

THE IMPACT OF LAND USE ON TRAFFIC

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ABSTRACT: The need for a simplified and rational process to assess the impact of new developments upon the surrounding traffic patterns lead the Traffic Authority of NSW to initiate a series of surveys and research investigating the impact of land use on traffic. Stage I of this work is complete and has indicated implications far beyond the immediate problems of development applications. The conditions which lead up to the study and the overall planning problem posed by land-use activity are reviewed. The study process and the detailed results for office developments are presented indicating the broader implications for both regional planning and policies as well as the micro analysis of impacts. The directions indicated for metropolitan land-use traffic and parking policy are discussed and the study team conclusions presented.

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INTRODUCTION

No, this is not another paper dealing with the latest land-use/transport interaction model, theory, or optimal city form! Rather the work to be discussed arose out of the practical need for a rational and simplified process for resolving the seemingly endless conflicts which arose out of the development applications for new significant traffic generators.

The Traffic Authority of NSW was created in 1976 and among other matters was given the responsibility for -

- . reviewing traffic arrangements and improving those arrangements.
- . establishing general standards and principles in the provision of traffic control facilities.
- . co-ordinating the activities of public authorities when they are concerned with traffic matters.

With these responsibilities in mind the Authority initiated in 1977 a research program aimed at developing policies and procedures relating to the control of land-uses and access to and from arterial and sub-arterial roads. Stage I of this work involved detailed surveys of ten sites for each of four major land-uses (offices, shopping centres, factories and major clubs).

The work highlighted the need for joint approaches to solving and understanding the problems of our cities. The policy makers and regional planners have been traditionally concerned with the "macro" impacts and have seldom been concerned with individual site impacts. By comparison the developer, local government planners, and planning control bodies have largely been concerned only with the "micro" impacts, ignoring or taking as given the macro planning and policy development.

Both the macro and micro planners are working towards goals, but it is a myth for either group to think they will reach the complete solution. While working in relative isolation, and with poor understanding of the inter-related consequences of macro and micro policies and impacts neither group can ever hope for a complete solution.

It is the aim of this paper to emphasise the inter-relationships between both groups of planners and policy makers. The traditional transport planner and policy maker can gain from the research into micro impacts such as being undertaken by the Traffic Authority.

The first section of the paper reviews the background to existing procedures and details the circumstances which led us to today's controls and impact assessment methods. The next section further examines the planning problem as it relates to local issues, the setting of planning objectives and the broad issue of regional planning. The Stage I study

is reviewed, the methods and results obtained, indicated and detailed results for offices discussed.

Finally study team conclusions are presented.

BACKGROUND

At the present there are two main devices for controlling development and its impacts. These devices are the planning schemes and local planning codes. The planning schemes designate the allowable land-uses and the conditions on height, floor area ratio etc. The planning codes of local authorities indicate the amount of parking which must be provided and details of such matters as parking bay size, aisle width, etc.

The planning schemes are notoriously static to changing conditions and wide use has been made in Sydney of interim development orders which supercede the planning scheme and allow for greater planning flexibility. The review of planning schemes is slow and changes to codes are often made following strong development forces rather than actually guiding the development forces.

The local parking codes vary widely between different authorities for the same development. Table 1 indicates the range of variation presently in the Sydney codes.

While the above devices are all that has been used for minor developments, the application for a significant traffic generator may require comment or concurrence from a large number of authorities - for example, the Planning and Environmental Commission, the Local Traffic Committee, the Traffic Planning Branch of the Police Department and the Traffic Authority.

In recent years the Traffic Authority was established with the role, amongst others, of co-ordinating these various authorities and approval of developments. The problem with co-ordination however, is the lack, frequently, of a consistent view between the various authorities on how to assess the development or even what to assess.

Such a climate makes it difficult to reach a consensus. Authorities not only have difficulty in reaching a consensus on the impacts of a particular development but there is frequently protracted disagreement on the scale of the development and the works or measures necessary to mitigate that impact. Because of these problems it has become a fairly general rule that any development which is considered to be a significant traffic generator requires a traffic impact study to be undertaken at the expense of the developers.

