Working paper

A dynamic understanding of travel demand: A sketch

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Arbeitsbericht

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Kurzfassung

Dieser Aufsatz diskutiert zwei bisher von der Verkehrsverhaltensforschung vernachlässigte Gebiete: a) die Struktur der sozialen Netzwerke in ihrer Wechselwirkung mit den wesentlichen Mobilitätsentscheidungen der Verkehrsteilnehmer; und b) die Dynamik der Verkehrserzeugung von Tag - zu - Tag. Als Hintergrund skizziert die wirtschaftliche Entwicklung der letzten 50 Jahre, die die beobachteten Veränderungen im Verhalten ja erst ermöglich hat.

Die Diskussion bleibt konzeptionell, da die notwendige Empirie bisher fehlt. Die Argumente des Aufsatzes legen nahe, dass die Veränderungen in der räumlichen Verteilung der sozialen Netz zusammen mit der Zersiedlung die wesentlichen Kräfte hinter dem beobachteten Anwachsen der Kilometerleistungen waren und bleiben werden. Die Verkehrserzeugung in dem vorgeschlagenen theoretischen Rahmen ist das Erzeugnis eines rhythmischen Bedürfnisaufbau und seiner Befriedigung durch Aktivitäten und längerfristige Projekte.

Schlagworte

Verkehrsverhalten, Dynamik, Soziale Netze, Nachfrage, ETH Zürich; Institut für Verkehrsplanung und Transportsysteme (IVT)

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A dynamic understanding of travel demand: A sketch

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Abstract

This paper highlights two under-researched areas in transport planning: a) the structure of travellers' social networks in connection with their basic mobility choices; and b) the day-to-day dynamics of activity generation. This discussion is set against the background of overall economic changes during the last 50 years, which have funded the behavioural changes observed.

The discussion is conceptual, as there is not enough empirical evidence available to conclusively demonstrate the trends identified . The paper argues that the spatial dispersion of the social networks in combination with the residential location choices were, and will be, the main factor in the observed increases in miles travelled. The conceptual framework for the day-to-day dynamics is based on the rhythmic patterns of need accumulation and their satisfaction through activities and long-term projects.

Keywords

Travel behaviour, dynamics, social networks, activity generation, travel demand, ETH Zurich, Institute of Transport Planning and Systems

Preferred citation style

1 Averages and dynamics

Transport planning claims to understand the dynamics of the systems it analyses: transport infrastructures and travel behaviour. A closer look reveals that certain dynamics are well understood, others less so, some not at all. The reasons for these partial understandings are the previous and current professional tasks of the discipline and the preferred modelling tools. Understanding the systems as being in equilibrium is not a motivation to search for change (See also Manski, Forthcoming). No one doubts the usefulness of the mathematical tools provided by the equilibrium concept, but the differences between two different equilibria do not necessarily tell the analyst anything about the path of the implied system and behavioural changes.

In this paper, we cannot set out a theory for everything; we cannot even provide a description of every substantial dynamic process in the transport system. We want to highlight two specific areas against the background of the overall economic change of the last 100 years. The paper is speculative, despite of using figures at various stages in its argument. It has to be speculative, as there is little empirical base on which to draw for the two main issues it wants to address: a) changes in the spatial distributions of social networks and b) intrapersonal dynamics of daily travel behaviour.

Transport planning details behaviour during particular times and in specific locations. It uses the parameters estimated from these to forecast changes which may occur with new structures of generalised costs, new population levels and distributions, and activity opportunities. Notions of constant time budgets and money budgets, as well as constant tastes, help to justify this approach (Zahavi, 1979; Becker, 1976). While constant interpersonal time budgets have been reported in the literature, money budget shares have not been constant over the last 50 or 100 years. (see below), which raises doubts about the approach. In addition, even 25 years after Zahavi's work, no credible mechanism has been suggested to explain the observed stabilities in average travel times over the years. These stabilities are surprising given the overall change in social and economic conditions .

In the first part of the paper, we will inform readers about the scale of those changes mentioned above by highlighting a small number of key developments. In the second part, we will discuss likely impacts of the anticipated further changes on the physical distribution of travellers' social networks. Finally, in the third part, we will outline a framework for the daily dynamics of travel behaviour which translate these bigger changes into daily practise.

2   A brief look back

The key development of the last 100 years is the translation of the accumulated differences between productivity and population growth (See Figure 1) into mass consumption. Key sectors in this process were housing and travel demand. In housing, the trend to smaller households combined with the use of cheaper suburban land made, for example, about 50m^2 available for each Swiss by 2000[1]; an increase of 66% since 1950 (Rumley, 1984).

