European Passenger Travel Demand Analysis and Strategy Responsive Forecast

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INTRODUCTION

The paper reports of the first comprehensive attempt to analyse and forecast long distance passenger travel in Europe under different hypotheses of future transport supply development. It is based on the work which has been pursued in the OECD Programme on European Intercity Passenger Transport Requirements. The OECD, together with the ECMT and the EEC, had been asked by 12 European governments to carry out a prospective study, the objective of which was to assist Member Countries in the task of devising long-range strategies to meet the growing demand for passenger transport between metropolitan regions of Western Europe.

From this, five working objectives were derived:

- description and analysis of the intercity transport system;
- analysis of factors affecting future demand;
- analysis of possible new modes and improvements to existing services;
- formulation of possible, European transport strategies;
- examination of the possible consequences and impacts of alternative strategies on passengers, carriers and the community.

In the following, emphasis is put on the description of the characteristics of European passenger travel, the model formulation and calibration, and the simulation and forecast of travel.

OBJECTIVES OF THE FORECAST

The question to be answered was not: What will be the magnitude and structure of the European travel demand in 30 years from now? But rather: What could be the future demand under status quo conditions and how could the demand be affected by different transport policy measures intended to bring a change to the status quo development.

To study the consequences of possible future courses of action in transport policy, a strategy approach was adopted. A transport strategy is defined as the co-ordination of major decisions affecting the transport system in order to achieve long-term objectives. They are of transport internal nature, like shorter travel times and lower costs, or external nature, like regional planning or industrial policy, and may be conflicting. One main aim of strategy is undoubtedly to reduce the objectional characteristics of today's transport modes.

The strategy options, i.e. individual policies and programmes, which permit a choice of strategy fall into three broad categories:

- management, like pricing or regulation;
- infrastructure, like new facilities;
- research and development.

Too numerous are the possibilities of formulating options in a quantitative way and combining them to transport policy alternatives.

Four main strategies were chosen for study, based on four alternative philosophies towards the fundamental problem of how to deal with the growing demand for transport:

– *Status Quo Strategy:* The basic thesis underlying this strategy is that market demand must be met by providing sufficient capacity. This strategy was intended to represent a continuation of transport policies of the sixties. The growing demand is to be matched by new roads and airports.

– *Controlled Mode Strategy:* The hypothesis is, that the main problems are caused by excessive demand for car and air, and the solution must be found in attracting demand to a greatly improved rail system. This implies a rather modest road building programme and major service improvements, i.e. higher speeds, in the European intercity rail network. One variant of this strategy was the superposition of a very high speed rail network of new infrastructure to the existing network.

– *Controlled Demand Strategy:* Assumes that excessive demand for car and air travel connot in practice be satisfied by rail and must therefore be restrained directly by introducing taxes at the largest airports and motorway tolls around the largest cities.

– *Planned Demand Strategy:* The basic thesis is that the problems are largely due to excessive concentration of demand in certain places at certain times. The solution is to disperse demand over time and space. This strategy calls into question land use planning, which the other strategies accept as given.

These strategies were interpreted in terms of structural additions to the road, rail and air networks in each country, so that different networks with different service characteristics were derived for each strategy. The objective of the demand forecast was to produce an estimate of the mode specific passenger flows for each transport situation as defined by the strategies and thus, give a quantitative idea of the impact of strategy on demand. It was clear that this task for a study area with around 350 million inhabitants and a transport network, which comprises around 50.000 Kms of highway, 45.000 Kms of railway and 105 international airports, could be solved only - if at all - by means of a demand - supply model.

ANALYSIS OF PAST AND PRESENT DEMAND

Recent Developments of Long Distance Travel

Although good statistics of long distance passenger traffic in Europe are scare it is well known that the demand particularly for car and air travel, has evolved dramatically since the War, mainly as a consequence of population and economic growth and technological advance. Nine-tenths of the present motorway network were built, and nearly all Europe's airports were built or rebuilt, during this period. Between 1950 and 1973 the car population expanded from 5,6 million to 75 million and the annual number of passengers by air grew from 4 million to 91 million. Intercity rail passenger traffic grew much slower, however increased by an estimated 75-100%, despite the enormous new competition from road and air.

