ACTIVITY-TRAVEL ANALYSIS: A REVIEW OF THEORETICAL ORIGINS, RECENT DEVELOPMENTS AND LOCAL APPLICATION

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1. INTRODUCTION

A review of the international literature on travel analysis reveals a number of methodological streams. These include: aggregate methods (1950s-60s); land use-transport interactive and disaggregate methods (1970s); dynamic and micro-simulation methods (1980s); and strategic policy appraisal and activity-based methods (1980s-90s). A further review of the national literature on travel analysis reveals that while activity-based methods are a major focus of academic research internationally, they have received comparatively little attention locally. The purpose of this paper is therefore to provide an overview of this methodological stream for local practitioners for whom it may be unfamiliar. It is hoped that the paper, together with its references and selected bibliography, will provide a useful resource for anyone wishing to explore the stream further. Local practitioners who have followed international developments in activity-based methods will no doubt find the brevity of this paper unsatisfying.

The paper is divided into three main sections. The first identifies the theoretical origins of activity-based travel analysis. The second discusses the motivation for, and emergence of, activity-based travel surveys and forecasting models. The third concludes with a discussion on the experience of, and prospects for, the application of activity-based methods in South Africa.

2. THE THEORETICAL ORIGINS OF ACTIVITY-BASED TRAVEL ANALYSIS

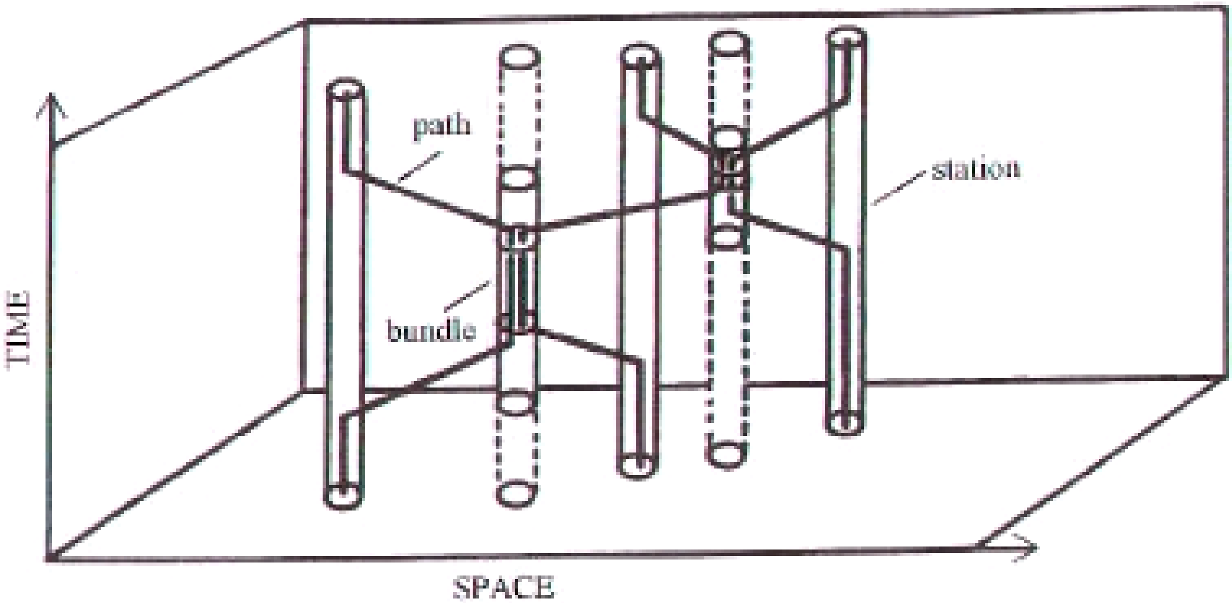
Earlier methodological streams drew behavioural theories and modelling techniques from a variety of fields. Aggregate methods for instance drew from physics and economics in the development of (gravity theory-based) models of trip distribution and (equilibrium theory-based) models of network assignment, while the later disaggregate methods drew from micro-economics and psychology in the development of (utility maximisation and random utility theory-based) models of mode choice. As will be illustrated later in this paper, activity-based methods have continued to draw from other fields, particularly micro-economics and psychology. What makes these methods distinct from earlier methodological streams however, is that their theoretical roots lie *primarily* in 'time geography'. Time geography emerged out of research undertaken in the late 1960s and 1970s, by Torsten Hägerstrand and colleagues at Lund University.