Figure 1   Western European productivity and population growth rates since 1000
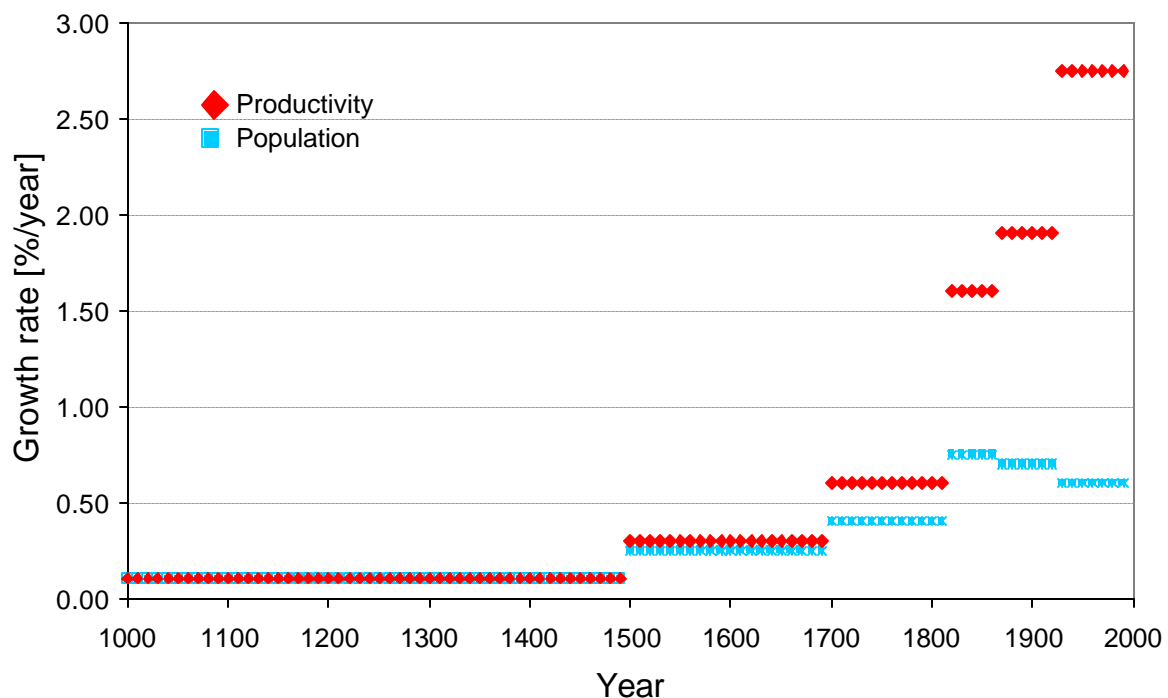
Source: adopted from Galor and Weil (2000)

In terms of travel demand, the Swiss, like most other populations of the OECD area, have achieved almost complete motorisation, defined here as (almost) universal licence ownership and (almost) universal car availability of licence holders. Figure 2 shows that women raised during and directly after World War II will be the last group to be excluded from this. A share of non-licence holders will remain, but very few out of a reasoned voluntary stance. The

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[1] The numbers for Germany are substantially lower: 41 m^2/person in 1998 (Statistisches Bundesamt, 2000) and substantially higher for US metropolitan areas: 59 m^2/person for blacks and 73 m^2/person for whites (Kahn, 2001)

licence has become too much of a badge of adulthood to be ignored. Car availability among licence holders is impressive for all age groups. It is clear that certain younger age segments (to some extent) do not have the resources, which delays the universal access[2]. Virtually everyone has access to the parallel technology, telephony. Its process of adoption started earlier than that of the car, ran parallel with it for most of the post-war period and is now in a new phase, during which households are slowly starting to replace the joint household land-line access with mobile phones for each member.

The access has been translated into use, and the associated speed gains translated – in the main - into longer distances (Figure 3 and Figure 4). The discussion about the translation rate is still inconclusive, but the majority opinion suggests a value of 1.0, i.e. a constant travel time budget (e.g. Schäfer, 2000). The pattern is consistent with the on-going process of residential dispersion visible in all OECD countries.

Figure 2   Access to motorised travel in Switzerland by age

Adults with a driving licence   Car access of driving licence holders
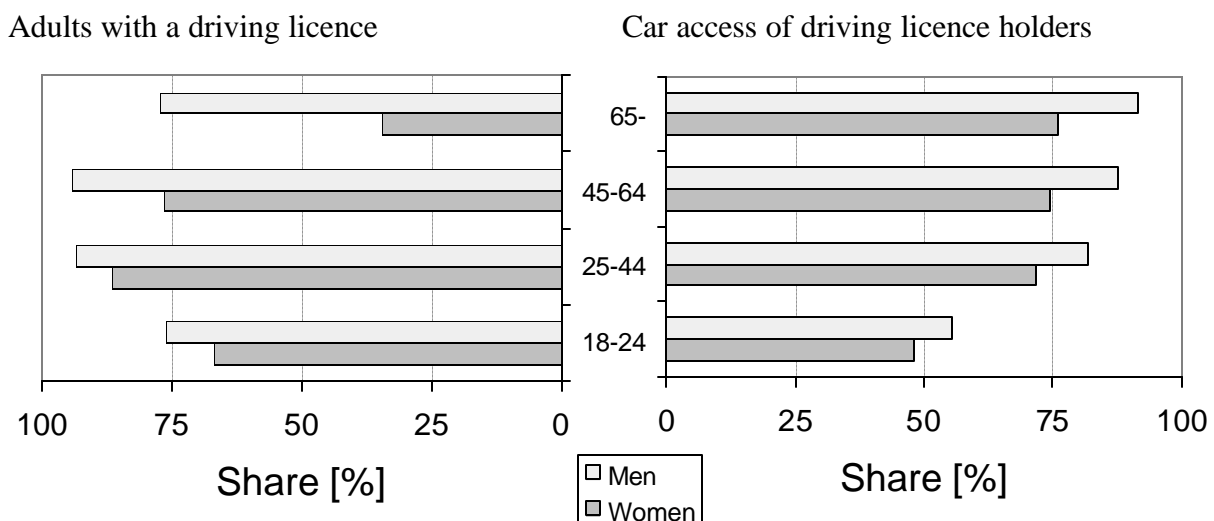
Data source: Mikrozensus Verkehr 2000 (ARE and BfS ; 2001)
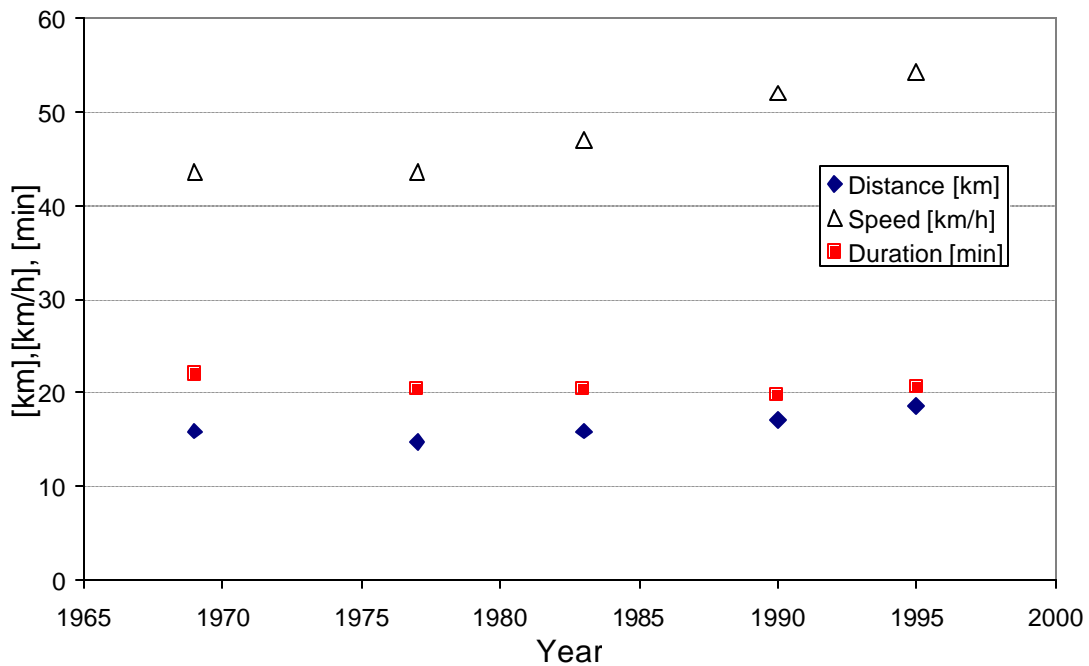
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[2] The population of licence holders without access would be an interesting subject of in-depth study.