While the traffic on intercity roads multiplied around six times between 1950 and 1970 in some central European countries, international road traffic grew much faster. In only ten years, the number of frontier crossing cars increased by 7 times. This traffic, however being international, constitutes only a very small part of the total road traffic. The international portion of rail traffic has also been growing, at a rate of 2,6% p.a. in the last ten years.

In 1950 European air transport was in its infancy and the growth rate was naturally higher. During the 1960s, air traffic in Europe increased by 15-20% p.a., mainly because of the charter traffic, and the international part grew from 17 million passengers in 1960 to 90 million in 1973. In the same time the international rail traffic grew from 28 million to 38 million. The rail share of total international rail and air traffic decreased thus from 62% to 30%.

Socio-economic as well as supply factors have strongly influenced the growth of travel. Whereas the total population rose only by 17% (from 290 million in 1950 to 340 million in 1970), the urban population, which is responsible for much long-distance travel, rose by 34% and the number of urban households probably rose by about 50%. Employment shifted from the primary to the secondary and, more important, to the tertiary sector, thus causing an increase in business travel. The intersectoral movement of labour was associated with a big increase in national income, and a new life style, which again contributed to more travel.

A large part of long-distance travel is leisure travel undertaken in the course of holidays or weekend trips. Since 1950, holiday allowances for employees have increased from two weeks to four, whereas weekly working hours have come down to normally 40 within a 5-day week.

With higher incomes, more and more people became car owners. At the same time, costs of transport decreased. In real terms, the family car became not only cheaper to buy, but also to run. Air travel too became cheaper at least until 1973. Thus, lower costs combined with greater and denser networks and faster and more frequent services contributed on the supply side to the strong growth in European passenger travel.

Characteristics of Todays' Travel

Household Surveys

Because of a severe lack of passenger transport statistics information of the magnitude and structure of demand for long-distance travel was almost nonexistent. In order to understand the demand and to predict with some confidence how it will respond, either to changing socio-economic conditions or to alterations in the quality and price of transport, it is necessary to know about the people who travel or do not travel, why they travel (or not), what sort of places they come from and go to, and what factors determine their choice of mode. To get information of this kind, household surveys were conducted in 9 European countries.

About 5.200 households with over 15.000 members were questioned about all their long-distance trips during the preceding year. Information of the following characteristics of all trips with a minimum distance of 80 Kms during the year was obtained:

- trip purpose
- travel mode
- distance
- destination type and size and nationality
- season
- type of accommodation
- party size.

In addition, characteristics of the household, like size age structure, occupation of employed members, income, car ownership, etc. were asked.

Not all results of the survey were representative for Europe, like the total number of trips generated or the split between national and international trips, nor could some of them be used directly for calibrating a demand model, because they were only of descriptive nature, like the information on business travel. It became therefore necessary to identify and structure the information in such a way as to reveal causal or typical relationships, which then could be applied for the whole of Europe.

Trip Generation

The analysis revealed details of today's trip making of Europeans, that were unknown before. The average European undertook in 1973 less than two journeys with a one-way distance of more than 80 Kms. A few people travelled much more often than others: 5% of the population made 33% of all journeys, while 30% didn't travel at all and 25% made only one journey. This means that more than half of the population did not travel or travelled only once a year.

There are three principal reasons why people travel: Some 25% of the trips were for business, another 25% for holidays, 45% were for weekend recreation and 5% were for other personal reasons. For analytical purposes the latter two groups were combined as "short stay personal" trips. Thus the travel market consists of three clear divisions, business, holidays and short stay personal, in which the motivations are so different that it is necessary to separate all demand analysis into these three parts.

Unlike business trips, which are generated by the need of the working place, personal trips are largely generated by the needs, desires and resources of the household. Three household characteristics have been identified as main factors influencing trip generation: income, age structure, and car ownership. The number of trips per household rises considerably as income rises. Whereas this relationship is of pure descriptive value in the case of business trips, it is presumed to be a causal one for personal trips. The relationship should, however, not be exaggerated: household income has to increase by the factor eight, before the trip generation rate (trips per household per year) doubles.

The impact of car ownership is striking on short stay trips but not on holiday trips. The possession of a car induces households to make nearly three times as many weekend trips, compared with non-car-owning households of the same type and income: but is is not a major factor in determining whether or not they go on holiday. Obviously, as incomes rise, households tend to move from non-car-owning to car-owning households.