Hägerstrand (1970) argued that in analysing only mass probabilistic behaviour, regional science -- a growing field within the social sciences at the time that specialised in the analysis of human behaviour in space using mathematical models -- was unable to engage with important questions of poverty and quality of life of the individual. Hence his seminal paper posed the question: 'what about people in regional science?'. Here he argued for an analysis of the micro-situation of the individual, as well as of what he referred to as the 'twilight zone between biography and aggregate statistics', where the life and identity of the individual was not lost in large-scale analyses of aggregate behaviour.

Hägerstrand and his colleagues argued that in order to analyse the micro-situation of the individual, *time* needed to be incorporated into space studies as a way of disaggregating aggregate population statistics. In the theoretical framework of time geography they developed, time and space were regarded as *resources*, and the primary determinants of the human experience were seen to be the *constraints* that restrict an individual's utilisation of these resources. Constraints took three forms. 'Capability constraints' referred to the physical and technological limitations of an individual. 'Coupling constraints' referred to the need for an individual to undertake certain activities at certain time-space locations, or 'stations', with other people -- which results in a 'bundling' of individuals' activities at specific stations (e.g. school classes). 'Authority constraints' referred to institutionally imposed restrictions and regulations (e.g. office or shopping hours) -- which result in a hierarchy of overlapping 'domains' in time-space within and beyond which an individual's access is controlled.

Two key analytical tools were developed by the Lund School to trace an individual's, or a group of individuals', utilisation of time and space resources, and the constraints that are imposed upon this. These included: 'time-space paths', and 'time-space prisms'. These are discussed below, and illustrated in figures 1 and 2.

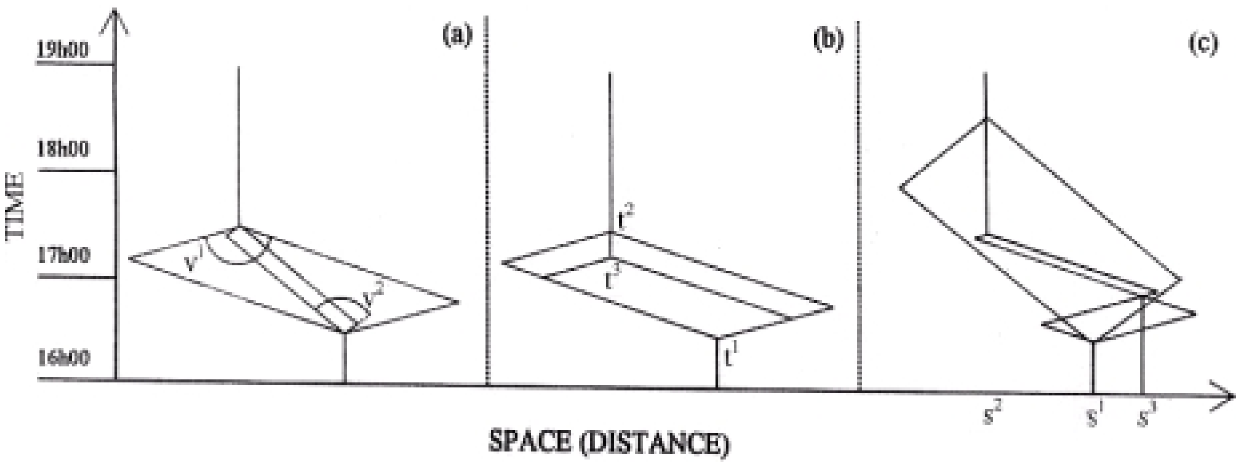
Figure 1: *Time-space paths, stations and bundles*



A time-space *path* referred essentially to an individual's activity schedule through time and space. An individual's possible location in space at one point in time was seen to be determined by his or her location in space at both preceding, and anticipated future, points in time. The paths of individuals were not seen to be isolated. As indicated above, they come into contact in the form of bundles, in accordance with the varying influence of the three types of constraints, and the positioning of 'stations' in time-space. A human population was therefore conceived of as forming a web of individual paths which flow through, and at times connect at, a set of time-space stations.

