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AN ADDITION TO THE STAFF OF CLARKE GAZZARD AND YEOMANS IS MR. B. C. S. HARPER, B.E., DIP. T.C.P. (SYDNEY), M.SC. (TRAFFIC AND TRANSPORTATION) (QUEEN'S UNIVERSITY, CANADA), CHARTERED ENGINEER. MR. HARPER HAS BEEN MADE RESPONSIBLE FOR A NEW SECTION OF THE CLARKE GAZZARD YEOMANS ORGANISATION, HANDLING TRAFFIC AND PARKING STUDIES AND HIGHWAY PLANNING PROJECTS. HE DELIVERED A PAPER TO A GENERAL MEETING OF THE AUSTRALIAN PLANNING INSTITUTE (SYDNEY DIVISION) ON FEBRUARY 17TH 1961. THIS PAPER, ENTITLED "URBAN TRANSPORTATION - A REVIEW OF CURRENT U.S. PLANNING TECHNIQUES" IS REPRODUCED BELOW AS THE FIRST OF A NEW SERIES OF SPECIAL REPORTS WHICH CLARKE GAZZARD & YEOMANS WILL PUBLISH FROM TIME TO TIME.

**URBAN TRANSPORTATION: A REVIEW OF CURRENT UNITED STATES PLANNING TECHNIQUES**

All town planners are familiar with the term origin and destination survey as applied to road traffic. Most realise that this type of survey can be made in a number of different ways, having varying reliabilities depending upon the task confronting the highway planner. However, few are probably aware of the wide use made of the home interview origin and destination survey as a basis for developing techniques for planning highway and public transportation networks in the large cities of the United States.

Urbanisation is proceeding rapidly in the United States and the nation which once had the majority of its citizens living in rural areas now has about two thirds of its 180 million people massed in cities. Together with this urbanisation movement, America was confronted with an even more rapid motorization. Increasing real wealth, a good system of rural highways and magnificent scenic attractions, combining with a social pressure to own an automobile, led to the people becoming great car users. Naturally, with the urban areas containing the people and the industrial concentrations which form the backbone of American economic strength, a majority of the traffic is within cities. While representing only a small fraction of the total United States land area, and having only 10 percent of the nation's highway mileage, urban areas carry on their streets and highways 50 percent of the total vehicle miles of travel made each year in that country.

Americans in general have demonstrated a preference for automobile travel and a willingness to pay any additional costs involved. As a result, an extensive programme of urban highway construction has been undertaken

or is being planned for their cities. This represents a tremendous investment of public capital and it is necessary for the public to know that after the general decision to invest in good highways has been made, the money allocated is being spent to maximum advantage. Fortunately for the public interest, the Federal Bureau of Public Roads has control of the finance for the urban construction programme, and must be convinced that the planned system in any city is not only adequate to serve future traffic but represents the most efficient system in terms of vehicle miles of travel. These two criteria for judgement have stimulated research into highway planning and developed in the United States sophisticated techniques for planning overall transportation networks in urban areas.

The motor city of Detroit was the leader in developing these techniques. Chicago, Pittsburg, Washington, San Diego, Denver, Philadelphia, Seattle, Wichita, Minneapolis-St. Paul and a number of smaller cities have followed. Each has refined and added to the methods, in many cases greatly improving the accuracy. However the principal credit must go to J.D. Carroll Jr. and his staffs on the Detroit and Chicago studies.

Although the growth of these methods have considerable interest, the main concern of Australians must be to familiarise themselves with the techniques as presently developed. Also, though there exist a number of different techniques, the differences are like variations on a theme, and in this paper we shall concentrate on the basic theme and its implications for the town planning profession.

The Metropolitan Area Transportation Study, as it is known in the United States, is based upon a number of premises. First, that a reasonable estimate of the movement taking place in a city may be obtained by interviewing the occupants of a carefully selected sample of dwellings, and the operators of a sample of the registered trucks and taxis, and expanding the movement to represent the universe. This is the home interview origin - destination survey referred to earlier, which has been developed and extensively used in that country for highway planning purposes for the last fifteen years. Some criticism may be levelled at the statistical accuracy of many of the surveys. However, there is no doubt that by careful sampling and interviewing, a very good and reasonable estimate of overall city travel may be obtained. In this respect the survey just nearing completion in Brisbane has improved greatly upon American practice, as we in Australia should always endeavour to do.

The second premise is that the movement taking place within a city is related to the use being made of land within that city and that the amount of travel reflects the amount of development on the land. Planners in this country would

have no quarrel with this assumption.

In fact, members of the profession have been making this point for years. However, American practice has taken it a step further to say that the traffic generated by a particular type of land use can be measured and that the movement between areas can be represented by a mathematical expression involving the number of dwellings or the amount of floor area or land area in various uses.