Families have the lowest trip generation as compared with young and old adult households, given the possession or non-possession of a car, and the young adults have the highest trip generation. With one exception: old adults, who own a car, make more holidays than the other household types.

Trip Length and Attraction

The average trip lengths (air distance) in the survey were around 480 Kms for holidays, 260 Kms for business, 150 Kms for short stay personal trips, and 260 Kms for all trips. The trip length distribution by trip purpose is shown in Fig. 1. More than 50% of all trips with a minimum distance of 80 Kms were shorter than 150 Kms and 75% shorter than 300 Kms. Only 10% of all trips exceeded trip lengths of 500 Kms. The distribution is quite different for holiday trips, which are on average much longer. Less than 50% of them are shorter than 300 Kms and almost 10% are longer than 1200 Kms.

The comparison of average trip lengths by purpose is somewhat misleading since only trips of over 80 Kms are considered. As can be seen in Fig. 1 there are in fact far more short stay personal and business trips below the 80 Km limit than above it; whereas there are not many holiday trips of less than 80 Kms. The survey showed that income affects trip distance, however, only of holidays. Higher income groups tend to go farther for holidays but not for weekend trips.

Whereas the typical destination of business trips is the town and the city, it is the rural area and the small town for personal trips. Less than 20% of all long-distance trips are "intercity", i.e. have both ends in towns of over 100.000 inhabitants. More than 50% are urban rural trips and the remaining 25% are purely rural. Since public modes offer in general their best services in intercity transport they cater only for a small part of the market. The survey proved in fact that the car is also for long-distance travel the mostly used mode.

Modal Split

Under today's circumstances, over three-quarters of all trips over 80 Kms are done by car. It takes roughly two-thirds of business and holiday trips and nearly eight-ninths of short stay trips. Nearly 15% of all travellers chose the train, but over 20% of business travellers did so. More business travellers took the train than others, because business trips concentrate rather more on intercity relations. In contrast only 8% of the weekend travellers took this mode. The air is negligable for short stay trips but takes about 10% of business trips and a little less of holidays, about 40% of the holiday air passengers went by charter. The bus was chosen by less than 4% of all travellers, mainly for personal reasons.

One of the principal determinants of modal choice is the length of the trip. Fig. 2 shows the modal distribution by trip length. As can be seen modal split varies greatly with distance. The car takes most of the short trips, while the plane takes most of the trips over 1200 Kms. The share of the train exceeds at no distance that of the car or the plane and rises to a maximum of around 30% between 500 and 600 Kms. The bus takes a steady 3 to 4% of the market at most distances.

Trip length, however, is only one factor which influences model choice. The presence of other factors is indicated if one compares the modal distribution of each trip purpose, for car-owning and non-car-owning households separately, as shown in Figs. 3, 4, and 5. Most business travellers choose the plane from distances of 600 Kms upward, but some prefer to go by air already on trips with more than 200 Kms (air distance).

Whereas the plane plays an important role in holiday travel for car-owning as well as non-car-owning households, it is as yet unimportant for short stay personal trips. Clearly, the train takes over a major part of the travel of non-car-owning households, particularly for holidays. A striking fact is, however, that in those households the car is the principal mode over the shorter distances, both for holidays and short stay personal trips. This suggests that non-car-owners often travel in other people's cars for leisure purposes.

DEMAND MODEL

General

It was felt that only a network study could reveal or take account of the important interactions between different parts of the network, which occur as consequences of different, regionally limited developments of transport infrastructure or socio-economic factors. The means for accomplishing this was a fairly elaborate demand - supply model by which all the main demand and supply factors affecting the future development of travel and traffic can be taken into account.

Nevertheless the model is only a tool designed to give broad answers to simplified questions its purpose is to make some big and laborious calculations in order to help the analyst to come to some conclusions. The results need careful interpretation, with a full understanding of the model and its weaknesses. One weak point in the model is the treatment of goods and short-distance traffic using the same network as long-distance passenger traffic. Only crude forecasts could be made of their volumes on the intercity network.