In order for such a study to define the likely impact of the development it is necessary to establish:

TABLE 1

COMPARISON OF SOME SYDNEY PARKING CODES

COUNCIL	LANDUSE One Parking Space Required for each Measure			
	Office & Commercial Premises	Retail Shops	Factories	Licensed Clubs
Bankstown	35m ²	35m ²	1/2 employees or 70m ²	6m ²
Blacktown	93m ²	33m ²	50m ²	18.5m ²
Campbelltown	46m ²	46m ²	1/2 employees or 46m ²	4m ² bar 5.5m ² lounge
Concord	30m ² or 1/3 employees	35m ²	75m ² or 1/3 employees	5.5m ²
Kogarah	28m ²	28m ²	37m ²	6.5m ²
Leichhardt	46m ²	46m ²	1/4 employees + 2	4 employees 10-15 members
Mosman	37m ²	37m ²	1/2 employees 56m ²	2.4m ²
Randwick	40m ²	40m ²	1/2 employees 50m	6m ²
South Sydney	56m ²	38m ²	1/6 employees 186m ²	1.8m ² bar 5.6m ² lounge
City of Sydney (Z)	139m ²	23m ²	139m ²	5m ²
Wollondilly	35m ²	35m ²	1/2 employees 45m ²	2m ² bar 5m ² lounge

Source: Metropolitan Parking Standards 1976, Prepared by Sinclair Knight & Partners Pty Ltd.

Note: The data has been simplified occasionally and all codes converted to m² where given in ft².

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- . the likely traffic generation rate of the development.
- . the way in which this traffic will distribute itself on the road network.
- . the existing level of traffic flow in the surrounding network.
- . the level of congestion and problems created by that existing level of traffic flow.
- . any new problems which will be created by the traffic generated by the development or existing problems that will be exacerbated.

In order that the developer and the authority can reach agreement on a particular development it is necessary that the authorities and the developer agree on each of these five factors involved in determining the traffic impact of a particular development.

The existing level of traffic flow is readily measured in the field and is not generally a major source of disagreement between the authorities and the developer. The distribution of trips from a proposed development is generally established by examination of either population or market distribution and whilst on occasions, this is a cause for debate, is generally not critical to the impact of the centre and is generally fairly readily agreed upon.

The definition of existing and future problems is partly a result of objective analysis based on established analytical processes such as the calculation of "Y" values to determine the way in which intersections are operating, and partly a subjective appraisal of the functioning of the road system.

The problem is agreement on the likely generation rate of a proposed development and in the past there has been significant and continuing disagreement between the various authorities and developers as to the appropriate rates to apply in relation to different types of development.

In default of good data various results of limited nature widely scattered in time and space and often hopelessly out of date, have been modified by those undertaking impact studies and by their opinion of the way that these particular generation rates apply in particular situations. In fact, in practice, because of the lack of good data the generation rates used have generally resulted from either a compromise agreement between the developer and the authorities reached early in the analysis to avoid argument later, or a high generation rate well above that which anybody would reasonably expect again, avoiding any argument at a latter stage. Often protracted argument has ensued in the attempt to reach an agreed value.

This scenario while about Sydney conditions, is widely applicable Australia wide. The variation in parking codes, the disagreement about the scale of trip generation and the often complex development process are all too common.

It was against this background that the Traffic Authority began the task of developing policies and procedures relating to the control of land-uses.

The Traffic Authority in collaboration with the New South Wales Planning and Environment Commission established a Development Technical Committee to consider land use proposals with major traffic implications. Recommendations have been made for amendment of the Local Government Act to require Councils to seek the Traffic Authority's advice, in lieu of other bodies as at present, when dealing with land development applications.

Procedures have been proposed for ensuring that decisions which relate to problems of only local significance are dealt with at that level. Thus minor development applications would be dealt with by Councils or the local office of the Department of Main Roads, or, if of regional significance by the Development Technical Committee of the Traffic Authority, a committee taking over the role of the Ribbon Development Sub-Committee of the Planning and Environment Commission. Applications for developments of exceedingly complex nature would be considered by the Traffic Authority itself.