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Figure 3   France: Estimated daily personal travel [km/day]
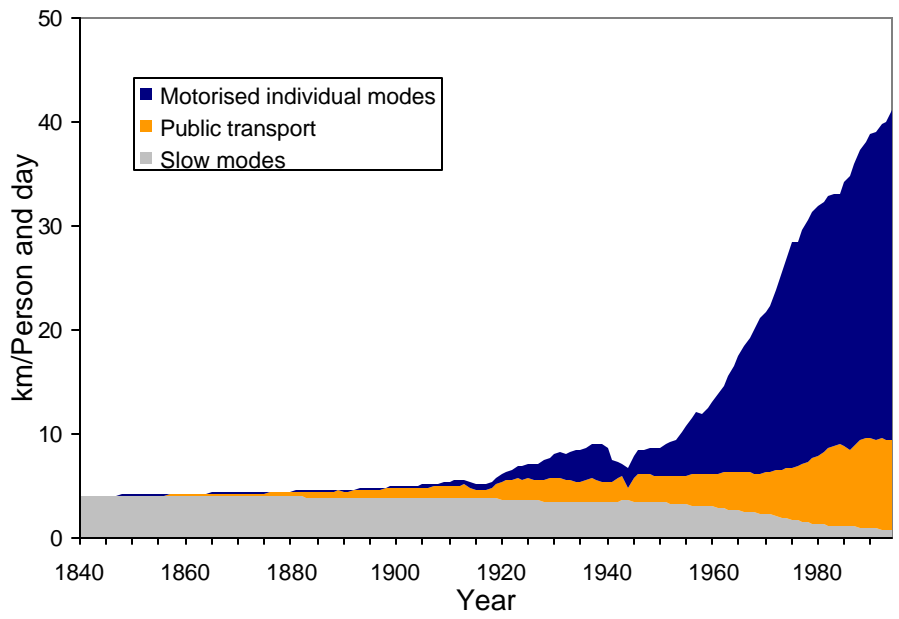
Source: adopted from Gruber (1998)

Figure 4   USA: Development of daily commute

Source: http://www.publicpurpose.com/ut-6995commute.htm using US NTSurvey data

These increases in housing consumption, distances travelled and telephone contact have led to a rearrangement of increasing household budgets (Figure 5). Expenditure for food dropped massively as a result of industrialised retailing and agriculture, while the shares for leisure, education, travel, and communication (respectively) have approximately doubled since 1913, for example in Switzerland. The larger shares for leisure and education reflect the longer life expectancy in Western Europe, the longer time spent in school, the shorter work week and longer retirement. The adoption of the car is the main reason for the increase in the share for travel and communication.

The motorised, connected, and spatially dispersed population of today with its access to cheap travel must have different patterns of work and sociability than the population of 100 or even 50 years ago. The next section will discuss one element of this change: likely changes in spatial structures of the overall populations' social networks.

