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ABSTRACT

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The last decade has witnessed a considerable change in the objectives of urban transport policy and hence in the methods employed for solving transport problems. In particular, there has been a significant switch from high cost additions to the transport infrastructure to low cost measures designed to manage the existing infrastructure more efficiently. Most of the successful developments, however, have been in traffic management techniques, such as bus lanes and mini-roundabouts which have been designed solely to reduce travel time for existing patterns of movement. By contrast, transport management measures, such as fares subsidies and restraint, which are designed to encourage a change in the pattern of travel, have met with far less success.

This paper, which is the text of Professor May's inaugural lecture, reviews these developments, discusses some examples of both successful and unsuccessful transport management proposals, and identifies the aspects of these proposals about which there has been greatest concern and uncertainty. It suggests, from this analysis, the changes which need to be made in techniques of prediction, experimental design and policy implementation if the role of transport management is to be more clearly understood.

# BREAKING THE HABIT - THE CHALLENGE OF TRANSPORT MANAGEMENT

## 1. INTRODUCTION

An Inaugural Lecture serves many functions, but surely one of the most important is the opportunity which it provides for introducing some of the research problems and challenges of one's subject to colleagues who have a layman's interest in it. In this respect, at least, this Inaugural Lecture must be very different from most, because few of you will consider yourselves laymen in my subject; indeed most of you will hold your own views on the directions which transport research and, more important, transport policy should take. Further, your views will almost certainly differ widely not just among you as individuals, but depending on whether your viewpoint at the time is as a driver or a bus user, as a pedestrian or a resident. In all probability, too, your views on transport problems will range far more widely than they would have done ten or fifteen years ago. No longer is transport policy simply a matter of moving vehicles through the transport system as quickly and as safely as budgetary constraints will allow; today we are concerned also as transport users about the relative performance and efficiency of different means of transport, as residents or pedestrians about the intrusion of traffic and new roads into our environment, and as caring members of society about the effects of transport on the consumption of energy and other scarce resources, on urban form and on economic activity. Almost inevitably these differing aspirations for transport policy conflict; it is, for instance, difficult at the same time to improve both accessibility to centres of activity and the environment of the areas which surround them. It is these conflicts which make transport policy an ever-popular subject for debate, and it is not surprising to find an analyst of *The Times* correspondence columns reporting that transport ranked high among the topics dealt with (Table 1); below, it must be admitted, those taboos of religion and politics, but higher than the economy, pay policy, medicine and human rights (Taylor, 1979). (As an aside, it is interesting to note that letters on transport issues seem to be shorter on average than most; whether this is indicative of the clarity of thought of those who enter the debate, or of the ease with which one can take an extreme position is difficult to judge!) All of this, of course, makes transport a stimulating subject on which to work; it is reassuring to find such public interest in one's activities, even if it is sometimes disheartening to find oneself criticised more often than one is congratulated.

Table 1. Letters to the Times: 1978

| Subject | Number | Length (inches) |
|---|---|---|
| International Affairs | 311 | 5.3 |
| Arts | 283 | 3.9 |
| Politics | 278 | 4.4 |
| Church Affairs | 254 | 4.3 |
| Legal Matters | 191 | 5.2 |
| Environmental Planning | 179 | 4.7 |
| Education | 142 | 4.5 |
| TRANSPORT | 137 | 3.9 |
| Economy | 133 | 5.5 |
| Pay Problems | 127 | 5.0 |
| Racial Questions | 120 | 5.8 |
| Human Rights | 116 | 5.1 |
| Medicine | 112 | 5.4 |
| EEC | 85 | 5.4 |
| Conservation | 79 | 4.8 |
| Press | 79 | 3.8 |

*Source:* Taylor (1979)

It is always tempting for the analyst to take sides in this debate, and to advocate one particular solution or another. It is, however, wiser to resist these temptations, because there is rarely any one correct solution to a given set of transport problems, and the analyst who has appeared insensitive to the adverse effects of one policy leaves himself open to suspicion of possessing a similar bias on future occasions. Decision making in transport policy requires a careful assessment of all the advantages and disadvantages of a particular course of action and a sound political judgement as to their relative values. While the transport analyst may make his own personal assessment of these values, he is rarely in a position to take a view on society's assessment of them.

Such decisions, however, also require a sound technical judgement of the scale of these advantages and disadvantages, and transport research is far more likely to contribute successfully to this complex area of public policy by providing the basis for an objective assessment of the impact of alternative transport strategies, and hence ensuring that decision-makers have the best technical advice on which to base their often unpalatable decisions. This of itself is no mean task, and it is instructive, in looking at some of the problems of both predicting and measuring the effects of certain strategies, to take as an example those policies which endeavour to change the ways in which people make their journeys: to, as my title puts it, break the habit of driving alone by car, or of travelling at the height of the peak period. Before doing so, however, it may be useful to describe briefly the developments which have led to an interest in such policies.

## 2. RECENT TRENDS

The decade just passing has seen major changes both in the context and in the form of urban transport policy. Early in the decade, the context altered in four particularly important ways. First, the effects of transport policy on the non-user, and particularly on his environment, became a much more dominant concern. This concern was manifest initially with new highway building, and the opening of London's Westway in 1970 in particular focused pressure for a reduction in highway building and for greater protection for those adversely affected when highways were built. The Land Compensation Act of 1973 provided some relief, but in doing so added significantly to the costs of new urban roads. It was not long, however, before concern was being expressed also at the effect of vehicles on the environment, and stress was placed on the need to reduce vehicle activity in particularly sensitive areas.