The model was used to predict future traffic movements and costs on the European network, on the basis of numerous assumptions or judgements, including alternative transport strategies. By using a model the analyst is forced to assemble in a coherent and internally consistent manner the many known facts and relationships which determine the volumes of traffic by each mode on every link of the network. This has to be done in a way which facilitates the substitution of different data to represent the future, i.e. 2000. It must permit the substitution of alternative data, to represent alternative socio-economic developments and alternative transport strategies.

Models are no better than the data with which they are built. The amount of data available on European traffic is small, although information on the infrastructure is rather good. The model was built primarily on the basis of the household survey results and some national and international surveys, and was calibrated against surveys and statistics, which existed in some countries and international organisations.

The model consists of two parts: supply and demand. The supply part consists of a detailed, quantitative description of the transport system and the services it offers, including prices. The demand model consists of all the main factors determining decisions to travel, including the transport services and prices on offer. The demand model thus reacts to supply, in that effective demand must be consistent with the services offered, but the supply model does not react to the demand, because that would have entailed an iterative model beyond the resources of the study. In addition, the level of detail in the simulation of the traffic conditions was not fine enough as to justify the development effort. A planning study, but not necessarily a strategy study should aim at simulating equilibrium conditions. Nevertheless, the model results must be checked in this respect before they can be accepted.

The spatial unit of the demand analysis is the zone, of which there are 109 in the study area (see Fig. 6). On average, three million people live in a zone, which measures 24.000 Kms^2 in size. Travel flows were calculated between the 109 zones by the three trip purposes: business, holiday and short stay personal. These purpose categories are the main components of long-distance travel. Although purpose specific statistics did not exist, it was felt necessary to distinguish between these purposes, since the factors which underly travel decisions, and their importance vary considerably with trip purpose.

Fig. 7 shows the structure of the demand model. As can be seen it follows the conventional subdivision into trip generation, spatial and modal distribution, and assignment. This process is however, again subdivided into many behaviourally based categories and the model phases are combined differently by trip purpose.

The models for the two personal travel groups are conceptually similar, treating trip generation, distribution, and modal split as separate phases, whereas the business trip model is a combination of direct demand and modal split.

Personal Travel

Trip Generation

As a result of the long-distance travel survey, trip generation rates for holiday and short stay personal trips were found for 30 household categories, which are combinations of three household types, two car-ownership classes and five income classes. The income classes relate to the declared household income in nine predetermined classes. The following table gives the trip generation rates (trip/person/year) as found in the survey:

Income class	Household Category					
	Non-Car Owning HHs			Car-Owning HHs		
	Young Adults	Old Adults	Families	Young Adults	Old Adults	Families
	1) Holiday Trips					
A	2,9	1,2	0,8	3,1	1,4	0,6
B	1,6	1,3	1,0	2,4	2,0	1,5
C	2,2	2,0	1,0	2,4	4,2	1,8
D	1,95	1,95	1,7	2,9	2,7	1,95
E	2,4	1,85	4,4	3,1	4,8	2,7
	2) Short Stay Personal Trips					
A	2,8	1,0	1,1	5,7	4,0	3,3
B	2,7	1,1	1,2	9,5	2,4	3,5
C	2,3	4,4	1,4	5,7	5,6	3,8
D	2,4	1,6	1,2	4,1	7,1	4,6
E	3,4	4,9	0,9	6,6	3,3	6,0

As one can see some variation of trip rates remained, which cannot be explained by the three factors forming the categories. It was found that a further stratification of factors would improve the description of reality, but not necessarily the forecast, given today's data situation in European zones.

Based on the hypothesis that income, age structure and car-ownership determine personal trip making, the trip rates were applied on the assumption that they would not change in the future. Changes in trip generation could therefore arise solely as a result of changes of these factors. The application of trip generation rates by category required a knowledge of the number of households and persons in each category, for each zone and each year under consideration.

The following variables were therefore predicted for each zone:

– the proportions of the three household types;
– the distribution of households by income;
– the proportion of households with and without a car by type and income class;
– the average household size by type.

These variables were derived from relationships with more basic data, which were predicted beforehand:

– population;
– GRP per head;
– number of households;
– average size of households;
– degree of motorization;
– percentage of households with cars;
– degree of urbanization.

The result of the estimation process was a matrix of the number of households and persons by category. The number of trips generated in each zone is given by multiplying the trip rate matrix with the household and person matrix.