A time-space *prism* referred essentially to the ‘autonomy’ of individuals to determine their time-space paths. The above-mentioned constraints were seen to be central in defining the shapes and sizes of these prisms, and the paths that individuals took through them. The height of a prism was defined by the available time within which an individual could move from one spatially fixed activity to another, and make a discretionary trip(s) within this time as part of a trip chain. The width of a prism was defined by the distance that could be covered by the individual to discretionary trip destinations within the time available. The amount of time available and the speed of the travel mode used therefore places constraints on an individual’s time-space path. Time-space prisms enabled the collection of data on what people can and cannot do, rather than simply on what they chose to do (as in the case of revealed data collected in time use surveys). This was argued to be more instructive for the purposes of formulating policies aimed at the creation of an ‘isotropic plane of choice’, or ‘equitable urban environment’ -- the Swedish policy ideal at the time (Thrift 1977).

Figure 2: *Time-space prisms*



Note: Diagram (a) illustrates the effect maximum travel speed has on the width of a prism, where v^1 represents driving speed and v^2 cycling speed. Diagram (b) illustrates the effect time has on the height of a prism, where t^1 is the end of working hours (16h30), t^2 is the close of a child day-care centre (17h30), and t^3 is the adjusted close of the day-care centre (17h15). Diagram (c) illustrates the constraints placed on a parent leaving work (s^1) by car (v^1) and needing to draw cash from an automated telling machine (s^3) on the way to collecting his or her child from the day-care centre (s^2) before t^2. From (c) it can be seen that the parent has the choice of few if any discretionary s^3 trip destinations, and would only have the choice of undertaking the trip chain by bicycle (v^2) if the day-care centre extended its closing time to 18h30.

The earliest time geography applications were in Hägerstrand’s studies of population movements in Sweden, where the detailed population statistics kept since the mid-1700s allowed the movements of specific individuals to be followed over many years. An early computer model constructed using the time geography theoretical framework was the *Program for Evaluating the Set of Alternative Sample Paths* (PESASP), developed by Bo Lenntorp (1978). The inputs to this model were a synthetic population’s postulated daily activity agendas, a spatial configuration of activity stations, and a transportation system connecting these stations. The outputs of the model were a quantification of the number of possible ways, given capability, coupling and authority constraints, the given activity agendas could be scheduled in time and space. As will be illustrated later in this paper (in section 3.2.1), the basic modelling procedure developed in PESASP influenced those of the early activity-based travel forecasting models.

The time geography theoretical framework, and more specifically its techniques of empirical observation, proved to be influential in various spheres of the social sciences. In particular, time geographic techniques were used in the field of social theory, and the notion of constraint was adopted by analysts of travel behaviour in the field of transport planning. It is towards the latter that this paper now turns.

3. THE EMERGENCE OF ACTIVITY-BASED METHODS IN TRAVEL ANALYSIS

The emergence of activity-based travel analysis in the late-1970s and early-1980s marked what Eric Pas (1990) argues in his retrospection to be the only Kuhnian ‘paradigm shift’ in the evolution of the field. Pas argues that the shift from aggregate to disaggregate analytical methods that occurred in the 1970s was essentially a shift in statistical technique, rather than a shift in paradigm. The paradigm shift referred to involved, in essence, a redefinition of the phenomenon being analysed -- *activities*, and the demand for travel derived from participation in these, replaced *trips* as the new unit of observation.

With a limited number of exceptions, the earlier aggregate, disaggregate and land use-transport interactive methodological streams mentioned at the beginning of this paper had up until this point been based upon: the analysis of discrete trips; the analysis of choices in relation to discrete trips (using either deterministic or probabilistic methods, but remaining within the broad theoretical framework of utility maximisation); and the achievement of, or at least the assumption that cross-sectional data collected on trip-making behaviour were in, some form of equilibrium state. Critics argued that these hitherto trip-, choice- and equilibrium-based analytical methods did not explain travel behaviour and responses to transport system changes very well -- particularly behavioural phenomena like trip chaining, timing, suppression and inducement, and intra-personal variability over time. Earlier methods had been developed primarily for the long-term planning and design of road capacity improvements. The shift from supply-side to demand-side transport policies internationally, that began in the 1980s, and more particularly the emergence of shorter term travel demand management strategies, highlighted the limitations of these methods in estimating the impacts of alternatives to increased road capacity (e.g. peak spreading, ‘park-and-ride’, telecommuting, congestion pricing). Despite incremental improvements, it was argued that such methods remained fundamentally the same as those originally developed in the seminal transport studies of cities like Detroit and Chicago in the 1950s and 1960s.