Guidelines for developers and for the traffic consideration of development applications are being prepared in consultation with the New South Wales Planning and Environment Commission. These will establish general principles and standards relating to traffic and developments and will be used by those to whom the Traffic Authority will delegate powers in the matter.

The need for a soundly based set of principles and standards is only part of the problem. Each development is still being treated on a one by one basis and while this is necessarily at the final approval level, the question still remain as to the area-wide and regional impacts from a series of "isolated" developments. Work has begun on the development of a Metropolitan Parking Policy which will need to consider these impacts.

THE PLANNING PROBLEM

The re-examination of land-use controls has raised a series of issues. The age old question of the role of arterial and sub-arterial roads and what land-uses should have access to them must be considered again. Denying access to these roads means that local streets must carry all circulating and access movements. Thus developments which provide access to lower standard streets are likely to be approved more readily than developments which could provide access to high standard streets. The impacts of a development upon street capacity and congestion are frequently major causes of objection. Thus a single large scale development is likely to have more difficulty being approved than a whole series of smaller scale developments which in total may have an equal or worse impact.

Congestion is frequently the major objection, but the cause of congestion may be due totally to through traffic that is heading for distant landuses identically to the land-use

development being prepared. Congestion may be largely caused by a poor distribution of land-use centres compared to the distribution of available road space. The local authority reviewing a development application will naturally not be concerned or be able to consider overall land-use questions and because of this the present system of development controls will be in reaction to changes rather than leading "desirable" changes. In response to greater congestion and parking short-fall the response will normally be a hardening of codes or a set of interim development orders. Frequently this can occur when a developer has proceeded according to the old codes then causing him significant additional expense.

The local resident is frequently the loser in the game of change and progress. Codes designed to restrict vehicles by limiting on site parking or the establishment of zoning schemes that do not consider the traffic impact if that zoning is suddenly fully developed have resulted in local streets being completely parked out and subject to heavy traffic volumes when once they were quite resident only streets.

A response to the problems of congestion of streets and parking areas is to look towards public transport. But nowhere is there any planning schemes or development codes which actively encourage public transport or offer development concessions if the development is conducive to public transport usage. The behaviour of the mode split decision might be well understood by the regional or policy planner but the micro planners rarely have the benefit of this knowledge or are given any clear directions.

Research into understanding how single isolated sites operate is necessary but by itself this knowledge cannot lead to anything more than more accurately assessing the impacts of the single site. As long as a site development conforms to the existing zoning regulations and parking regulations it can be built. Understanding in detail the impacts cannot by itself solve an area problem. It is the first step. The next step must be the joint approaches of regional policies and area wide controls combined with site controls. Presently regional or macro planners work largely in isolation to the processes of the micro planners. The meeting ground for the macro and micro planners could be in the development of area wide controls that reflect regional policies and the local environmental capacity.

The first application of environment capacity concepts are beginning to appear. Melbourne in developing its new parking standards recognises two cases, areas which have exceeded their environmental capacity and those which have not, and adopts different standards for each. Environmental capacity allows the development of an area to be judged against some total effect, rather than the isolated consideration of individual sites. Thus the development of a site for a peak evening use may not affect the environmental capacity whereas a smaller development but which has a day peak may cause the capacity of an area to be exceeded.

Land-use control raises not only the issues of the means of control but also the objectives of control. Each of the groups involved can have quite different objectives which today must frequently be solved by a continual series of ad-hoc compromises. The developer will have a profit maximisation objective; the local council will be seeking to maximise rates, minimise expenditure and maximise local resident or business benefits; the state authorities will be striving for regional economic efficiency and regional equity of benefits or costs. There has been little input from the regional policy maker into the areas of setting micro planning objectives. It is felt this is partially due to the poor understanding of the micro planning level and the potential for control by the regional planner. Hopefully the continuing of Traffic Authority type research will help this lack of understanding.

This discussion has not intended to offer any answers but rather to pose a series of questions that have arisen from the research. In particular the form of land-use controls and the setting of control objectives need greater definition. What should be the role of market forces and should the prime responsibility for control reside with local or regional authority? How can controls be made responsive to the potential of public transport and flexible to the ever changing conditions?