Figure 5   Switzerland: Shift in household consumption patterns
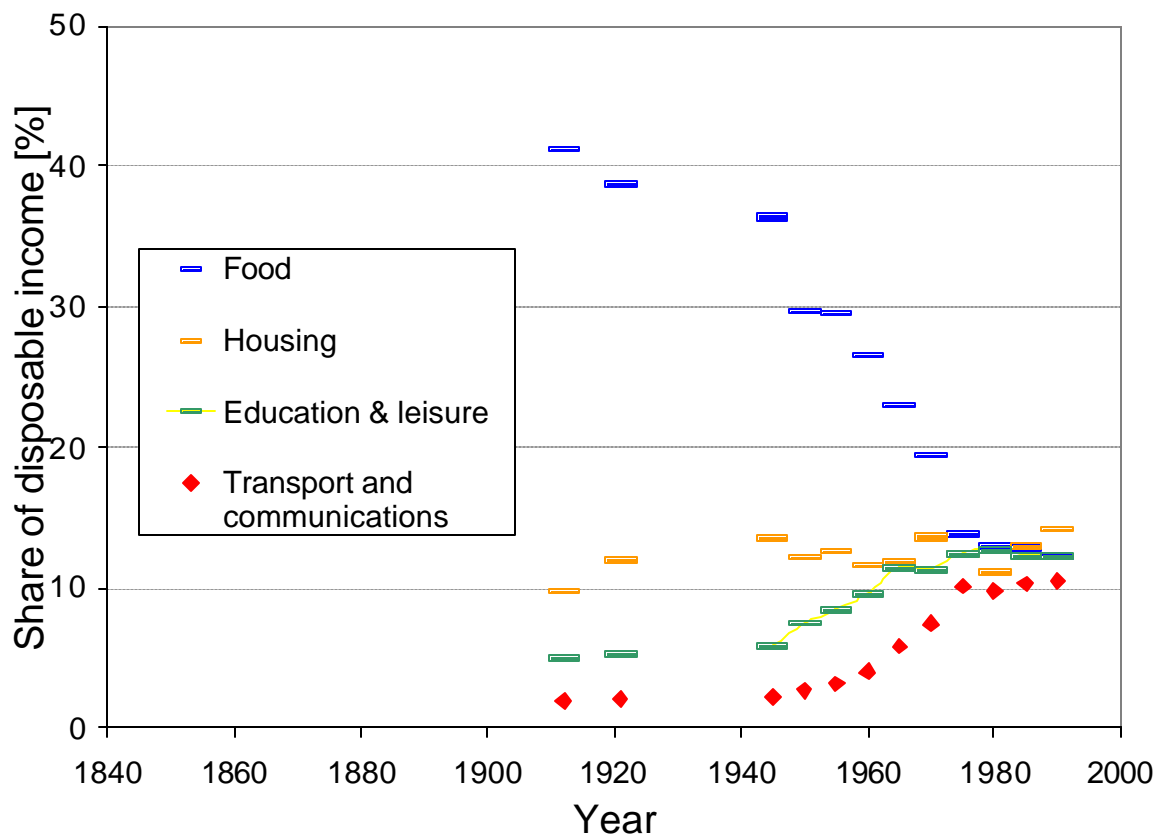
Source: adopted from Widmer (2001), 19

3   Activity space and social space

Daily life revolves around friends, family, work, school, and shopping (See for example Wellmann, 1996 and his website[3], or Törnqvist, 1970 and Burt, 2000 for similar work on the contact systems of firms). The distribution in space of these commitments/opportunities shapes the activity space of a person in his or her everyday environment. The size of this activity space determines a person's consumption of transport services, obviously including those are produced by the person walking or driving. If we accept this idea, then increasing distances between those poles of a person's activity system has long reaching and permanent effects: a dynamic which cannot be reversed quickly, given the investments people make into their work, their family, and friendships.

Wellman (2000, 2001) and Hampton and Wellman (2001) argue that society has been transformed from something based on *little boxes* to a network society;. This could be defined as a change from a situation where a person's social networks were strongly overlapping and spatially coherent to a situation where the membership overlap will be small and the members spatially dispersed. The reasons behind this are the breakdown of the walking environments dominant before the car and the associated weakening of the closed social milieus of yesterday: We do not live next door to our work colleagues anymore, our aunt does not serve us in the corner store, nor is the foreman/union steward/local councillor godfather to our children[4].

3.1   Structure of social networks

Wellman (1996) provides some information about the distances between network members' residences based on an earlier Toronto survey. He highlights the large number of contacts living relatively close by or working with the respondents, but mentions that these are not necessarily the emotionally/socially important contacts, except – obviously - those in the respondents' households. Unfortunately, his work has no time dimension so that no trends can be identified. Still, based on the general spatial trends one can assume the following:

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[3] See www.chass.utoronto.ca/~wellman

[4] It should be noted that this spatial density of the social networks never applied to aristocratic or later intellectual families.

- The spatial distribution of social networks' members will be wider than in the past, i.e. the average distances between the home locations will have grown

- Average social networks will be less coherent, i.e. fewer people will share multiple affiliations today than in the past

- The memberships will also overlap less in spatial terms, i.e. vis-à-vis their residential locations and activity spaces[5]

In transport terms these trends and assumptions imply longer distances when people want to meet face-to-face. The current unwillingness to replace face-to-face contact might fade over time, but currently most analyst agree that such contact is required to build up the trust required for on-going, productive relationships, in both private and work domains (Sobel, 2002).

Distance is the first perspective from a transport point of view, but frequency the second. Again, the literature is silent on this question, but one can argue for the following assumptions:

- People have a larger set of active contacts today than in the past, e.g. 50 years ago.

- The contacts are spread across more social networks than in the past.

- The maintenance of each contact requires more effort at the same level of quality than in the past.

Maintaining contact requires time and effort. One needs time to inform the other, to learn about the other, and to readjust to the other and his/her changed circumstances and contexts. Modern telecommunication and travel have become substantially cheaper, which reduces the generalised cost of personal contact (See Figure 6 for a transport example). In addition, cheap ways exist today to duplicate messages, e.g. xeroxed Christmas letters or email mailing lists. While these do not have the same quality as a handwritten letter as a token of interest in the other, they are a sign of life, and help the other side to stay informed. Still, the effort of maintaining the contact lies nearly exclusively with the person him (her)self, as less dense social networks might not convey information as reliably as in the past: the grapevine on which a

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[5] Current telecommunication technologies allow in particular the maintenance of contacts with friends and acquaintances from non-local earlier residential locations, who might have no overlap at all with the local social networks of a person.

wide range of information and assessments travelled has withered to an unknown extent[6,7]. Also, the opportunity for chance encounters is smaller when the overlap of the activity spaces of the network members becomes smaller. The on average reduced amount of overlap in contexts and social networks should increase the amount of information needed to be conveyed for each party to understand the other's position and situation on each renewal of contact.

