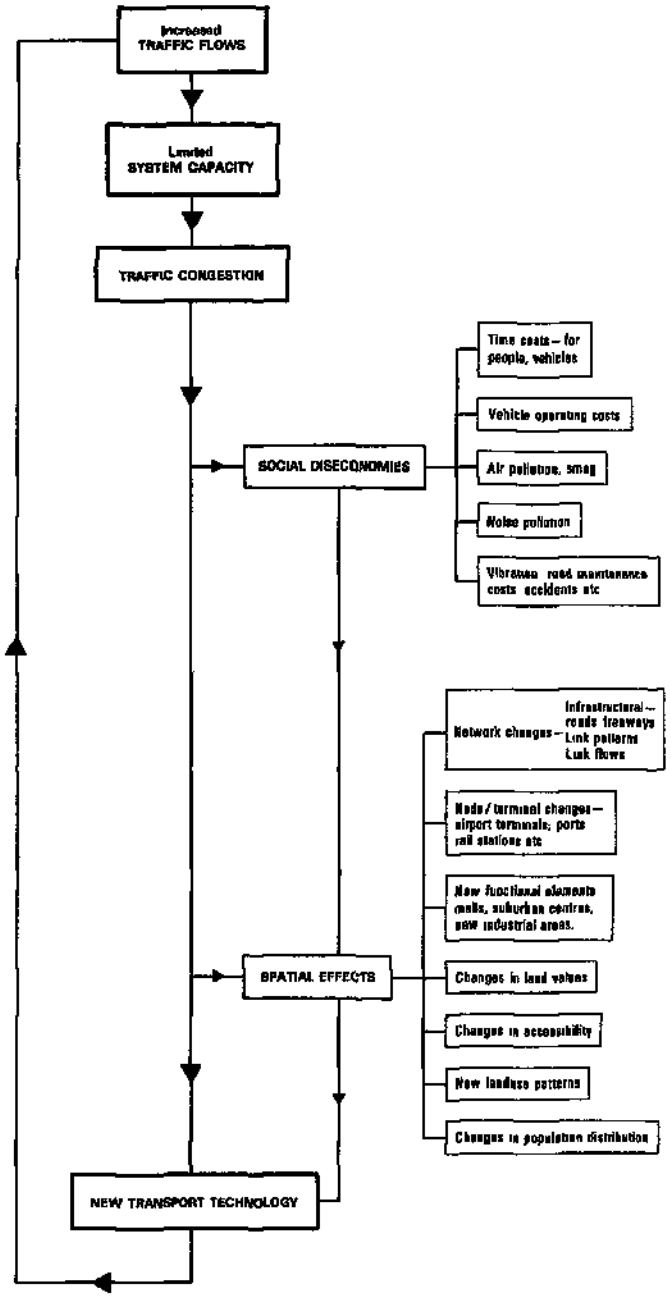
Consider also the spatial changes which have been influenced by delays and congestion to shipping For general cargo handling, increasing delays and costs during the 1960s led to the introduction of new technology, to the containerisation of cargo. This had a dramatic effect on Sydney's waterfront - the modification of existing berths at Darling Harbour, the construction of the Glebe Island and White Bay container terminals in the early 1970s and so on. Further growth of trade and increasing congestion at those terminals has led to the development of very large new facilities in Botany Bay, with the need for new roads and rail links and new movement patterns. At Port Kembla, congestion at the old coal loader necessitated the development of a new loader, on a much larger site, with large stockpile areas, new rail links and access ways

SUMMARY

Traffic congestion, whether in road, airline or maritime systems, is a powerful modifier of space and though it is not possible in a short paper like this to go into detail the basic principles are clear Figure 12 provides a useful framework for discussing the likely effects of congestion and it is worth a final brief note in summary

Increasing traffic flows through existing transport systems create congestion Social diseconomies, including the costs of wasted time, of vehicle operation and air and noise pollution result. There may also be significant spatial effects New road or route networks are created, new links between places are established and new flow patterns emerge, new traffic terminals and facilities are expanded or built. Congestion may also initiate, or be at least partly responsible for, new developments such as inner city malls and new industrial areas Because new links are created between places, some will be more accessible than others and land values may change so as to create new patterns of land use and population distribution. The problems associated with congestion may even constitute one of the most important factors, in the longer run, leading to the development of new transport technology. In due course, though, the process leading to traffic congestion will repeat itself.

Figure 12 **TRAFFIC CONGESTION AND CHANGE**



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