Changes in the transport system affect the generation of personal trips only via the car-ownership. The analysis of the long-distance travel survey did not yield a conclusive relationship between differences in trip making and interregional accessibility in addition to the relationship with the three factors mentioned. While this may be true for holiday trips - changes in transport services affect more the distribution and modal split than the generation of holidays - it is believed not to be true for weekend trips. A new motorway or cheap charter air services attract not only travellers from other modes but also new travellers who would not otherwise have made the journey at all or would have made a short-distance journey. By means of a comparison of distance distribution curves under different strategies the number of newly generated long-distance short stay personal trips was estimated. More research will be needed to improve the forecasting method in this respect.

Trip Distribution

Trips generated by residents in zone i were distributed to all other zones by means of a gravity type function (see Fig. 7). Since no data existed on the number of tourists attracted by different zones, a special analysis was carried out to develop, for each zone, attraction factors for holidays and weekend trips. These attraction factors should be a measure of the inherent power of the zone to attract tourists, i.e. they should reflect the proportion of all tourists in the study area who would be attracted to the zone if all zones were equally accessible. In the model they stand for the relative importance of attractions in the destination zones.

The study area was subdivided into around 1200 cells, the land use of which with respect to tourism was identified, e.g. resort area or urban area. Then each cell was graded according to the intensity of the land use and was given in a third step two weights, one for holiday attractiveness, the other for weekend attractiveness. This stage involved a considerable amount of judgement. To make the decisions as objective as possible, some controles were introduced. First, the average weighting of each of the land use types was made to agree with the actual distribution of trips as known from the survey. Secondly, the range of weighting in each type was determined by reference to tourist data from the Channel Tunnel survey. Thus each cell was eventually weighted and the cellular weights were added up to zonal weights, which were used as attraction factors in the model. These values were held constant for all transport strategies.

The impedance function should include variables which measure differences in travel resistance. To account for the varying marginal utility of money to travellers with different incomes, generalised time (T_{ij} *) was taken as the impedance measure. This factor varies both with the type of traveller and the mode of transport. Travel times and costs between zones were derived for each mode and type of traveller (i.e. by purpose and income) in each strategy as a result of the network analysis.

The perceived value of time of the traveller (λ^{I}) was assumed to be related to his declared household income, for holiday travel it was taken as 50% of the declared income per employed person of the household, and for short stay personal travel, 100%.

The distribution function was estimated from the survey results as a power function of the generalised time (T_{ij} *). Since T_{ij} * is a mode specific variable there are, for each t_i to be distributed to zone j, as many values of T_{ij} * as there are modes offered. The value applied in the distribution function was the minimum value per traveller type. The elasticity of demand with respect to travel impedance was derived from the trip distance distribution as revealed in the survey. For short stay personal trips, the elasticity was found α = 3,9 for car-owning and non-car-owning households and over all income ranges. For holiday travel, the value is lower and varies between $1{,}9 \leq \alpha \leq 2{,}1$, depending on the income of the household.

In the calibration process of holiday trips the calculated country-to-country flows were compared with national statistics from some countries, and some significant differences were noted.

It could be shown that the presence of an international frontier invariably had a great effect in reducing the volume of personal travel. As a result of the calibration a matrix of country-to-country time penalties was therefore calculated to reproduce the frontier resistances.

Modal Split

Travel flows between zones by trip purpose and household category, for each strategy, were modally split by means of a combination of category analysis and diversion curves. As part of the analysis of the long-distance travel survey each trip, which had been reported, was analysed with respect to modal choice criteria and alternatives. It was found that the factors which influence modal choice can be classified into three groups related to the traveller, the trip and the transport system. Age, income, car-ownership and party size pertain to the traveller; trip purpose, destination and duration to the trip; travel time, cost reliability, safety and convenience pertain to the transport system. One can assume that each traveller will weigh up the relative importance of these various factors and will decide on the mode which suits him best. His decision is thereby governed by a limited knowledge of the alternatives and their characteristics. For simulation purposes one should take account of a large number of factors, for long term forecasting one must concentrate on those which are significant and can be forecast without great problems. As a result of the analysis the following factors have been isolated:

- traveller's car availability and income;
- party size;
- trip purpose;
- trip destination;
- trip distance;
- travel time and cost.