Secondly, the contrast between the road user and the resident whose environment he affects formed only one example of a growing interest in the distributional effects of transport policy; comparison of the conditions for bus user and car user or for pedestrian and motorist led to pressure for policies which paid more heed to the needs of those unable to use a car.

Thirdly the Arab/Israeli war of 1973 started a process which saw petrol prices rise threefold in six years, and while inflation ensured that the real price of petrol later returned to 1973 levels (Fig.1), thus removing the only incentive for the individual to conserve fuel, the energy crisis cast continuing doubts on our ability to predict transport demands in anything but the shortest term.

Fourthly, as a direct result of the ensuing economic recession, finance available for transport began to fall in real terms from the middle of the decade. As a result, new urban roads had at once become less acceptable environmentally, more expensive, less secure as investments against a less certain future, and less easily financed. Not surprisingly, local authority expenditure on highway construction has fallen to about half of its 1973 value in real terms (Table 2).

Table 2: Indexed local expenditure on road construction and all transport (1972/3 = 100)

| Year | Actual | | | | | | Predicted | |
|---|---|---|---|---|---|---|---|---|
| | 72/3 | 73/4 | 74/5 | 75/6 | 76/7 | 77/8 | 78/9 | 79/80 |
| Road Construction | 100 | 108 | 86 | 88 | 75 | 59 | 55 | 57 |
| All Transport | 100 | 109 | 111 | 116 | 104 | 96 | 95 | 97 |

*Source:* Department of Transport 1979

There have been signs recently of a possible reversal of this trend, with the emergence of a fifth change in the context of urban transport policy. Growing unemployment and economic decline have placed greater emphasis on the need to assist industry and commerce and, particularly, to revitalise the decaying residential and industrial inner areas of many of our larger cities. While solutions to these problems must be sought in all areas of public policy, much has been made of the importance of an improved transport infrastructure in encouraging industrial development and in stimulating confidence in the inner city, and there are now several examples of new or resurrected highway proposals being pursued to these ends. It is difficult to determine as yet whether an upturn in highway building will result, or whether environmental and financial pressures will curtail it. More fundamentally, it is by no means clear that such developments are the most appropriate way of assisting industry; there

are several indications that industry's transport problems are more amenable to solution by more localised, low cost measures (May, 1979). What is clear is that concern over the transport needs of industry and commerce has added a further, and particularly important, objective to the range which transport policy must endeavour to meet, and against which transport strategies must be assessed. Any instrument of transport policy may now need to be judged by its effects on travel time and operating costs, consumption of fuel and other scarce resources, the budgetary constraints of government, safety, a wide range of environmental factors, accessibility to centres of economic activity, and changes in urban form, as well as by the incidence of such effects on different members of society.

These, then, have been the changes in the context of transport policy; at the same time there have been several changes in its form. The most obvious is the one to which I have already referred, the reduction in highway construction. Because significant additions are no longer being made to the transport infrastructure in urban areas, it has become more important to make better use of that which exists, and the management measures required to do so fortunately also satisfy the current need for inexpensive policies which produce fairly rapid results. Policy has therefore switched quite markedly from a high-cost one, involving long-term investment in additions to the transport infrastructure, to a low-cost one designed to manage the existing infrastructure more effectively in the short term. This change has inevitably brought with it its own jargon. In this country the Department of Transport now advocates the use of Comprehensive Traffic Management to manage the use of existing road networks with the intention of achieving a compromise between the needs for movement and the local environment at a reasonable cost (Department of the Environment, 1975). In the United States the talk is of Transportation Systems Management designed to 'co-ordinate (automobiles, public transport, taxis, pedestrians and bicycles) through operating, regulatory and service policies so as to achieve maximum efficiency and productivity for the system as a whole' (U.S. D.o.T., 1975).

Much of this activity has been in the form of traffic management measures designed to increase the capacity of the existing road system, or reduce delay for the existing traffic (or for selected vehicles such

as buses), and environmental management measures designed to relocate traffic to protect sensitive environments. In these fields the 1970s have provided a fruitful period for experimentation with, and large-scale implementation of, several ideas which were first formulated in the 1960s. As examples of traffic management measures, one can cite mini-roundabouts which have increased the capacity of selected junctions by up to a third, centrally controlled traffic signal systems, which have been able to reduce system-wide journey times by up to 10%, and bus lanes which can, if well designed, reduce bus running times over the length of the lane by up to 25% without significantly increasing delays for other traffic. Environmental management meaasures include the removal of traffic from selected designated pedestrian streets, barriers to restrict heavy traffic in residential areas, and, on a larger scale, traffic cell schemes, which divert through traffic while still permitting access to the city centre. Although many of these measures have gone unassessed by local authorities understandably more interested in progress than in evaluation, enough have been studied and documented in detail by organizations such as the Transport and Road Research Laboratory, the Department of Transport's Traffic Advisory Unit and the Organization for Economic Co-operation and Development to ensure that at least their most immediate beneficial and adverse effects are well understood.

## The case for transport management

It is tempting to suggest that such management measures have been successful enough to remove the need for more drastic action. Particular interest has been shown recently in the apparent upward trend (Table 3) in peak period journey speeds in the central areas of London, five selected provincial conurbations and eight selected provincial towns. It is suggested that these 'point towards an optimistic view of the future' and that since off-peak speeds in the same areas are little higher there is not much room for further improvement (Department of Transport, 1978). Unfortunately this optimism may be ill-founded. The individual speed estimates are based on unsatisfactorily small samples and, even if speeds have in practice been rising, the causes are certainly not apparent, and there would be little justification (even without the latest peak period data point for London) for a direct

extrapolation into the future. Equally, these figures disguise local variations, and particular corridors may well give cause for concern.