Only the first stages of development have occurred. The detailed surveys of four land-uses will be discussed in the next section. Presently surveys are underway on another nine land-uses. The mass of data will provide the basis for establishing new procedures and it is felt the opportunity to co-ordinate the planning objectives and policies held by the various relevant groups should be capitalised upon.

LAND-USE SURVEYS

The surveys were designed to collect data so that a series of prediction equations could be developed. The desire was to understand the functioning of each land-use activity so that impacts could be predicted and if necessary modified to an acceptable level. In the past surveys of land-uses have often concentrated only on vehicle movements and on-site parking accumulation. Such surveys were felt to be totally inadequate, for the desire was to understand the total activity pattern of a land-use, hence the surveys were designed to consider person movements as well as vehicle movements, on-site as well as off-site parking and such variables as mode split, car occupancy and details of the surrounding land-uses and traffic conditions.

It was decided that ten sites would be surveyed for each land-use. This was set as the minimum number necessary for developing adequate equations, and yet still providing a good range in location and size. More sites would have provided better results but have limited resources to a smaller number of land-use types.

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Stage one of the surveys covered:

- . Office blocks
- . Shopping centres
- . Factories
- . Licensed clubs

Stage two, presently under way is covering:

- . Car sales and spare parts sales centres
- . Car accessories and tyre shops
- . Warehouses
- . Recreation uses (squash, tennis courts, etc)
- . Road transport terminals
- . Hotels, including drive-in bottle shops
- . Motels
- . Service stations
- . Drive-in fast-food outlets

In practice, ten sites appeared just adequate because of the great variety observed. Quite different results and conclusions would have been reached if, say, only one type of office block or smaller geographical spread had been surveyed. Ideally it would be desirable to survey additional sites to check any relationships developed. Initially, it was considered that existing data collected in other studies in Australian cities could be used to expand the sample size or check the results but it was found that the total set of activity data was rarely collected or that the data was collected for a completely different objective.

The selection of the ten sample points was made from long lists of possible sites. Each long list site was visited and the short list was selected based on the following set of general desirable characteristics.

- . On-site parking provisions
- . Reasonably available to public transport
- . Recent construction
- . Possible to isolate for surveys
- . Geographical spread
- . Size range
- . Willingness of management to provide basic data and agree to survey.

Once the short list had been selected letters were sent to each site and interviews held with the owners or management. The objective of the interviews was to gain the management insight of peak times, activity pattern, any unusual factors and most importantly, data on floor area, number of employees and other relevant explanatory variables. This stage was crucial for the study objective of the development of prediction equations. Later poor results were often traced to inaccurate data supplied by management and revisits or complex measurements of floor area were necessary.

The survey technique differed with each land-use but in general the final set of data collected consisted of

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- . planning variables
 - floor area by type
 - employees by category
 - number of trains or buses per hour within 200 m
 - off-site parking supply by type
 - on-site parking supply
- . impact or activity variables
 - person trips by category (visitor, employee, delivery) in and out by time period (15 min-30 min)
 - mode split by time period (driver, passenger, bus, rail, walk, cycle, other)
 - parking accumulation by location (on-site, off-site by distance away)
 - length of stay
- . other variables
 - purpose of trip
 - post code of origin

In addition a series of indices (1-5) was developed from data supplied by the Urban Transport Study Group of NSW. This data was intended to be used for including the regional effects on the observed activity pattern. The data included

- . average volume/capacity ratio in the Council areas.
- . total amount of travel in the zone
- . average auto ownership of persons with destinations in zone
- . average public transport trip length to zone

The data is presently being analyzed in detail. The results from the office block analysis are discussed in the next section to illustrate the type of results becoming available.

OFFICE BLOCK ANALYSIS

The range of results was considerable. The floor areas were from 935 m² to 14,800 m² while the number of employees varied from 66 to 675. The range in number of visitors was surprising from a low of 14 percent to a high of 53 percent. Transit usage in the peak hour was between 2 and 81 percent with an average of 28 percent. All day transit useage varied from 2 to 45 percent with an average of 15 percent, the lower all day figures largely due to the large number of midday walk trips.

As can be seen from the above ranges the objective of surveying a range in size and type was achieved. The geographical spread can be judged by considering the areas in which the office blocks were surveyed.