That time geography offered a theoretical framework that could overcome some of the limitations of earlier methods, was first recognised in the late-1970s by studies funded by the (American) National Cooperative Highway Research Program and the then (British) Social Science Research Council. Two, at times closely interlinked, methodological streams emerged, or in the case of the former, gained prominence: dynamic methods that focused on longer term hysteresis, cohort and life-cycle patterns and changes in travel behaviour (e.g. the analysis of longitudinal data sets resulting from panel surveys); and activity-based methods that focused on shorter term daily, weekly or even monthly patterns and changes in travel behaviour. This section describes the development of analytical techniques within the latter stream.

Pioneering studies into activity-based methods were undertaken by Ian Heggie, and his colleagues Mike Clarke, Martin Dix and Peter Jones at the Transport Studies Unit (TSU), at Oxford University in the late-1970s and early-1980s (Clarke *et al* 1981). The work on activity-based methods in the 1980s focused mainly, but not exclusively, on *understanding* travel behaviour, and on new approaches to data collection and data analysis -- these are discussed in the first part of this section

(3.1). Most work on *predicting* travel behaviour, and on the development of activity-based travel forecasting models occurred later, in the 1990s, by which stage numerous other academic institutions in countries like the United States and The Netherlands had developed research capacity in the activity-based field as well -- these are discussed in the second part of this section (3.2).

3.1 The emergence of activity-based approaches to data collection and analysis

The emphasis in the activity-based approaches to data collection and analysis developed by the TSU, was on understanding the complexity and interrelatedness of travel patterns within households, and with the constraints that this interrelatedness placed on an individual's travel choices. In contrast to earlier methodological streams, as stated earlier, the emphasis was therefore not solely on travel, but on people's participation in activities and the connectedness among various activities. It was argued that it was not possible to understand how travel behaviour might respond to changes in the transport system, without a much deeper understanding of the everyday lives and activities within which travel decisions are embedded. The kind of data required in activity-based travel analysis therefore clearly necessitated more qualitative survey methodologies than had previously been employed in the form of inter-zonal origin-destination surveys, travel diaries or trip generation surveys. Data was collected in two main ways: activity-travel diaries; and in-depth interactive interviews.

3.1.1 *Activity-travel diaries*

Activity-travel diaries involve sample individuals and households keeping a temporal and spatial record of the activities they engage in, and of the trips they take in order to access these activities. The length of the diary usually varies from one to seven days, with the advantage of multi-day diaries clearly being that variability can be observed. The amount and nature of information collected varies considerably, according to the purposes of the survey in question. The diary sheets typically require information like the activity engaged in, locations, departure and arrival times, travel mode(s) and travel companions, which enable activity and travel patterns to be identified. They also require personal and household information like age, gender, employment status, child-care and housework responsibilities, possession of drivers licences, car availability and household income, which enable relationships between age, gender, income, life-cycle stage, etc. and household activity-travel patterns to be analysed. Studies that have compared the quality of travel data collected using conventional trip diaries and activity-travel dairies, have shown that trip recall -- particularly shorter trips and trips made by non-motorised modes -- tends to be higher in activity-travel diaries. This is generally attributed to the fact that in activity-travel diaries the respondent is required to account for his or her time continuously, and is therefore forced to recall past events more rigorously.

The data collected in activity-travel diaries have been analysed in various ways. A common form of analysis has been to assemble representative daily household time-space paths to illustrate interpersonal linkages and variability. Representative household time-space paths are typically established on the basis of analyses of the activity time budgets of household categories specified on the grounds of life-cycle, income, location or some other variable. Activity-travel data, analysed through these kinds of time-geographic techniques, have been applied in the investigation of various behavioural phenomena, including: trip chaining; inter-personal interactions in travel decisions; and intra-personal travel variability over time.