Table 3. Speeds (km/h) in central areas of UK towns and cities

| Year | Greater London | | Provincial Conurbations | | Provincial Towns | |
|---|---|---|---|---|---|---|
| | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak |
| 1967/68 | 20.3 | 19.7 | 14.9 | 17.6 | 18.2 | 19.7 |
| 1971 | 20.6 | 20.2 | 17.7 | 20.2 | 19.7 | 23.4 |
| 1974 | 22.7 | 20.6 | n.a. | n.a. | n.a. | n.a. |
| 1976/77 | 19.7 | 20.2 | 20.5 | 21.4 | 20.8 | 24.9 |

*Sources:* Greater London: unpublished data.
Other areas: Department of Transport 1978.

To bring the analysis much closer to home, it is easy to see many of the remaining problems from data collected on Otley Road. It will be common experience that travel times are significantly higher in the peak periods; as column 2 of Table 4 indicates it takes about 50% longer to travel from the ring road to the University at the height of the peak. Surprisingly, the major contributor to the corridor's traffic, traffic crossing the ring road (columns 4 and 5) is not as peaked as one might expect; even so a more even distribution could reduce the highest 10-minute flow, and perhaps remove the trigger which causes queues to form. A more interesting pattern emerges when looking at the movement of people rather than vehicles; while numbers of car occupants vary little (column 6), those of bus users are remarkably peaked, with about 60% of the peak period travellers travelling in the peak 40 minutes (column 7). While this adds little to congestion, it does demand extra buses at a time when they are unlikely to be used for more than one journey in each direction per day. A further indication of apparently inefficient use of transport facilities comes from a study of the extent to which the vehicles in the traffic stream are used. In cars average occupancy is only about 1.4 people (columns 6 and 8), and there are more than enough spare car seats to accommodate all those now travelling by bus. Even on the buses it appears that there is enough spare capacity to provide space for a significant number of car users, while still leaving room for those wanting to board buses further in (columns 7 and 9).

Table 4. Travel times, flows and vehicle occupancies, Otley Road, Leeds.

| Time Period | Average Travel Time[1] (min.) | Time Period | Vehicle Flows | | Person Flows[2] | | Seats Available[3] | |
|---|---|---|---|---|---|---|---|---|
| | | | Cars | Buses | In Cars | In Buses | In Cars | In Buses |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0745-0800 | 6.6 | 0740-0750 | 165 | 4 | 224 | 112 | 660 | 228 |
| | | 0750-0800 | 180 | 5 | 250 | 139 | 720 | 313 |
| 0800-0815 | 7.3 | 0800-0810 | 157 | 9 | 224 | 334 | 628 | 625 |
| 0815-0830 | 10.2 | 0810-0820 | 153 | 10 | 216 | 334 | 612 | 668 |
| | | 0820-0830 | 153 | 10 | 230 | 366 | 612 | 696 |
| 0830-0845 | 9.9 | 0830-0840 | 140 | 10 | 197 | 334 | 560 | 640 |
| 0845-0900 | 7.5 | 0840-0850 | 131 | 5 | 219 | 187 | 524 | 337 |
| | | 0850-0900 | 146 | 6 | 197 | 231 | 584 | 342 |
| 0900-0915 | 7.9 | 0900-0910 | 158 | 2 | 214 | 78 | 632 | 142 |
| 0915-0930 | 6.4 | 0910-0920 | 144 | 3 | 186 | 129 | 576 | 213 |
| | | 0920-0930 | 121 | 2 | 162 | 32 | 484 | 128 |
| 0930-0945 | 6.6 | 0930-0940 | 132 | 3 | 169 | 64 | 528 | 197 |

Notes: 1 Ring Road to Clarendon Road (4.0 km)
2 Crossing the Ring Road, inbound
3 All seats, occupied and unoccupied, in vehicles crossing the Ring Road, inbound
4 *Source:* data collected in June 1978

This data suggests that a considerable saving could be made in the numbers of vehicles required, and hence in travel time, bus operating costs, fuel consumption, and impact on the environment, if more people could be encouraged to change the ways in which they use vehicles or the times at which they travel. Transport management (as opposed to traffic management) aims to do this by encouraging, in the main, three types of change - a switch from car to bus, increased car sharing, and more even distribution of demand during the peak. It is worth noting at this point that the correct direction of change between car use and bus use is not clear. The bus is a more efficient mover of people in terms of its use of road space and fuel, and provides a more generally available service. However, if that bus has to be provided simply to make one journey per day in each peak period it may be that the extra staff and vehicle costs are not justified, and that it would be preferable to encourage some peak period bus users to share cars instead.

Experience with transport management measures is far more limited than that with traffic management, partly because relatively few of them have been implemented on a significant scale, partly because there has been a reluctance to monitor carefully those which have been introduced, and partly because monitoring is made more difficult by the diffuse nature of their effects. It is, however, useful to review such evidence as there is, looking first at measures which encourage rather than force a change in travel patterns since these, if effective, are likely to be politically more palatable.