The combined effect of these factors has been accounted for by placing trips in one of a number of categories and then considering the modal choice case in each category. The categories consist of specific groups of travellers making similar trips in similar circumstances. They are distinguished by traveller and trip related factors. The modal choice is then determined within a particular category by transport service variables, i.e. travel time and cost, whereby an attempt was made, to reflect the perceived values of these factors.

18 Categories have been identified for holiday and short stay personal travel, which are shown in Fig. 8. The cases, where there is little or no real modal choice have been separated from those where there is an important modal split, and the latter have been divided between those with bimodal and multimodal choices. Diversion curves were then derived for the modal choice cases which describe the probability of choosing mode m_1 from modes m_1 and m_2 as a function of the ratio of the generalized times T_{ij} * of the two modes. The function has been found to be of a logistic type and its form varies considerably with the modal split case, indicating the varying importance of the generalised times and of other factors not explicitly included in the analysis. Some diversion curves have rather flat slopes, which means, that other factors besides travel time and cost influence the modal choice.

One can conclude from the modal split analysis of the survey that the majority of weekend trips were undertaken without modal choice considerations. They were mode specifically generated, in most cases car generated trips. In contrast, for most of the business trips there were modal choice situations.

The technique of estimating the modal split by a category analysis simplifies the analysis and gives a higher accuracy in each category, it may create, however, a forecasting problem of allocating flows to certain categories. It was therefore necessary not to create too many categories.

Business Travel

Direct Demand

Contrary to personal travel, business trip attractions can be described by the same variables as the generations, the spatial distribution of trips is determined by the locations of business contacts, factories, branch offices, clients, etc. In contrast with personal travel, too, the decision to make a business trip usually includes the decisions about the destination, so that for modelling one can combine the two phases, trip generation and distribution. A gravity function has been taken by which the total number of business travellers on an origin-destination link was directly estimated, using regression analysis for calibration. Generation and attraction variables are the same and are the product of the gross regional product (GRP) of the origin and destination zones. The GRP has been chosen as a measure well describing the economic output, given the poor availability of economic data of European zones.

The impedance factor was rather well described by the travel time. This confirms what has been found in former studies of business travel, namely that business travellers seek to minimize journey time rather than journey costs. If one employs travel time only as the impedance variable, in a model which simulates the flow on all modes, it is not sufficient to take the travel time of one mode only. The modally weighted travel time was therefore applied as a measure of total impedance. This required the modal split phase before the generation-distribution phase.

The coefficients were calibrated using two sets of data business flows between zones in the United Kingdom and the Continent, for international travel, and between selected zones in Germany for domestic travel. Other data on business travel were not available. Since both situations were not typical for all European domestic and international flows, national correction factors had to be introduced.

Since the model employs GRP directly as a generation and attraction factor, national currencies had to be converted into some common unit. For simplicity the U.S. dollar had been adopted, but account was taken of the fact that market exchange rates do not and did not give a true comparison of the international purchasing power of different currencies.

Modal Split

The modal split of business trips was estimated by means of the same method and on the basis of the same data (from the survey) as for personal trips. Generalised time was taken as the modal split variable because of future changes in the tariff structure in some strategies. Nevertheless, the costs play only a minor role since the value of time of business travellers is more than twice as high as of personal travellers. The inclusion of generalized time required a stratification of travel flows by travellers' income.

For the modal split analysis business trips were placed in four categories:

- trips of less than 250 Kms to rural areas → car trips;
- trips of less than 250 Kms to towns and cities → car and train trips;
- trips of between 250 Kms and 1200 Kms → car, train, and air trips;
- trips of more than 1200 Kms → air trips.

The first and last category are predominantly unimodal, whereas the second offers a bimodal and the third a trimodal choice. Clearly, most of the business trips can be found in the modal choice categories.