Figure 6   Example for the change in the generalized cost of travel: Zürich – New York
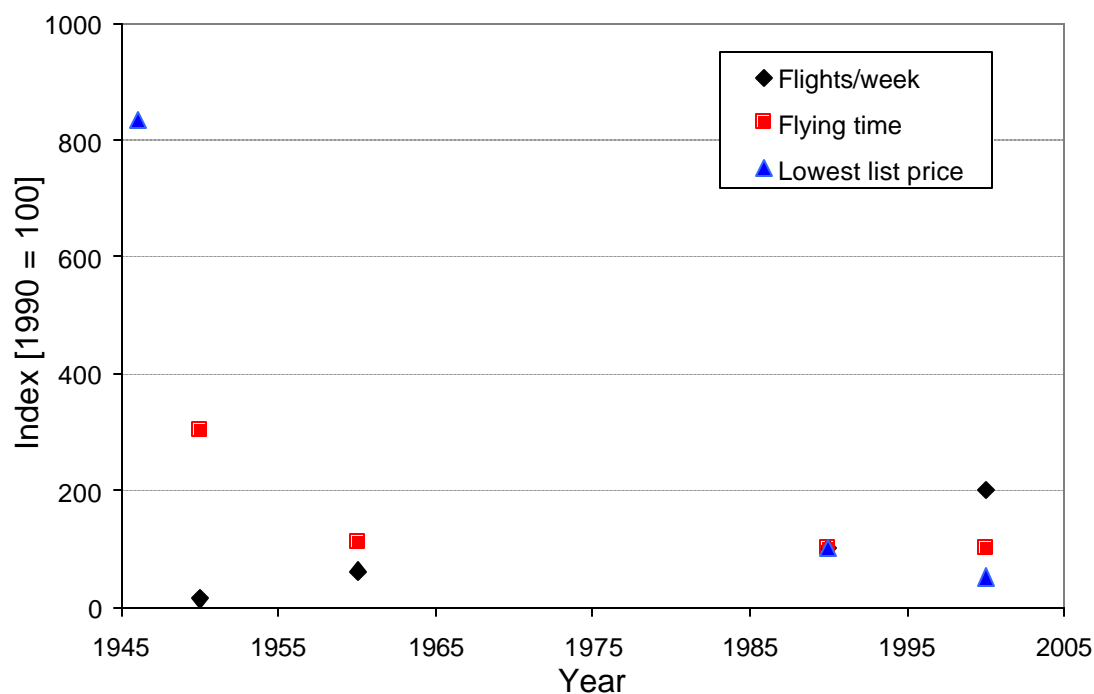
Source: adapted from Widmer (2002)

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[6] Commercially distributed gossip about the rich and famous, on the other hand, has increased by orders of magnitude.

[7] The role of the internet as a supplier of personal information and particular of assessment of reputations is still unclear, although the experiences with cumulative ratings of sellers on web-based auction sites are an interesting indication of future possibilites.

[8] The weighted sums of the monetary costs, the time taken and the comfort of the trip or contact. In the case of telecommunication this includes: direct and fixed charges; search time for the other person; quality of connection and its bandwidth; for the complementarity between travel and telecommunication see Claisse and Rowe, 1993.

The developments described above could offset each other; thus, no clear trend can be postulated for the distribution of the contact frequencies among the members of a social network. The reduction of the generalised costs of travel and telecommunications[9] speak for more contacts overall, and relatively more contacts with persons further away, as long distance travel and communication had a steeper drop in their generalised costs than local travel and telecommunication. The increase in the required total duration of the direct contacts (face-to-face, personal email, telephone conversation) implies a concentration on fewer people than in the past combined with more superficial contacts with a larger number of people overall.

Given the acknowledged trend away from strongly localised social networks , the two arguments indicate that the activity space of an average person should be larger now than in the past. It is necessary to point out that this activity space consists of two elements: the local activity space[10] and the non-local contact space. The characteristics of each can be chosen by individualsdepending on their preferences/habits. Examples might include: the owner of a platinum frequent-flyer card who walks to everything locally, the suburban car-owning couple, who travel regularly to their weekend home in the region, or the cyclist who visits her partner 400 km away every weekend by train.

The further dynamics of these trends are difficult to forecast. The passing of the cohorts born before World War II means that the full motorisation will soon be the rule in Europe, as it already is in North America: licence ownership rates of 85-90% combined with car access rates of licence owners of around 80-90% (See Figure 2 above for an example). This will increase car-based travel further, but the relative contribution to social totals will be small, as the big growth spurt due to initial motorisation is past in the already industrialised countries. The size of the impact will depend on further rate of suburbanisation, i.e. the development of the average speeds of motorised travel. While this means normally car based-travel, regional rail-systems can have substantial impacts as well. In addition, high-speed rail systems can act as super-regional "stopping trains", if the price system favours commuting use.

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[9] The weighted sums of the monetary costs, the time taken and the comfort of the trip or contact. In the case of telecommunication this includes: direct and fixed charges; search time for the other person; quality of connection and its bandwidth; for the complementarity between travel and telecommunication see Claisse and Rowe, 1993.