The third assumption is that people do not choose their travel route erratically but that they attempt to take the shortest time route consistent with their mode of travel. On this basis it is possible to devise a procedure for assigning trips to the transportation network and obtain estimates of traffic flows on the various links in the network.

The problem facing United States Cities, which led to the development of the Metropolitan Area Transportation Study, is the same as that facing cities in Australia today. That is, to design a co-ordinated transportation system to meet future needs of travel, using the existing capital investments to the fullest, while being consistent with the expected pattern of development and the choice of the populace as to means of travel.

The area wide transportation study sets out to solve this problem in the following way:

- (1) Make an inventory of the existing land use pattern of the area determining the number of dwellings in various types, residential densities, floor area in various types of use and the acreage of open space.
- (2) Make an inventory of travel by means of the home-interview origin and destination study, the external road-side interview and the taxi and truck survey.
- (3) Make an inventory of the existing transportation facilities, the location, classification and capacity of existing roads and public transport routes.
- (4) Determine desirable standards for city growth and land use planning, and for transportation service and the planning of the transportation network.
- (5) Relate the existing travel desires, as shown by the origin and destination surveys to the existing land use pattern to determine trip generation for various land uses and determine

a mathematical equation to represent movement between areas on the basis of the amount of land use in the areas.

- (6) Develop a method of assigning movements to the transportation network and assign the existing travel desires to the system, check and adjust against the existing flows.
- (7) Make a land use forecast and plan for the study period or design year of the transportation plan.
- (8) Using the design year land use forecast and the trip generation factors and distribution model determined, predict future trip distribution.
- (9) On the basis of trip distributions for the design year, financial considerations and land use patterns, select a number of alternative plans for addition to the existing network.
- (10) Assign design year trips to the existing plus proposed network, determine traffic flows, check against capacities, adjust, calculate total miles of travel for each of the alternatives proposed and select the final system.

This study outline compresses a great deal of information in very few words. In fact many words used are technical jargon probably unintelligible to other professionals. Still the study divides itself simply into four parts; the gathering of facts; the statement of objectives and standards; the development of a means of forecasting movement and the design and testing of a transportation system.

The fact gathering stage, as set out in steps 1, 2 and 3 is fairly straightforward. Detailed statistics on the existing use of land and building are collected together with information on the existing transportation system. The only departure from complete accuracy is in the origin and destination travel study where, as set out previously, a sample is used. These facts provide the foundations for preparing the plan.

The statement of objectives is a very important step in the study in which desirable standards for community development, transportation service and financial and economic considerations are examined and resolved.

It is with the change from facts to forecasts that the method becomes harder to follow. As was noted before, two of the basic premises of the method are that traffic and land use are related and that the relationship may be represented by a mathematical expression. All this third stage entails then, is a careful study

of the facts collected so as to find a mathematical expression or model which can be used, in conjunction with forecasts of future land use development, to estimate future traffic movement.

The design and testing process, steps 7, 8, 9 and 10, involves the preparation of forecasts of land development, and the use of the travel estimating relationships found in the third stage, to prepare and test a series of alternative proposals. It should be clear from the steps outlined that in this fourth stage great responsibility is placed upon the land plan of the town planner.

Before considering this important point it is probably desirable to outline in more detail the traffic forecasting model. By examining the travel patterns and existing land use survey it is possible to obtain figures for the number of trips generated by various land uses on an average day. The word generation may be defined in a number of different ways, depending on the particular study design. It may also be expressed in different terms, such as trips per dwelling unit and trips per 1000 sq. ft. of floor area, or as trips per residential acre or commercial acre, and may be related to density for greater control. These figures, applied with care to the future land use forecasts, provide estimates of design year trip generation in the area under study.

The foregoing procedure will give an estimate of the amount of trip origins and trip destinations, but to be of value a method must be devised to connect origins with destinations. There are a number of different methods of predicting these interchanges, each with its relative merits and shortcomings. The preferable ones use a measure of the attractiveness of a zone and compare it to all other zones on the basis of its relative attractiveness and the difficulty of travel to it and to other competing zones. This may sound rather difficult, and indeed it would be impossible without computing equipment, but the work in the United States has advanced to such a state that reasonably accurate predictions of interchanges are possible.

This of course is tested by the closeness with which the mathematical model represents the existing pattern of movement between origins and destinations as determined in the origin and destination survey. However, when applied to the future, detailed land use forecasts must provide the standards of relative attractiveness and the responsibility for accuracy falls on the land planner.