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TABLE 2

LOCATION OF OFFICE BLOCK SITES

1	Central Sydney
2	Hurstville
3	St Leonards
4	Pymble
5	Chatswood
6	North Sydney
7	Epping
8	Liverpool
9	Parramatta
10	Surrey Hills

Equations were developed by multiple linear regression. The desire to make the equations simple to use and related to what is known before a site is built meant that most equations became a function of either floor area or number of employees.

The mode split equations and car occupancy equations presented the most difficulty. While good statistical fits with a large number of independent variables have been obtained they are not considered good predictors. Mode split must be influenced by regional policies and impacts. At this stage of development, good judgement, regional analysis and policy decisions must be made for mode split. Future development may allow greater accuracy and better predictive power.

The full set of equations is given in Table 3. Equations are shown for:

- total daily person trips
- midday person trips - 1 hour (The maximum person trip movement).
- person trips in the peak vehicle one hour
- peak parking accumulation

To apply these equations in considering any single development application, the procedures set out in Figure 1 would be applied. The decision as to whether the impact is acceptable or not cannot be determined by the equations or the system. This aspect of the system must await the development of areawide and regional policies. There are three key areas where the impacts relate to an areawide control system:

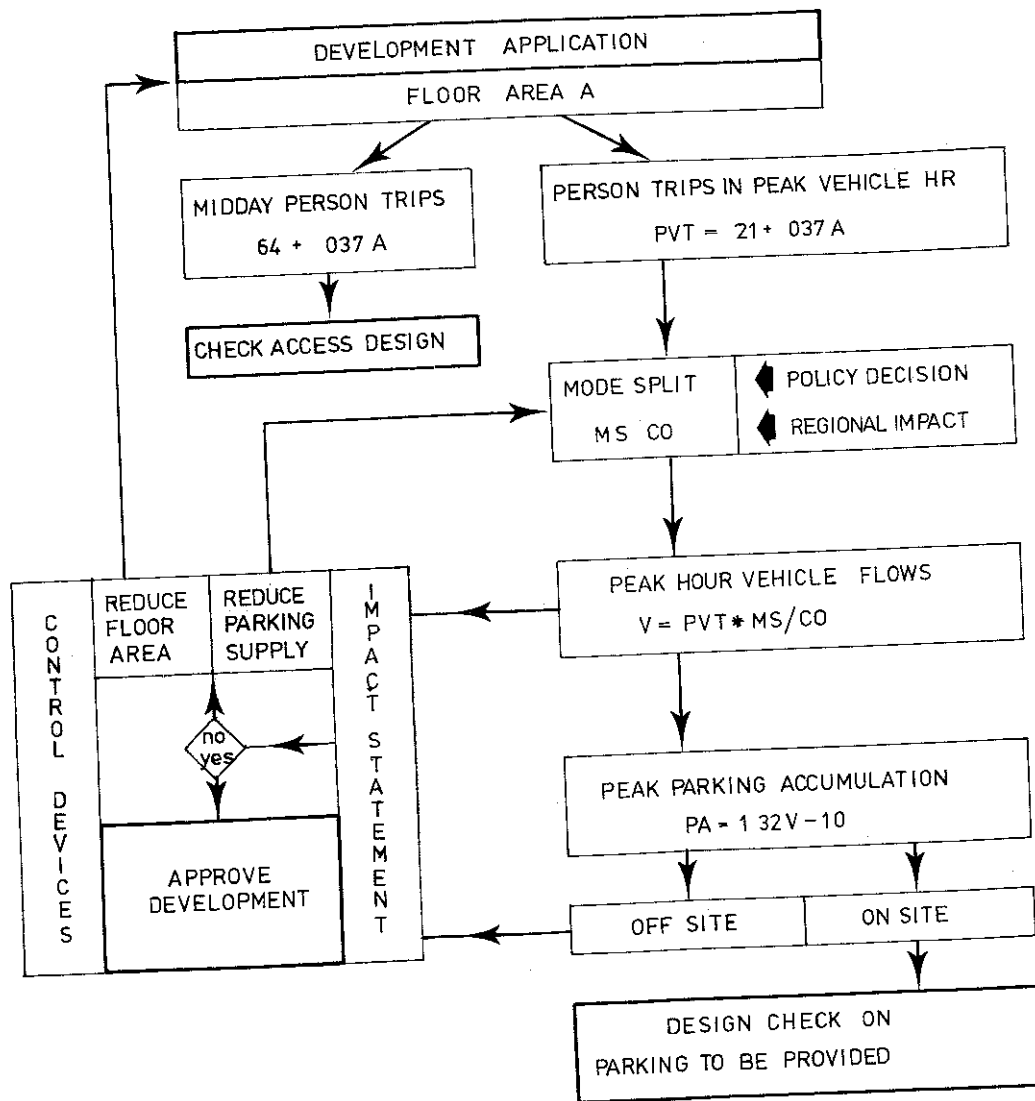
- the mode split decision
- the impact of vehicle flows on the surrounding roads.
- the use of on-street parking facilities