Among the incentives to encourage a switch from car to bus, the one on which most experience has been gained is that of using subsidies to hold fares down. Operators' receipts suggest that a 10% reduction in fares is likely to increase bus journeys by about 3%(Bly, 1976); but an increase in bus journeys does not of course necessarily result in a reduction in car journeys. Information on where the new passengers come from is harder to obtain, but what there is suggests that most are existing users making more journeys, or walkers using the bus instead; car use is only likely to fall by well under 0.5% if fares fall by 10%. Thus reduced fares may permit more travel for existing bus users, but are an expensive way of achieving a very small reduction in car use. This is not, perhaps, surprising. The combined out of pocket and time costs of a typical car journey to work are only about half those for a similar bus journey, and even if fares were removed completely they would still be lower (Webster, 1976). More fundamentally, the car user may well experience bus travel only rarely, and is quite likely as a result to overestimate its costs and disadvantages.

Intuitively, encouraging the car user to share his car should be easier than encouraging him to travel by bus. He retains the door-to-door service of the car and while he loses some flexibility and privacy he is able to choose his travelling companions, and can share his costs with them. These arguments led the US Department of Transportation, in the wake of the energy crisis, to promote over one hundred projects designed to encourage and match would-be car-sharers (Bonsall, 1979). Perhaps because these projects were a response to an emergency, little evaluation was carried out at the time. However, a retrospective analysis suggests

that response was lower than had been expected. Of those employees exposed to the extensive car sharing publicity, about one in six made applications to join the scheme, but only about one sixth of these actually became car sharers, and of these about one third subsequently reverted to their original mode, resulting in a net 1.7% of those originally encouraged to do so becoming long-term car sharers. Although the schemes amply repaid their promotional costs by reduced vehicle operating costs and fuel consumption, the resulting reduction in vehicle use for the journey to work will have had little effect on travel times. Further analysis suggests that the success of these projects was limited mainly by the reluctance of those who were matched to contact one another. Personal contact and a common bond - be it through family links, employment or mutual interests - are apparently particularly important if matches are to be successful.

Transfer of these findings to this country is of course difficult; not only are journey to work patterns and relative levels of car and bus use very different, but it might be expected that an underlying British unwillingness to co-operate could reduce the potential for car sharing. Legal restrictions have until recently made it difficult to gain practical experience of car sharing in this country, but the 1978 Transport Act made it legally possible for drivers to receive payments from passengers, and the 1980 Transport Act has further relaxed the restrictions on advertising. In advance of this legislation, however, some interesting work has been carried out in this University in an attempt to predict the potential for car sharing. Estimates based on a survey of the characteristics and attitudes of commuters to central Leeds suggest that 1.5% of them (a percentage remarkably close to the figure of 1.7% in the US) would become car sharers as a result of both publicity and a matching service, and that of these 40% would switch from bus travel (Bonsall & Kirby, 1979). However, model predictions based on individuals' stated attitudes must be somewhat uncertain, and work is now well advanced on three car-sharing experiments in the Leeds area designed to test these predictions in practice.

In the third possible area of change, that of spreading peak period demand, there has been substantial activity for much longer; wartime pressures, for instance, led to many employers being required to change

their hours of work to ease the load on the transport system. Since the war, there has been varying success with attempts to encourage employers to stagger their working hours to achieve a spread of what would still be fixed hours of work either between places of employment or within a single large office or factory. Some, such as those in Sunderland and Newcastle, were initially successful, but their effects were eroded as working hours fell; others - such as the attempt in London in 1956 where only one fifth of the employers approached, representing less than 2% of the Central London workforce, were prepared to cooperate - have failed. The most significant success in this area has been in Manhattan where between 1970 and 1974 the employers of over a million employees changed their hours of work. Unfortunately while there is some useful evidence of the effects of such changes on the transport system, there is little indication of the relative importance of the factors which will encourage one firm to make such changes and another not. It is clear that concern over lost business efficiency and disruption to the employee's home life have to be weighed against the benefits to employer and employee of an easier and more reliable journey to work, but it is difficult to predict, without time-consuming negotiations, which of these factors will predominate in a particular instance.

More recently, changes in working hours in this country have been brought about more frequently by the introduction of flexible working hours - 'flexitime' - in which the employee is free to choose his own hours of work provided that he works an agreed total number of hours per month and is present for at least certain specified 'core' times. In most cases such changes have been promoted from within the workplace by employees keen to reap the substantial benefits which flexibility provides. While improved travelling conditions are clearly one of these, the opportunity to take time off, and the improved balance between private and working life, appear to be more important to the employee. This development has two important implications for the transport analyst; firstly, most such changes pass unnoticed and unsurveyed, and secondly, the introduction of flexibility makes it far harder to predict the extent of any changes in the distribution of demand during the peak. While there are now a few surveys which have measured the

changes in travel patterns which have occurred after flexitime schemes have been introduced, there has been no analysis of the causal factors which have determined the extent of these changes, and hence no basis for predicting the effects of a proposed scheme. Research has recently started in this University in an attempt to remedy this situation (May, Montgomery & Wheatley, 1980).