Another extremely complex problem which requires computers is the assignment of movements to the transportation network in order to produce the traffic flows necessary for design. It is far too complicated mathematically to be of interest to town planners, and it is sufficient to say here that on the basis of minimum time it is possible to use for this purpose a theoretical method developed to find the shortest path through a network for telephone switching. This assigns movements between areas to their shortest route

and accumulates volumes on each link in the system. Travel times on each link may then be adjusted in the light of these volumes and the process repeated until it is brought into equilibrium. Naturally the existing loadings of routes in the present network play an important role in the establishment of this procedure. From the assignment of existing movements to the present network the flows may be checked and the reliability of the assignment procedure ascertained.

Most of this work, because of its specialised nature, must be in the hands of the traffic engineer, but with the statement of objectives and design the town planner is very much involved. With this type of study, there is no problem of coordinating land use planning and transportation planning. In fact, the land use plan dictates the planning of transport routes. Of course, different forms of transportation will give rise to different forms of land utilisation and so affect the land use plan. However, this is a problem of objectives which must be examined in the second part of the study. If it is desired to actually test alternative transportation methods, then a number of land use plans can form the basis for making and testing the different transportation plans.

Of much greater importance to the town planner is the reliance placed on his land use forecasts. No longer will coloured maps and broad statements suffice; precision is necessary in order to reasonably estimate traffic movements. This represents a challenge to the profession to improve land use forecasting techniques in this country.

Improvement must start with the development of a more scientific attitude of mind towards the forecasting problem. As a first step statistics must be collected which will enable the problem of estimating future population to be approached from a number of different directions. The economy of an area must be investigated and understood by the town planner in order to make forecasts of employment in different classifications. He must be familiar with industry and service growth and the relationship of the city considered to the national, as well as to its state and local markets. The estimates therefore have to consider possible incomes and consumption levels and the likelihood of production to meet these needs. They should always be made in a number of different ways and checked against other forecasts of national and industrial growth to ensure their reasonableness.

These population and employment forecasts for the design year of the transportation plan form the basis for detailed estimates of land use. This type of study requires figures on the number of dwellings, the number of square feet of floor space in various commercial and industrial uses, and their distribution throughout the area. The existing population and employment figures related to the detailed inventory enable overall requirements to be estimated. However, the planner must understand the present conditions of supply and

demand and of building trends in order to carry these to the future. Finally, he must allocate the growth throughout the city, allowing for existing patterns, redevelopment and the extent of the powers available to him in guiding and controlling growth.

Town planning can not just remain at the present stage of haphazard control based on guesswork. It must get down to detailed forecasts of needs to aid in planning and designing public works. In order to do this effectively, research into methods should be undertaken in the university planning schools in this country and practicing planners should also strive to improve the factual basis on which they work. When faced with a problem, members of the profession should be critical of the established analysis technique and always seek a more refined method.

The metropolitan area transportation study represents the endeavours of the highway planner to improve the tools available to aid in his decision making. The complexity, originality and sophistication of this type of study is obvious, yet the success achieved is certainly remarkable. By basing the forecasting programme on land use, a consistent and logical method has been developed. As well, the study is so designed that as new information makes necessary the revision of the land use forecast, the transportation plan can be re-appraised at any stage of construction without the need for field surveys.

Because the transportation study requires considerable fact gathering and depends upon the use of high speed computing equipment for its analysis, it must be carefully designed and directed. Undoubtedly many people will consider it too costly or unnecessary for Australian conditions. It must be reiterated, however, that a country of limited resources cannot afford to make mistakes in any form of capital works construction it undertakes. In Australia everything should be carefully planned and built to the limit of our technological ability. This applies particularly to a transportation system in which mistakes are not so readily apparent due to the fact that traffic tends to find its own level throughout the network. Up to the present there has been no way of balancing construction costs against travel costs in weighing one proposal against another. The comprehensive transportation study enables this to be evaluated by obtaining total vehicle miles of travel on each of the alternative networks for consideration with construction costs.

Also, by careful forethought and design the study can provide basic information for planning all forms of transportation at any desired future year and at various stages of new construction. It can also provide the land use planner and the economist with much valuable information on the relationship of various industries, land uses and the functioning of the city as a whole. It should be stressed that the mode of transportation does not affect the basic survey information, since the forecast of movement can be made in terms of people and goods and

these assigned to various travel modes. It must be emphasised that the overall design of a study such as this is of the utmost importance. The commencement of a home interview origin and destination study without an overall plan for traffic forecasting may well be a waste of money. Travel patterns gathered in such a survey are out of date when they become available, and it may be impossible later to relate them to land use and obtain a basic understanding of the forces involved. An understanding of the forces causing movement is already enabling American planners to dispense with the costly fact gathering stage of the survey and enter directly in synthesising future movement. In urban transportation, Australia cannot afford to make errors in planning. The American comprehensive transportation study must be adopted, adapted and improved to suit our conditions. It is the only technique available which enables different overall transportation plans to be rated and in doing so provides estimates of future traffic volumes essential for designing the freeway system and its interchanges or for scheduling the purchase of vehicles for the public transport system.