[10] The local activity space will be duplicated for persons and groups which follow a regime of season migration, a practise which has always been important (See Grieco, 1988 and 1996 or Weber, 1976 for European exam-ples.
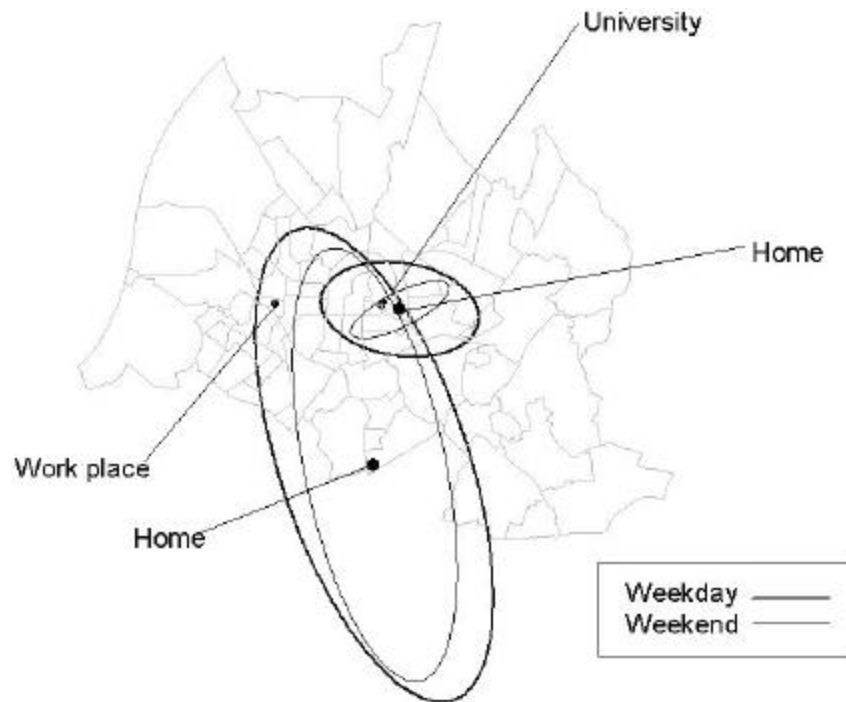
3.2   Activity spaces

There is an increasing amount of literature, which highlights the importance of lifestyle patterns for the structure of a people's travel behaviour (e.g. Götz, Jahn und Schultz, 1998). Central to the spatial definition of a lifestyle is the combination (Simma and Axhausen, 2001; Axhausen, Scoot, König and Jürgens, 2001) of

- Work/school location
- Housing location and the style of neighbourhood
- Mobility tool ownership (bicycle ownership, car ownership/access, public transport season ticket)

 shows the impact of the last three factors on the size of the activity space. The measure of the activity space is very crude (two-dimensional 95% confidence intervals of the geo references of all locations visited during the six-week diary period, see examples in Figure 7; for the Mobidrive data source see Axhausen, Zimmermann, Schönfelder, Rindsfüser and Haupt, 2002), but it indicates a trend.

Figure 7   Two example local activity spaces (Measured as 95% confidence intervals of all locations visited during a six-week diary)

Source: Schönfelder and Axhausen (2001)

Figure 8   Variation of the size of the activity space by home location, car and public transport season ticket ownership
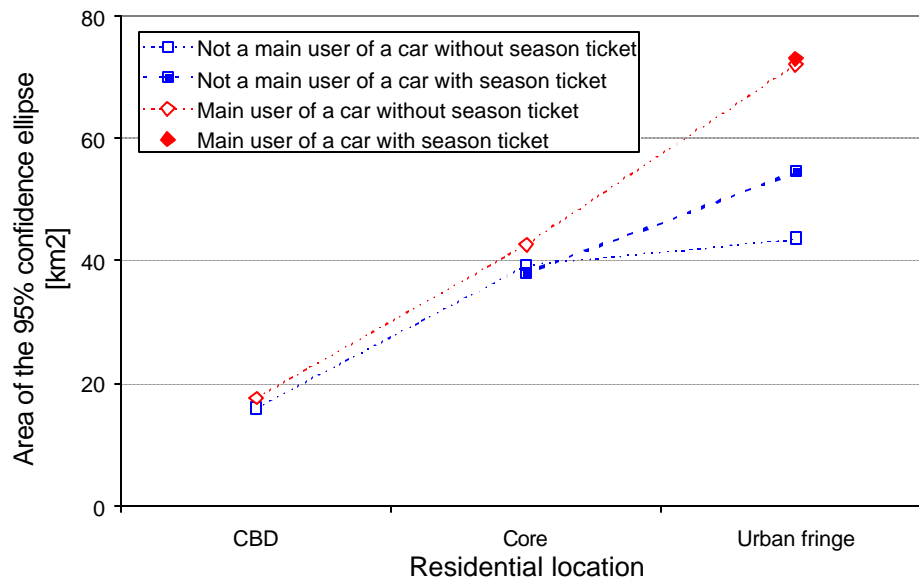
Source: Axhausen, Scott, König and Jürgens (2001)

There is currently no data allowing us to trace the development in the sizes of the activity and contact spaces of the public. As discussed above, motorisation, suburbanisation, and the network society should have increased it substantially over the last 50 years, but we have no idea whether it will continue to grow and, if so, how quickly. Has airline deregulation since 1980 and the vigorous competition in the telecommunication markets since 1990 given its growth a new push ? We do not know, but we should, as these trends have substantial social externalities.

We cannot review this topic here, but it is clear that the current patterns of sociability leave many people worried (see Putnam, 2000[11]; Sobel, 2002; Franzen, 2000 or for a selective review Axhausen, 2000). Does the stronger selectivity[12] of social networks today improve the quality of life? Does reduced local networking lead to more reliance on commercial/government services in times of crises, such as acute illness, or permanent care? Is less generalised trust (see Seligman, 2000 for a discussion) a corollary of less dense local net-

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[11] Putnam's focus on the decrease in organised sociability misses the range of informal, but still regular contact patterns, which might have taken up the time freed up .

[12] The ability to select one's social contacts given the spatial range the car makes available to most households.

works? (E.g. the pervasive feelings of a lack of safety reported by many urban and suburban residents.)

3.3   Research issues

Home, work, mobility tool ownership, and social network membership interact and depend on each other. The further trajectory of these interactions will, to a large extent, determine the shape of personal travel in the future. Unfortunately, the current focus of travel behaviour research is on daily travel behaviour with little attention given to longer-term commitments of people and households. Some effort should therefore be redirected to the following types of studies:

- **Mobility biographies**[13]: documenting changes in home and school/work location plus changes in mobility tool ownership against the background of personal/household development (household structure, income, shopping preferences); for a partial example see Roorda, 1998.