It will be clear from what I have said so far that the power of incentives to encourage a significant change in travel habits, and hence to reduce travel time, operating costs, energy consumption or environmental intrusion, is at best unproven. Not surprisingly it has been felt for some time that more restrictive measures, involving some form of traffic restraint, were needed if such changes were to be achieved. As the Crowther Report put it in 1963 in presenting Buchanan's 'Traffic in Towns' (Crowther, 1963): 'Distasteful though we find the whole idea, we think that some deliberate limitation of the volume of motor traffic in our cities is quite unavoidable'. In practice, however, no such deliberate limitation has yet been successfully introduced in this country in the sixteen years since those words were written, partly because of a lingering hope that less restrictive measures would be sufficient and partly, as we shall see, because of the difficulty of designing effective restraint measures, but mainly because of doubts whether restrictions on the individual and his freedom of choice and the potential adverse side-effects of such restrictions could be justified by the benefits to be gained. Before considering possible measures of restraint it is important to be reminded of the need to identify clearly all their possible effects, both beneficial and adverse, rather than, as has tended to be the case in the recent past, seeing restraint on the car as an end in itself. Restraint measures inevitably restrict freedom of travel for some and add to their costs, and it will be difficult to justify such restrictions if the time or cost savings which they produce are offset by congestion elsewhere or by car users deciding to work or shop in unrestricted areas. The analyst has a responsibility, therefore, to provide those responsible for deciding on the adoption of restraint measures with the best possible advice on the full range of their effects.

The idea of traffic restraint has been pursued in three different ways: by the control of parking within the city centre, by the use of physical controls to impose a delay on vehicles approaching the city centre, and by charging for the use of road space in the city centre.

The first of these, parking control, was advocated by the Buchanan Report, which suggested that the practice of controlling on-street parking by limiting supply and by price could be extended by giving local authorities control over all off-street parking, both public and private. It seems clear that such controls would have been effective in limiting car traffic *to* the city centre, but in practice Buchanan's advice was not taken and at present between one and two thirds of city centre parking space is outside local authority control in private car parks. Proposals were formulated in 1976 for the control of such parking by enabling local authorities to close, tax or sell permits for the use of all but a basic minimum number of operational spaces attached to each property (Department of the Environment, 1976). However, during consultations on these proposals concern was expressed not only at whether the controls would be effective, but also at the unreasonableness of controls which would require owners to relinquish, or pay for the use of spaces which they had been forced to provide under earlier planning legislation. As a result these proposals were excluded from the 1978 Transport Act. Even if such parking had been controllable, the effect would still not have been comprehensive since at least a third of cars entering most city centres do not park but pass through. As a result, while public parking can be restricted, restrictions are most likely to benefit those able to park in private car parks or driving through the area; surveys suggest that this has in fact occurred in central London (May, 1975).

Physical and fiscal controls on moving traffic do not provide the loopholes which parking control does. Although pricing had been suggested earlier, it would have required new legislation, and was thought to be unfair to the poorer car owner. Physical restrictions, on the other hand, could be introduced within existing legislation, and the delay imposed would, it was argued, bear equally heavily on poor and wealthy car users. These arguments provided the justification for Nottingham's Zones and Collar experiment of 1975 shown here diagrammatically in Figure 2. The intention was to impose a delay which, together with

public transport improvements, would have been sufficient to induce a reduction of 10% in the number of cars entering the city centre. Cars were delayed at a collar of points around the city centre, by forming queues which buses could bypass. Because queues sufficiently long to have the desired effect would have blocked the ring road, further delays were imposed instead at the points at which traffic joined the main road system from two residential zones. Public transport improvements were provided in the form of park and ride services and an increase in bus frequency. In practice the scheme was unsuccessful for several reasons; delays in excess of three to four minutes were difficult to impose because of lack of queue storage space, and about 5% of drivers violated the controls, thus reducing their effectiveness. As a result travel times for cars increased by only about $2\frac{1}{2}$ minutes on average. On the other hand, bus travel times fell by about 1 minute on average. However, during the experimental period, bus fares rose 20% in real terms, while petrol prices fell 15%, and as a result the combined time and money costs of car travel fell slightly while those by bus rose. Not surprisingly there was little change in the level of car use apart from a slight spreading of the peak travel time and, since operating cost losses to private vehicle users were about eight times greater than the savings to public transport users and operators, the scheme was abandoned (Vincent, 1977).

Again the question of transferability of results arises; it is difficult to say whether the measures would have been more successful in another location with more queue storage space, less variable bus fares - and more obedient drivers. It is clear, however, that such controls start off at a disadvantage, since they impose an increase in travel time in order to reduce travel time, and the extra delay incurred by those unable to change their travel patterns must be more than offset by savings to bus users if net benefits are to be gained. Pricing as a form of control is likely to be more efficient, since it imposes its penalty by transferring money rather than by consuming resources; it may or may not be more equitable. The original proposal for road pricing, presented in the Smeed Report of 1964 (Ministry of Transport 1964) was for a meter which would record the amount of congested road space used by each car and issue a charge to cover the extra congestion

costs imposed by the driver on other road users. In practice this proposal, while theoretically superior to other forms of pricing control, would have required a considerable investment in equipping vehicles, and, more important, would have demanded a high level of computational skill in the driver, who was expected to be able to select the cheapest route and time to travel. Further developments have all concentrated on much simpler methods which levy a fixed charge to enter or be within a designated area at specific times. One of the earliest detailed proposals was submitted in 1974 for a supplementary licensing scheme in London, which would have charged drivers £1.50 per day at today's prices for a licence to be displayed on any car being used in central London between 8 a.m. and 6 p.m. It was estimated that this charge would have been sufficient to reduce car traffic entering the area by 45%, increase speeds within it by 40%, produce a net benefit to travellers of £70m. p.a. and raise a net annual revenue of £100m. (Greater London Council, 1974). Similar schemes have been proposed in several other cities around the world. The World Bank has been stimulating interest in the use of licensing in several congested cities in the developing world, the US Department of Transportation has been seeking a city willing to experiment with such measures (Higgins, 1979), and several European cities have considered similar measures. The latest of these, Stockholm, has recently announced that it is considering a scheme for implementation in 1982. Most such proposals have, however, been abandoned, and several reasons have been put forward for their rejection. These fall broadly into six categories: doubts about the authorities' ability to administer and enforce the controls; doubts about the power of a fiscal penalty to induce a change in travelling habits; doubts that if it did public transport or bypass routes would be overloaded; doubts that drivers would desert jobs, shops or business in the controlled area; doubts about the distributional effects of the controls and, fundamentally, a feeling that it is wrong to restrict drivers' freedom to use the road.