MODEL RESULTS AND DISCUSSION

The demand boom of 1950-1973 is certainly not fully spent, though in some respects it is slowing down. On the assumption of the central forecast that

- population grows from 340 million to about 400 million in the year 2000 with more people living in urban areas,
- the gross national products multiply by 2,1 - 3,1 (2,5% - 3,8% per annum) in the 11 countries with relatively developed economies and by 4,3 - 5,0 (5,0% - 5,5% per annum) in the other five, the precise amounts depending on population growth, and
- car-ownership rises from 60 million to around 150 million and the number of car-owning households from 47 million to around 115 million,

and on many hypotheses regarding the development of costs, transport services, and relationships in the demand functions one may expect that - under Status Quo conditions - long-distance travel will double between 1970 and 2000, with the strongest growth in air travel (by the factor 3,75) and lowest growth in bus travel (by the factor 1,3). The 70% predicted growth of rail traffic consists largely of business passengers and is quite critically dependent on the improved level of service assumed (at investments outlays of 25 billion US $).

The impact on rail traffic of a much faster rail network, together with a somewhat worse road network than in the Status Quo (Controlled Mode strategy), is substantial: high speed trains with maximum crusing speeds of 250 Km/h in a European network, raise the number of rail trips by nearly 20%, with 350 Km/h by additional 10%. The Controlled Demand strategy, restraining traffic directly by low investments and charging motorway tolls and airport taxes, proved remarkably ineffectual in reducing road traffic, but much more successful in reducing air traffic.

The Planned Demand strategy generates more traffic than the other strategies because the decentralisation of population and employment away from the biggest cities leads to the substitution of intercity trips for intracity trips. It is, however, the only strategy which significantly relieves the problem of road congestion near the largest cities. Only by actually reducing the population of these cities and with it the number of cars, does it seem possible to make any real impression on this problem.

How reliable are these forecasts? Clearly, they are subject to numerous uncertainties. Having studied the many assumptions involved and the sensitivity of the conclusions to errors in the assumptions, one must issue certain warnings. The business travel forecast could easily be too high, because the technique used was rather weak, due to lack of data. The holiday forecast could well prove to be rather low if a change of fashion should occur in favour of second and third holidays. Equally, the forecast of personal travel by air may be wrong, because air traffic is sensitive to price and incomes and one cannot easily forecast future consessionary price schemes, nor the numbers of people in the highest income group, which is primarily responsible for air travel.

The travel forecasts depend on three types of input variables of the model:

- forecasts of demand factors, e.g. income;
- hypotheses of supply factors (i.e. strategies), e.g. costs,
- functional relationships between demand and supply.

There is always a degree of uncertainty about the accuracy of the values chosen for the horizon year; indeed the analysis year values are sometimes open to question. As transport planner, one has to accept more or less the uncertainties in the forecasts of demand factors, i.e. socio-economic factors, because these forecasts often have an official character. They have been prepared (and revised) by government agencies and form a base for other sectors of politics.

The development of the transport system has a long term aspect in its infrastructural part and a short term aspect in its regulatory or management part. These characteristics can be treated as alternatives and formulated in a quantitative way rather easily by the transport planner.

The greatest problem lies in the formulation and verification of demand - supply relationships, because they have not been researched in sufficient detail and over sufficiently long periods, particularly with respect to interregional passenger travel. It seems that the efforts in research and development of the technology of new transport systems are more successful and more advanced than those which try to find out the demand for these systems. It is a clear fact, that we need better data of people's travel behaviour, the travel structure, and factors influencing travel. The transport planner has then - and not before! - the task and the responsability to establish causal relationships between travel demand and demand and supply factors, in a way which permits them to be used as forecasting tools. It is hoped that the description of the model, which has been used for strategic forecasting of European travel, has not only given an idea of its complexity but also its deficiencies, from which the need and the direction of further research should be deduced.

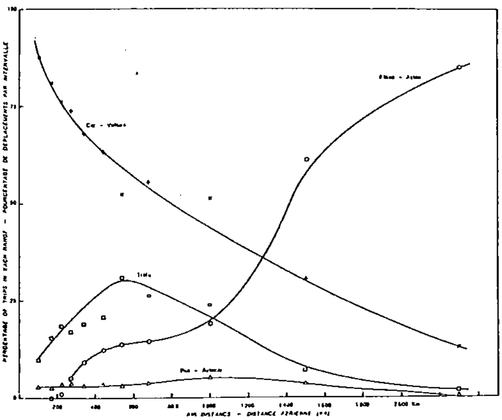

Fig. 2 - Modal distribution of trips by trip length (household survey data: air distance)