- **Biographies of network involvement**: qualitative/quantitative description of the number, type, and size of the network memberships over time; possibly including attempts to localise past and current members geographically.

- **Spatial patterns of social life**: Quantitative studies of the use of different locations for different purposes and for contacts with different people/members of the person's social networks. If possible, a snowball mechanism should be used to capture all members of a social network.

The first two are needed to reconstruct, (at least to attempt to reconstruct) the changes of the last 50 years, while the third is needed for on-going monitoring of further developments. These are expected to be dramatic due to the expected market penetration of the internet, anticipated further withdrawal from public space (e.g. use of malls or gated residential areas), further decreases in the cost of long-distance travel, projected increases in second and third residences, extrapolated increases in residential mobility or, alternatively, long-distance commuting (weekend-commuting)[14].

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[13] It would be helpful, if travel diaries would routinely capture all these elements in cross-section, for example season ticket ownership is frequently missing, as is information about exact locations of work, school, home , and regular shopping.

[14] To my best knowledge, the growing acceptance of weekly long-distance commuting in place of a residential move has not been documented in the transport literature. Long-distance commuting also raises the issue of divided activity spaces and activity repertoires.

4 Day-to-day dynamics

Just as it has generally ignored the biographical dimension of travel behaviour, transport planning methodology has also, as a rule, ignored the day-to-day dynamics of traveller behaviour at the individual level. There were good reasons for an engineering subject, such as transport planning, to limit its field of enquiry to what was perceived to be necessary to address the questions at hand (Weiner, 1988). However, this does not really excuse the lack of curiosity obvious in the larger-than-required gaps in data availability and theoretical understanding of this issue. It was only the interest in transport telematics, which has put the questions of day-to-day variability on the table during the last decade, that it became clear that learning and short-term behavioural change are crucial to the assessment of the business and economic case for this bundle of technologies.

4.1 Conceptual framework

The conceptual framework suggested below can therefore only be a sketch, as substantial issues have not yet been covered by empirical work. They will be flagged below. The building blocks are the following concepts (See also Axhausen, 1998):

- **action stream**, **activity**, and **activity calendar** to describe the structure of the actions in the short term.
- **activity space** and **knowledge space** to structure the **mental mapp**ing of the environment.
- **activity repertoire, needs**, **projects**, **commitments** and **self image** to characterise the medium and long-term.

Respondents, usually narrators, will generally report daily life at a level of abstraction transport planers and time use researchers call **activities** (Szalai, 1972; Ås, 1978; Grønmo and Harvey, 1982; Jones, Dix, Clarke and Heggi, 1983): They refer to a group of actions, which can be understood as a coherent whole: supervising the children, going shopping, working etc. The detailed **action stream** of the individual acts in all its normally confusing chaos can be recalled by a respondent, but only with great effort; chaos, as the performance of multiple activities is often intertwined, especially away from a structured work environment. The individual acts of the action stream can be named and described, but they make full sense only as part of the larger activity. For example, a phone call is part of organising an event, chopping the carrots contributes to the soup being prepared, and removing a weed readies a garden for the summer.

Activities have both purpose and meaning: purpose identifying the instrumental goal of the activity and the meaning indicating the expressive goal (See Axhausen, 1998 or Hargreaves – Heap, 1989); immediate utility versus contribution towards self-realisation given a person's **self-image**. The **activity repertoire** is the set of activity types (specific actions streams at particular - types of - locations and times), which a person knows of, or has performed in the past. The size of the repertoire changes over time as it is enlarged through experimentation and learning or reduced through forgetting and diminished physical or mental capabilities.

At any one time, a person has a subset of these activity types flagged as desirable or necessary to do in his or her **activity calendar**. The calendar can include multiple instances of the same type scheduled for different days, e.g. work, picking up the children from school, going gro-cery shopping. This notion has been put forward by a number of authors (Nuttin, 1984; Do-herty, Axhausen, Gärling and Miller; 2002; Gärling, Kalén, Romanus, Selart and Vilhelmsson, 1998). The empirical work until now was based on prompted recall, which raises the question whether the respondents think about their daily life in this way. Doherty and Miller (2000), for example, asked their respondents to fill out an agenda for the next week with the activities they had already planned or committed themselves to. While the respon-dents had no problems with the task, the question remains, if this thinking in "agendas" is natural for all respondents (see, for example, the discussion in Kiel, Post and Dollase, 2000 on "time-planning" and "non-time-planning" persons).

The concept of the calendar, even without its psychological relevance completely proven, is appealing as the locus of the decision and optimisation task of daily activity scheduling. It is constantly refilled with   activities deriving from the **long-term commitments** of a person: school, work, child care, and care for others, and household work. The time requirements for the basic **personal needs** of sleep, eating, and personal care have to be integrated. The time requirements of these two types have to be balanced against the freely chosen ones deriving from **projects,** individually planned activities or spur-of-the-moment choices. A project is any group of activities, which have a joint goal. This can be as simple, as preparing dinner for friends or as complex as building a house. Depending on the complexity of a project, it will be divided into parts or sub-projects. The time horizon of a project varies, some lasting a day or two, others stretching over years. For very long-duration projects the concept starts to blend with the idea of *life goals* (Nuttin, 1984).

The calendar, as seen here, is the instrument which allows the person to schedule time and other resources to perform his or her plans. Activities will be added, modified and sometimes

removed before they are finally executed in a particular form.The variables describing the final form of activity are clear:

- Type of activity
- Location
- Timing
- Duration
- Size and composition of the company
- Money expenditure, physical resources used, social resources used[15]

The variables describing the logic of the scheduling and rescheduling are less clear, in spite of the recent work in the area (see Ettema, Borgers and Timmermans, 1995). Nor is there a clear understanding how the calendar is filled up, how much buffer time is provided, and how the "when and why" of any activity are decided.