While the last of these is solely a matter for political judgement, the others all question, in one way or another, the technical predictions of the effects of pricing. It is not surprising that these doubts are raised, because the analyst has little basis on which to make his predictions. Furthermore his standard analysis models are not able to answer several of the questions which are raised, and are likely to provide an unsatisfactorily wide range of estimates for those which it can answer.

Table 5. Predicted effects on peak period traffic of two fiscal restraint measures in Central London

| Charge (1977 prices) | Supplementary Licensing £1.30/day | Area Control £0.50/day |
|---|---|---|
| Percentage change in | | |
| Terminating traffic entering | -40% | -15% |
| Through traffic entering | -60% | -90% |
| Traffic on boundary route | - 6% | +16% |

*Sources:* Greater London Council 1974. Prestwood-Smith 1979.

As a simple example, Table 5 presents the estimated changes in peak period car traffic for two alternative licensing schemes for central London. The first was produced in the Supplementary Licensing study, and suggested that a charge of £1.30, at 1977 prices, would reduce terminating traffic by 40% and through traffic by 60%. Because the boundary route outside the central area takes substantial flows of traffic to that area as well as around it, the net effect of reducing terminating traffic and increasing diverted through traffic was estimated to be a 6% reduction in flow on the boundary route. The second, produced in the more recent Area Control study, suggested that a 50p charge - again at 1977 values - in a slightly smaller area, would reduce terminating traffic by 15% - roughly proportional to the earlier estimate - but through traffic was predicted to fall by 90%, producing a net 16% increase in boundary route flows, which would result in substantial congestion there (Prestwood-Smith, 1979). Which of these estimates is more realistic? It is almost impossible to judge without some experience of similar controls, yet the answer is clearly of considerable importance in assessing the merits of the scheme. This analysis is indicative of the dilemma in which transport analysts are placed in assessing such policies; on the one hand we need some experience of such measures in order to understand and predict their effects, while on the other we are only able to obtain such experience if schemes are introduced in the absence of adequate predictions. We owe a debt of gratitude, therefore, to the government of Singapore, who were prepared in 1975 to introduce an area licensing scheme without being able to predict its effects. They faced the same

initial problems, realising that they had no basis for selecting the best level of charge or period of control, and that they could not be sure that no adverse side effects would arise. They decided, however, that the risk was worth taking, and that they would be able to modify the controls if changes proved necessary. The controls as implemented required drivers to buy a licence costing about 60p per day to enter the 500-hectare city centre between 7.30 and 9.30. Parking charges in the area were increased at the same time. In the light of experience the charge was later increased to 80p and the control period extended to 10.15. Licences have to be displayed on windscreens, and enforcement staff check vehicles without stopping them as they pass the entry points and send summonses to the owners of vehicles not displaying them. Buses, commercial vehicles and cars with four or more occupants are exempt, the last exemption being designed to assist the poorer car user. An admirably comprehensive monitoring programme was planned by the World Bank, although unfortunately problems arose with some of the surveys (Watson, 1978). The most immediately obvious result was a 75% reduction in the number of cars entering the area in the controlled period, resulting in a 44% reduction in all traffic, and increases in speed of about 10% on the approach roads and 28% within the area. Home-based surveys indicated that drivers had switched to a variety of alternative means of travel, as indicated in Table 6. Of those previously driving to the area during the controlled period by car, 39% continued to do so, 17% did so but in shared cars, 22% travelled by car outside the control period, and only 19% switched to bus. Of those driving through the area, 27% continued to do so, 43% drove round the area, 16% travelled outside the controlled period and 14% transferred to bus. As a result of this wide spread of alternatives, the only adverse effects were slight increases in ring road congestion and off peak flows. There appeared to be little difference in the effect on poorer and wealthier car users and little immediate effect on the level of employment or business activity, although this last result must be treated with caution, since any effects could be expected to take some time to be manifest.

One set of results like these does not, of course, answer all the outstanding questions on such controls. It does, however, provide some guidance. It has, for instance, demonstrated that both administration and enforcement of such controls are practicable and that drivers can

Table 6. Modes used after implementation of area licensing by previous peak period car drivers in Singapore

| | Percentage of those driving into the area | through the area |
|---|---|---|
| Continued to use low occupancy cars in the peak | 39% | 27%* |
| Formed car pools | 17% | |
| Travelled outside control period | 22% | 16% |
| Transferred to bus | 19% | 14% |
| Drove around control area | n.a. | 43% |
| Other | 3% | 0% |

* Split not clear from data. *Source:* Watson 1978

be expected to respond in significant numbers to fiscal controls. In addition, however, it has indicated the reluctance of drivers to return to using the bus, and the importance of providing several alternatives both to attract drivers and to spread the effects of the change. This, in turn, indicates a further problem which analysts have in predicting such changes; not only was it impossible to estimate the effect of the change but neither the switch to car sharing, nor that to off-peak travel could have been predicted using standard transport analysis procedures. Finally it has demonstrated the inherent flexibility of such controls provided that the willingness is there to modify them as needs arise. Most of these results should be technically transferable - they should be able to be replicated elsewhere in direction, if not precisely in magnitude.