A well-documented example of an application of activity-travel diaries to data collection and analysis, is the study conducted by the TSU in Banbury, Oxfordshire. In this study, detailed seven day activity-travel diaries were collected from all the members of 196 households. Households were categorised into eight groups on the basis of their life-cycle stage. The dairies collected detailed information about the way in which household members spent their time over the seven day period. In addition, data was collected on the spatial and temporal environment in which the respondents assembled their activity schedules -- particularly the location and opening hours of potential activity stations, and the supply of transportation. This enabled opportunities for alternative activity schedules to be assessed. Among the main findings of the study was the importance of the, hitherto largely unrecognised, role of children in determining household travel behaviour. Children were found to be important, not necessarily because of their own travel needs, but because they significantly transform the activity patterns and travel constraints of the household as a whole.

3.1.2 *In-depth interactive interviews*

In-depth interactive interviews involve establishing very detailed activity schedules and travel patterns for a sample household, and asking household members how they would alter this if a change in the transport system, or in any other constraint on their daily activity schedule and travel behaviour, were to occur. In-depth interactive interviews therefore incorporate both revealed and stated preference interviewing techniques. They have been applied to investigate the probable impacts of a variety of changes in the temporal and transportation supply environment. For instance, in Adelaide they have been used to investigate the likely impacts of peak spreading measures, and in The Netherlands they have been used to investigate the likely effect of rescheduled bus services.

A well-documented example of an in-depth interactive interview technique is the *Household Activity-Travel Simulator* (HATS) developed by the TSU. In the HATS interview, the respondent is asked to plot his or her home activities, non-home activities and interlinking travel activities for the previous day, on a gameboard, using different coloured blocks. Having established the individual’s actual activity-travel behaviour for a particular day, the individual is then asked to rearrange this represented activity-travel pattern in response to a range of hypothetical temporal or transportation supply changes through rearranging the blocks. The revised individual activity-travel patterns are then quantified and analysed.

3.2 The emergence of activity-based approaches to travel demand forecasting

The results achieved by the activity-based methodological stream in the late-1970s and early-1980s came into criticism. Critics argued that activity-based methods had failed to uncover empirical regularities that could produce more reliable or accurate predictions of traffic flows on network links, than had been achieved using earlier aggregate or disaggregate four-stage models. Hence it was argued that they had not assisted in making better decisions regarding the planning and design of infrastructure improvements. Critics also argued that the underlying behavioural theory was weak. David Hartgen (1988) for instance, in his response to Ryuichi Kitamura’s (1988) fairly positive retrospective evaluation of the field, argued that without the link to capital improvements activity-based methods presented ‘perhaps insurmountable problems’, that its underlying theory was ‘trivial, almost pop sociology’, and that the largely empirical analyses had not produced much more than could be gleaned from ‘a few minutes of introspection about ones own personal life’.

Criticisms of the ‘triviality’ of the underlying theory were perhaps fair, if a little harsh, given the problematic behavioural assumptions embedded in the gravity, utility maximisation and equilibrium theories that underpinned conventional models. The time geographic theoretical framework could say a lot about how people arranged their lives in time and space to complete ‘projects’, but could say little about the societal relations that led to particular people undertaking particular kinds of projects in the first place. Criticisms of the failure to produce more accurate link flow predictions were however, in my view, misconstrued. These criticisms failed to recognise the aforementioned shift from supply-side to demand-side policies in the 1980s, within which the activity-based methods had, either explicitly or implicitly, emerged. They evaluated these methods from a supply-side, or 'predict-and-provide', policy perspective, in which the solution to transport problems was essentially seen to be increased infrastructure capacity. Hence a failure to produce information that assisted in the design of capacity improvements, was construed to be a major failure in the method. Nevertheless, in response to these criticisms, the 1990s saw a fairly rapid development of activity-based travel forecasting models that could provide more accurate link flow predictions, as well as the development of a more elaborate underlying theory.