The data provides insight into the potential for influencing impacts. Public transport was widely used and in order to understand the vehicle impacts of a site the mode split characteristics must first be known. The existing methods of using standard vehicle generation rates and parking

TABLE 3

OFFICE BLOCK MODEL SYSTEM

IMPACT	VARIABLES	EQUATION	FIT R2
Total Daily Trips	Employees (E)	$TT = 24 + 5.1E$.91
Total Daily Trips	Floor Area m ² (A)	$TT = 251 + .221A$.92
Midday Trips	20% of above	$PT = 50 + .044A$	NA Correlation is .91
Midday Trips	Floor Area (A)	$PT = 64 + .037A$.83
Person Trips Peak Vehicle Hour	Employees(E)	$PVT = 4 + .81E$.86
Person Trips Peak Vehicle Hour	Area (A)	$PVT = 21 + .037A$.98
Peak Vehicle Trips	Mode Split (Ms), Car Occupancy(CO) and Peak Persons Trip (PVT)	$V = PVT \times Ms/CO$	as good as PVT, Ms, & CO
Peak Parking Accumulation	Peak Vehicle Trip(V)	$PA = 1.32V - 10$.98 using observed V



OFFICE BLOCK OPERATIONAL FLOW DIAGRAM

FIGURE 1

rate must assume an implicit mode split and car occupancy. The data on parking location was also revealing. The percentage of parking on-site ranged from 16 to 99 percent; in all cases, on-site parking was used until it was full or demand was satisfied. However, on average only a third of the parked cars were in on-site car parks. Only a third of the parking is controlled by on-site parking standards! There is a natural balance between on-street or other parking supply, mode split and hence the resultant vehicle flows.

The data on length of stay, however, indicates that the impacts cannot be treated by a single control mechanism. The percentage of people who stay for less than one hour is on average 38 indicating that short term parking is an important element and that two distinct types of trips should be recognised when seeking to establish standards and controls.

Further analysis of the office block data will add to the understanding of how any particular procedure might operate. Analysis of the other land-uses will further add to the understanding.

CONCLUSIONS

From the research there has emerged a strong feeling that the present application of zoning and parking code controls on a site by site basis is not an adequate method for assessing or controlling new or even existing development.

The basic data provided by a broad based and compatible set of surveys will allow a understanding and a predictive ability of the activity pattern associated with the various land-uses. The range of observed results and the relationships developed will allow for a simpler and consistent set of procedures to be applied to future development applications.

Considering a site in isolation, however, is only the start as a strong need has been identified for procedures which:

- . provide for individual site control
- . provide for area-wide controls
- . provide for regional parking and development policies.

Careful consideration needs to be given to developing workable measures of environmental capacity that allow for a balance in transport planning between the economic pressures for development and the capacity of the road and parking systems to handle the necessary increases in demand. Public transport does offer the potential for moving more people but it must be part of a total area development approach, not a issue tacked on at the end of the process.

The need for a closer working relationship between the regional policy maker, planner and local groups is necessary if solutions to our city's problems are not to be complete myth's.

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POLICY DECISION
REGIONAL IMPACT

VEHICLE FLOWS
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CUMULATION
-10

ON SITE

CHECK ON
PROVIDED