What of course is less transferable is the political framework within which the scheme was introduced, administered and modified. It still seems unlikely that European or American politicians will be prepared in the foreseeable future to run the risks which experiment with such measures involves. This could be taken as suggesting that the benefits from such measures, in terms of reduced delays and operating costs, reduced fuel consumption and an improved environment are not sufficiently attractive to justify the risks of adverse side-effects and the certainty of political opprobrium, but this is perhaps too harsh a judgement. Certainly the continued interest in the less

restrictive transport management measures, such as car sharing and peak spreading, suggests that these benefits are still being sought, even if research suggests that these may not be the most effective means of achieving them.

More generally it may appear from my comments so far that, unless a measure as dramatic as charging for use of roads is introduced, transport management will have only a marginal effect on travel patterns, and is therefore not worth pursuing further. It is important to remember, however, that the marginal traveller in the peak is particularly expensive to provide for, and that changes by several such marginal travellers may be enough to reduce bus costs substantially, or avoid the build-up of peak period queues. Even a small change in travel patterns at this critical time may well be worthwhile.

What then is the way forward? How can research help most in increasing our understanding of the potential of transport management techniques? Two areas of development suggest themselves, and need to be pursued in unison. The first is an improvement in predictive techniques to provide better answers to the wide-ranging questions which transport management raises, and which existing transport models fail to answer. The second is a detailed study of actual changes to provide the information on which to base such techniques.

Considering first the improvement required in predictive techniques, this assessment of transport management measures has identified several potential impacts which current methods of analysis are unable to predict. The most important of these are the scale of response to a major increase in travel costs, the extent to which travellers might elect to share cars or change the times of their journeys, the likelihood of drivers deciding to avoid controls by working, shopping or doing business elsewhere, and the incidence of benefits and disbenefits among travellers. None of these can be assessed satisfactorily by the standard form of transport planning model which considers groups of travellers in aggregate, fails to distinguish between car sharers and ordinary car users and assumes that the total number of journeys to a given area in a given time period is fixed. Recent research has indicated that there are several personal attributes in addition to those of the journey being made which influence the individual's travelling

habits. The probability of his sharing a car, for instance, is affected by his choice of possible travelling companions, his willingness to make contact with them and the importance to him of retaining flexibility in his travelling arrangements (Bonsall, 1979). Equally his choice of the time at which he travels is influenced by constraints imposed by his employer, by his own leisure activities, and by the demands of other members of his family (Jones, 1977). No model which considers this diffuse set of characteristics only in aggregate for the group of people making a particular journey is likely adequately to predict choices of these kinds. What is needed instead is a predictive model which analyses choice at the individual level and attempts to account for variations in all these attributes. Some recent developments have attempted to do this (Spear, 1977), and models of this kind, by describing the attributes of the individual who is likely to be affected in a particular way by a particular transport management measure, are also likely to make incidence analysis easier to perform.

Predictions of changes in place of work or in the location of shopping or business activities require the development of models of a different form, which describe the interaction between the transport system and land use patterns and, again, there have been some recent developments in this area (Mackett, 1979). Developments of both these types of model make considerable demands on the researcher, who must have both the perception to understand the range of influences on individual travel behaviour and the data against which to test his model formulations. While some of this data can be obtained by cross-sectional analysis, comparing the reactions of apparently similar people to different influences, much more use could be made of studies of people's reactions to change. In some cases opportunities arise to measure reactions to the changes introduced by specific transport management schemes; past studies of bus subsidies, current experiments with car sharing in the vicinity of Leeds, and the past studies of restraint in Nottingham and Singapore are cases in point. But changes do not necessarily come about by design, and much can be learnt from individuals' reactions to inadvertent changes in the transport system. Two recent local examples which provided suh opportunities were the 1978 Leeds bus strike, and the six-month closure of Lendal Bridge in York the following winter. There was, inevitably, little warning of the five-week bus strike and several opportunities for analysis of its effects were missed, partly because no pre-strike surveys could be arranged, but also

because it took some considerable time to realize the potential which the strike provided for analysis, to design appropriate surveys and to find the resources to conduct them. Even so some surveys were conducted, and interesting results are beginning to emerge, suggesting that car sharing increased significantly, and that shopping activity was deferred rather than reduced (Wood, 1980). In the case of the closure of Lendal Bridge,there was time enough to plan comprehensive surveys of the changes in travel patterns induced by reduction of over a third in cross-river capacity. Again, interesting results are beginning to appear suggesting particularly that drivers have considerable flexibility in changing the time at which they travel to avoid congestion (except, apparently, when driving children to school) and that shopping trips by car across the river were more seriously affected than those for other purposes (Dawson, 1979). Even so this latter point raises one of the problems of designing a comprehensive survey; a reduction in shopping trips does not necessarily imply a reduction in turnover, since shoppers can still buy the same amount on fewer trips. Yet it has taken considerable time and effort to encourage shopkeepers to part with the data on turnover which is the vital key to determining the true effects of transport management on retailing activity (May & Weaver, 1980).