The single defining feature of the activity-based travel forecasting models that emerged is perhaps that they attempt to predict travel behaviour by simulating changes in the daily 'activity schedules' of representative synthetic individuals, or households, in response to changes in the temporal, spatial and transportation environment. In the case of some models at least (e.g. SAMS [*Sequenced Activity Mobility Simulator*], TRANSIMS [*Transportation Analysis and Simulation System*]), the trips that result from activity schedules are then aggregated and used as the basis for network assignments -- thus providing link flow predictions. Most models however focus primarily on activity participation and scheduling.

Numerous approaches to activity schedule modelling have been developed, and it is not possible to describe a general model structure or theoretical framework in the same way it would if one were describing earlier four-stage models. Numerous authors have attempted to categorise the different modelling approaches, but most of these authors have ended up with quite different categorisations and labels. The literature is therefore at times quite confusing to anyone for whom mathematical modelling is not their core field of interest. For the purposes of this paper, the following broad categorisations offered by Theo Arentze *et al* (1997) are adopted: 'constraints-based' approaches; 'utility-based' approaches; 'rule-based' approaches; and 'hybrid' approaches.

3.2.1 *Constraints-based approaches*

The theoretical origins of constraint-based approaches to activity schedule modelling are rooted directly in time geography, with the PESASP model discussed earlier perhaps being the earliest example. Constraint-based models identify potential feasible activity schedules in time-space, given changes in capability, coupling and authority constraints. They measure the likely impact of time-space or transport system changes on the 'flexibility' of activity scheduling. The models' inputs take the form of an agenda of empirically derived activities of a certain duration, that need to be performed within particular time frames at particular locations. A 'combinational algorithm' is used to generate, and test the feasibility of, all possible activity schedules. The algorithm essentially rejects infeasible schedules in which sequential activities either overlap in time, or in the event of needing to occur at different locations, do not allow for sufficient travel time in between. An example of a constraints-based model within the transport planning literature is CARLA (*Combinational Algorithm for Rescheduling Lists of Activities*), developed by the TSU. This model has been applied to investigate, amongst other things, the likely consequence of implementing reduced bus services in The Netherlands.

3.2.2 *Utility-based approaches*

The theoretical origins of utility-based approaches to activity schedule modelling lie in micro-economics and its principles of utility-maximising behaviour. Utility-based models extend constraints-based models by adding an actual choice prediction to the generation of feasible activity schedules. The prediction of actual scheduling choices made it possible to link these models, and their associated aggregated trip patterns, to models that assign trips to a network. Utility-based models use disaggregate modelling procedures, originally developed in the context of a discrete trip-and choice-based framework, to predict activity schedules. Thus multinomial logit models are used to predict an *individual's* choice from a set of possible complete daily activity schedules, or alternatively, nested logit models are used to predict choices at various stages in the activity scheduling process. In both instances, the choice of an activity schedule is predicted on the basis of that option from which the individual is likely to derive maximum utility -- although, typically, predictions are made within a satisficing, as opposed to optimising, framework. The models thus assume that an individual's search for a better option, in response to some environmental change, is abandoned once a satisfactory (as opposed to optimal) option is found. Some utility-based models have recently been extended to predict the choice of a *household* activity schedule, while accommodating the inter-related time-space paths of individual household members with given activity agendas. An example of an utility-based model is STARCHILD (*Simulation of Travel/Activity Responses to Complex Household Interactive Logistic Decision*), developed by the Center for Activity Systems Analysis at the University of California, Irvine. This model has been applied to investigate, amongst other things, the impacts of variable work hours, and changes in network travel speed.

3.2.3 *Rule-based approaches*

The theoretical origins of rule-based approaches to activity schedule modelling lie in psychology. Rule-based models focus on the process of decision making, and the heuristics that this involves, rather than assuming an overriding behavioural theory such as utility maximisation. Individuals, within a household context, are assumed to make choices on the basis of their opinions and imperfect cognitions of their environment. These opinions and cognitions are understood to be constantly collected and updated through their interactions and experiences. The models use a set of empirically derived rules, or 'condition-action pairs', to simulate the formulation and execution of activity schedules. The rules attempt to capture the decision-making process of individuals by specifying the execution of a particular action when, or if, a particular condition is encountered. The result is a schedule of activities performed at specific locations, and the routes followed in travelling between these locations. Examples of rule-based models are SCHEDULER, developed at the University of Göteborg, and ALBATROSS (*A Learning Based Activity and Transportation Oriented Simulation System*), developed by the Urban Planning Group at the University of Technology, Eindhoven. SCHEDULER has been applied to predict the impact of telecommuting on commuter activity patterns.