Recent work using long-duration travel diaries has shown that there are strong temporal rhythms for certain types of activities. The trade-offs made between activities and their characteristics in detail are still unclear (Schönfelder and Axhausen, 2001; Winston, 1992). It is known that the basic physical needs of a person are driven by diurnal rhythms. These in turn will produce repeating patterns for those activities associated with satisfying those needs (shopping, returning to a place for sleep, etc.). The rhythmical patterns identified for activities satisfying higher level needs, such as personal leisure, time with friends, contributions to civic activities, imply that the behavioural dynamics of the medium term (week to year) are driven by processes of need accumulation and satisfaction. Longer-term projects can be understood to address even higher level needs or aspirations by organising complex series of activities. There is very little awareness in transport behaviour research about the number and type of projects in which people engage in at any time, or about the way they are formulated or selected.

While it is attractive for the analyst to believe that the calendar leads to something approaching an overall scheduling optimum for any time frame considered, e.g. a day or week, empirical work has not shown that this is the case. People leave substantial parts of the day unplanned to allow for both unreliability in the activity and transport system and for unexpected activity opportunities. These times will be filled at short notice, clearly with activities

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[15] From the perspective of this section, the two most important social resources are the time one has saved with others and the favours one can draw on to achieve particular objectives.

from the activity calendar, but without an overall optimisation across a longer time period. At this time, we have no idea if this scheduling strategy is optimal given the unreliability of the systems and the probabilities of chance occurrences. What is clear is the stress experienced by persons who live *overbooked* lives. This group is at the mercy of the reliability of the transport and communication systems, and they experience high rescheduling costs when they do want to take advantage of unforeseen opportunities.

The long-term diaries mentioned above also allow tracking of the **activity space** of a person; the area which the person uses for his or her activities. The analysis of the Mobidrive data allows only the understanding of the local part of the respondents' activity spaces. One has to add the non-local parts, which derive from visits to friends, excursions, holidays, and previous residential locations. Furthermore, the activity space is only a subset of the **knowledge space**, which covers all locations a person knows of through word of mouth, reading, advertising, or watching television or films.

In decision making, the main difference between the activity space and the remaining knowledge space is the trust level a person can have in his or her **mental mapping** of the generalised costs of those locations and activities. The generalised costs include the effort to get there (generalised costs of travel) and resources used for the activities. For those places and activities already visited, perhaps frequentlyvisited , the traveller can trust his or her own experiences; there is an understanding of the distribution of possible outcomes. Depending on his/her risk averseness, the traveller can compare alternatives reliably. For the rest of the knowledge space, the traveller has to rely on second-hand information, which has to be weighted by assessments of the reliability of the sources.

The updating process of the mental map for the various cost elements is essentially unknown. Most previous work assumed a priori learning mechanisms, but did not derive them from empirical data. For an exception and a detailed literature review see Oladeinde, 2000.

4.2   Research questions

The conceptual framework sketched above sees two main processes at work in the activity system: first, the rhythmic patterns of need build up and satisfaction over the short terms , and second, the pursuit of longer-term projects, which generally will be one-offs during a person's lifetime. . The way these will be formulated and realised depends, in the medium term, on the longer-term commitments discussed in the section above. Given the longer-term projects and

those resource allocations (home, work, car, season tickets) the person will select activities from his or her activity calendar which is constantly being refilled. The exact form of the activities will depend on the **personal world** of the traveller. mental map, activity repertoire, and knowledge space are three ways of seeing this personal world. The mental map focuses on spatial relations and the generalised costs of travel; the activity repertoire describes the kind and form of possible activities and their generalised costs and qualities; and knowledge space emphasises the possible locations of different types of activities.

The main research questions concern then the following issues:

-   **Activity calendar**: How is it being filled? How much unscheduled time do people retain until what point in time? How do people reschedule activities? How do they judge the quality of on-going activities?

-   **Updating of the personal world**: What does it take to change the mental maps? What mechanisms are used to integrate different sources of information? Do people actively attempt to enlarge their personal world? If so, how? How are general expectations formed?

-   **Projects**: Do people use the same concepts as the one suggested here? How do they select projects? What changes happen to projects and why? Under what circumstances are projects abandoned? What number do people pursue at any one time?

The answers to these research questions would allow us to get away from the simplistic notions of optimisation embedded in the current state of the art transport models (Ben-Akiva, Bowman and Gopinath, 1996). They would also allow us to avoid non-causal pattern recognitions approaches, as those suggested in the state-of-the-art Albatross system (Arentze and Timmermans, 2000).

5   Outlook

The paper has attempted to direct attention to two areas overlooked in previous transport behaviour research: spatial and social structure of travellers' social networks, and an understanding of day-to-day dynamics of travel. It has argued that an understanding of the first issue is crucial for the assessment of the further dynamics of overall transport consumption. For a given number of joint activities the locations of friends, family and colleagues decide the amount of miles travelled, especially for leisure.

The spatial distribution of the social network is tied in with the basic spatial/travel choices of a household (home, work and school locations bound together by the mobility tools owned).

These basic choices also frame the day-to-day dynamics of travel given the overall time-space regimes of society (Hägerstrand, 1970). In turn, the experiences of daily life will lead to reassessments of these choices and possible change.

The discussion of day-to-day dynamics has centred on the process of activity generation and its interaction with the personal world of the traveller. Long-term commitments, higher level needs, and projects generate activities, which are coordinated by travellers through their activity calendars.

This conceptual framework requires both empirical testing through observation and surveys and application testing with suitable micro simulation tools (For references see Nagel and Axhausen, 2001). The first test is required to determine whether the framework is valid as a description of the behavioural dynamics. The second test is necessary to prove that the framework offers a better way of forecasting and assessing transport policy.

6   Acknowledgements

7   Literature

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