More generally, the planning of such comprehensive surveys of actual changes raises several problems. In the first place there are all too few planned transport management measures available for study, because most local authorities, unlike Nottingham and Singapore, are often reluctant to experiment with new measures. Lack of prior warning of those which are introduced and, of course, of most unplanned changes, means that many opportunities for study are in practice missed. Indeed local authorities themselves may ignore several opportunities for such surveys either for lack of resources or because they themselves are not particularly concerned about certain aspects of the measures which they introduce. When surveys are set up it is very difficult to avoid other changes influencing the results; the rise in bus fares in Nottingham was a case in point, as was the disastrous flood in York last winter, which clearly affected traffic flows and retailing activity. Our inability to control external influences in our live laboratory makes experimental design particularly difficult and also casts doubts

on the transferability of results from one location to another. It is here that the development of more comprehensive predictive models can help in unravelling the different factors which lead to a particular result, and in generalising from a particular experience. Indeed, these problems are challenges for those involved in survey design, rather than reasons for abandoning the task. Taken together they suggest the need for a carefully designed blueprint for the conduct of such studies and for the resources to enable surveys to be carried out when suitable opportunities arise.

These developments in transport management research require, of course, close co-operation with those involved in the practice of transport planning, both to enable us to be aware of impending changes which may present worthwhile opportunities for study, and to ensure that we are attempting to answer those questions on the effects of transport management which are uppermost in decision-makers' minds. They do also suggest a change in approach for those responsible for transport policy and the need for a greater willingness to experiment with transport management measures, to monitor them carefully - or to enable others to do so - and to disseminate their results. Experiments of this kind inevitably involve risks of adverse effects, but these risks need to be kept in proportion. Any adverse effects are unlikely to be prolonged, because transport management measures can normally be easily modified or, if necessary, abandoned and any abortive costs are likely to be small.

Thus transport management measures, in trying to break existing travelling habits, also require both transport analyst and practitioner to break theirs - by developing new methods of analysis, by responding more rapidly to opportunities to learn from changes around them, and by being prepared to experiment and learn from both successes and failures. Only in this way will we discover whether transport management is able to produce the benefits which its proponents promise.

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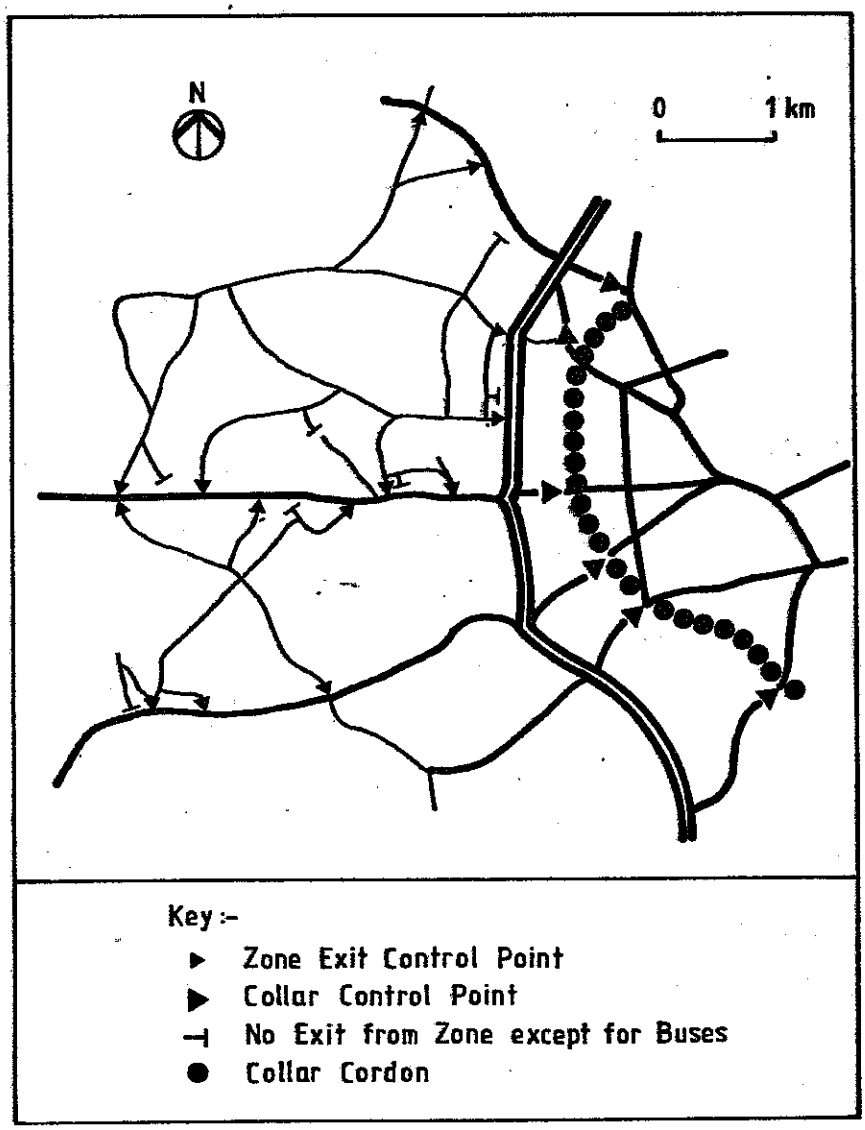


Figure 2. Nottingham Zones and Collar Scheme