3.2.4 *Hybrid approaches*

Hybrid approaches to activity schedule modelling draw from the theoretical frameworks and modelling techniques of various other approaches. An example is SMASH (*Simulation Model of Activity Scheduling Heuristics*), a model developed at the University of Technology, Eindhoven, which combines heuristic rule-based approaches and utility-based approaches in activity scheduling. Another example is AMOS (*Activity-Mobility Simulator*), a component of the SAMS model developed by Research Decision Consultants Inc. in San Francisco, which uses neural networks to derive the condition-action rules that drive the simulation of activity schedules. AMOS has been applied in the Washington (DC) area to assess the potential short-term response of commuters to 'transportation control measures' measures implemented in terms of federal clean air legislation.

4. THE EXPERIENCE OF, AND PROSPECTS FOR, THE APPLICATION OF ACTIVITY-BASED ANALYTICAL METHODS IN SOUTH AFRICA

What then has been the experience of activity-based analytical methods in South Africa? As early as 1982, in a review of procedural and methodological issues facing transportation planning in South Africa, Richard Brown and Bob Stanway recognised activity-based methods as a possible way of addressing common shortcomings in travel demand analysis. They noted however that activity-travel diary data would require highly sophisticated surveys, the feasibility of which, especially in less educated sectors of the population, would need to be established.

Most of the interest in activity-based methods in the 1980s was, however, displayed by researchers at the then National Institute for Transport and Road Research (NITRR). The first local application of activity-based data collection and analysis methods was undertaken in 1981 by Bill Cameron, Marina Lombard and Romano Del Mistro (1984), in their empirical study of activities, attitudes and trip-making in seven residential neighbourhoods in Pretoria, Johannesburg, Durban and Cape Town. In this study an activity-travel diary was used to collect the daily activity pattern of all the members of sample households, and a trip map was used to record the modes and routes used in making the trips associated with this activity pattern. Liz Fourie and Nesta Morris (1985) then, in 1984, applied a form of activity diary to analysing the effect of journey times on the daily activities of fifty shorter distance commuters travelling from Mamelodi, and of fifty longer distance commuters travelling from Bophuthatswana and Kwandebele. The sample was restricted to lower income workers employed by the same organisation located in eastern Pretoria, and to the previous working day. At the same time, Pat van der Reis (1985) undertook what was perhaps the most comprehensive local review of analytical techniques involving activity patterns and time budgets. In this review she recommended that the NITRR explore appropriate local forms of these techniques, and apply them to investigate, amongst other things: perceptions of time and the formation of activity patterns; the influence of household decisions and constraints on individual travel behaviour; and the consequences of long-distance commuting. Following on from some of these recommendations, a HATS kit was acquired from the TSU, and applied by Nesta Morris (1986) in a pilot study in Pretoria. As in her earlier work with Liz Fourie, the main objective of the pilot study was to investigate the impact of long-distance commuting on commuters' daily activity patterns. The study was limited to fourteen individuals living in Mabopane and Soshanguve, and to the previous working day. Despite encountering a number of problems in applying the technique, Morris concluded that such a study was feasible, and recommended that a larger commuter survey, as well as subsequent studies with other research objectives, be conducted.

Despite the apparent success of the studies undertaken by Cameron *et al* (1984) and Fourie and Morris (1985), and the recommendations made by van der Reis (1985) and Morris (1986) for further applications, no further studies using activity-based methods were conducted within the NITRR. This was presumably due mainly to the staff loss and commercialisation the NITRR experienced in the late-1980s. The interest in activity analysis and time use budgets did not die out completely however. In their retrospection on transport geography research in South Africa, Gordon Pirie and Meshack Khosa (1992) identify various geographers who continued to apply these research methods in the early 1990s to, amongst other things, gender issues and the impact of apartheid city forms on activity-travel patterns. Current research activities would appear however to be focusing solely on time (as opposed to activity patterns in time-space) -- the most notable of which is perhaps a national time-use survey presently being conducted by Statistics South Africa.

With regard to the prospects for activity-based methods in South Africa, authors that have reviewed trends and recommended future directions in travel analysis in the 1990s, have tended to ignore the activity-based methodological stream. Rather, the focus has tended to be on co-ordinating different geographical scales of analysis, and on adopting recent software developments within the four-stage modelling framework that offer more flexible and improved multi-modal assignment and graphics capabilities. An exception is a report authored by Andrew Shaw and Andries Naudé in 1996, in which activity-based methods are explicitly recognised as an important international trend. Echoing the critique of activity-based methods discussed earlier, Shaw and Naudé however argue that, whilst displaying promise as a possible 'academic lead' to future improvements, these methods have failed to significantly improve the reliability of travel forecasting models. They also point to the data intensity of these methods and the consequent difficulties in their application. The latter point perhaps reflects the sentiment that most local practitioners are likely to have regarding the use of the activity-based methods described in this paper. It is likely that the cost of activity-travel data, relative to those required by trip-based four-stage models, will be perceived as high, and perhaps unjustifiably so in the context of resource scarcity.

My own view is that, despite the costs and difficulties associated with obtaining qualitatively richer data (especially amongst illiterate households or in instances where language barriers exist between analysts and respondents), the application of activity-based methods offers an important, if not essential, means to improve analyses of travel behaviour in South Africa. The reasons for this are twofold: Firstly, recent policy documents indicate that the context which led to the development of activity-based methods internationally -- particularly the need to assess the likely behavioural impacts of transport demand management measures like peak spreading and congestion pricing -- has, at least at the level of transport policy discourse, begun to emerge in South Africa. Whereas the World Bank found in its reconnaissance mission to South Africa in 1991 that 'no urban transport policy statement addressed congestion and demand management', *Moving South Africa* addresses these issues directly. As transport authorities begin to introduce the 'tough' demand management measures envisioned in this strategy, and as the dominant analytical questions thus shift from 'what capacity should this facility have?' to 'what would happen to the use of this facility if ...?', it is likely that activity-based methods of assessing behavioural impacts will prove invaluable. Secondly, empirical studies that focus on *understanding* (as opposed to forecasting) the complexity, diversity and dynamism of travel behaviour are important in and of themselves. Commissioned empirical studies of travel behaviour in South Africa tend to be briefed to either gather the base data necessary for the calibration and validation of forecasting models, or if not directly related to a modelling exercise, to undertake regression analyses of trip-making behaviour for the purposes of developing trip generation rates. In many instances, due to the parameters of the forecasting exercises for which they are commissioned, these studies focus exclusively on discrete commuter trips within the peak period. As result, in my view, our overall understanding of the complexity, dynamism and diversity of travel behaviour in South Africa is limited. Without studies that attempt to extend our understanding of how people behave, and how their needs vary and change, erroneous propositions of needs and behaviour run the risk of being routinely entrenched in travel analyses. Activity-based methods of data collection and analysis provide a sophisticated framework within which to investigate behavioural complexity, diversity and (at least shorter term) dynamism. Household activity-travel diaries may be more expensive to collect and analyse than standard travel surveys, but they are potentially of greater multi-disciplinary interest. It is not difficult to imagine how data on time-space activity patterns would be useful to, amongst others, education, energy, gender and consumer analysts. It is possible therefore that the added expense of gathering more qualitative data could be shared across numerous commissioning agencies. It should also be noted that these more qualitative surveys are not necessarily intended to replace quantitative surveys, nor need they be conducted with equivalent sample sizes. Smaller, qualitative studies using activity-based methods need not therefore be prohibitively expensive.

An interesting development at the time of writing was a decision by the Greater Pretoria Metropolitan Council to adopt an activity-based approach to travel demand forecasting. Pilot studies to evaluate different activity-based modelling software systems are planned. The motivation for this shift was largely based on an observation in a recent commuter survey that a considerable portion of peak trips have either education purposes or are trip chains containing both work and non-work trip purposes. It would appear then that some transport planning authorities have recognised the advantages of activity-based methods in analysing such phenomena. The degree to which other authorities may follow suite remains to be seem.

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ACTIVITY-TRAVEL ANALYSIS: A REVIEW OF THEORETICAL ORIGINS, RECENT DEVELOPMENTS AND LOCAL APPLICATION

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