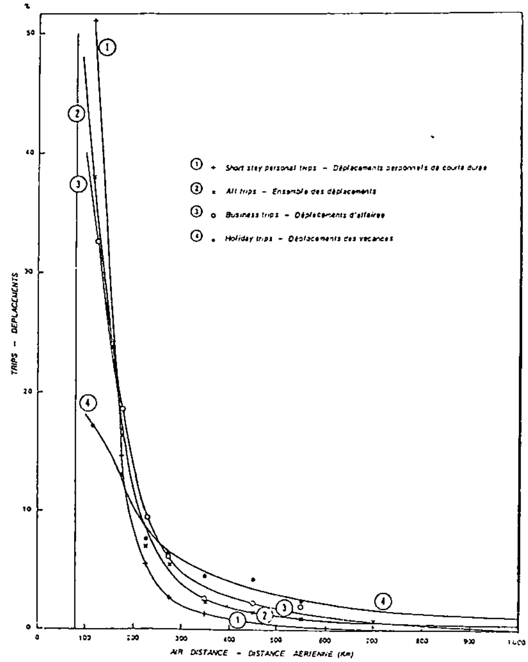

Fig. 1 - Trip length distribution

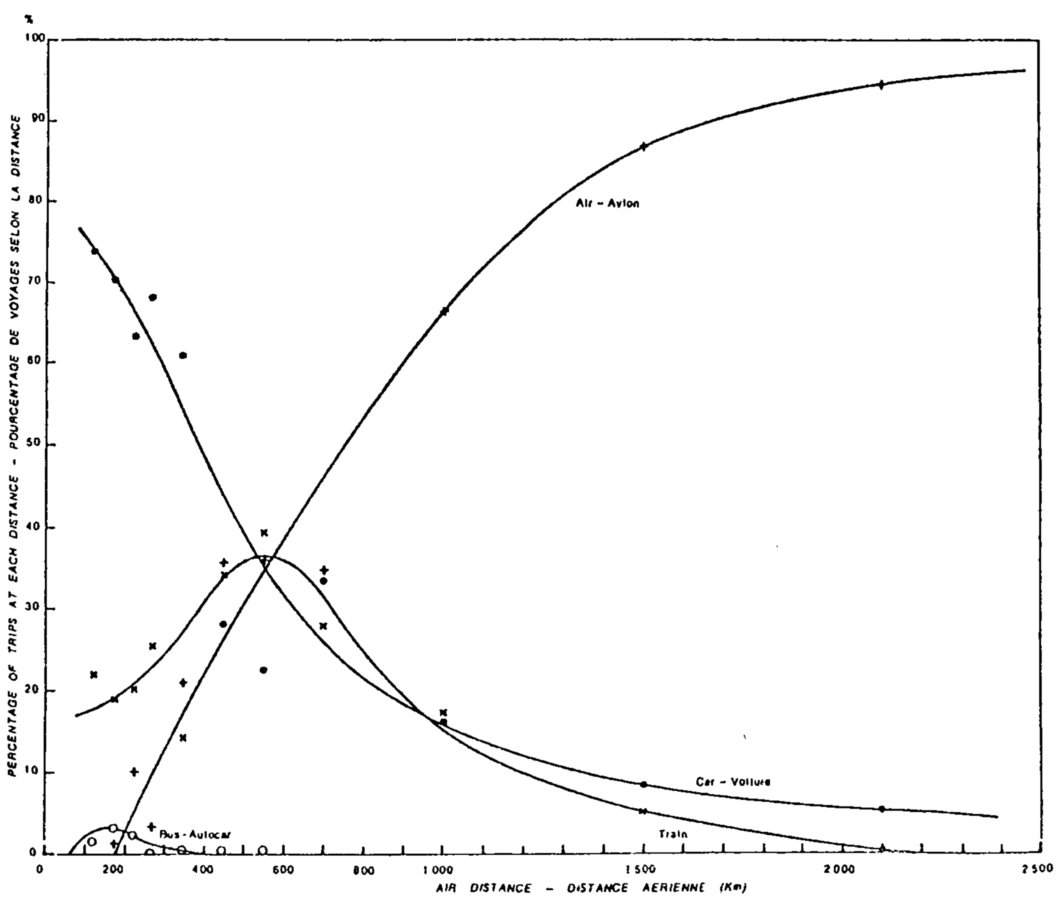

Fig. 3 - Business trips - modal split

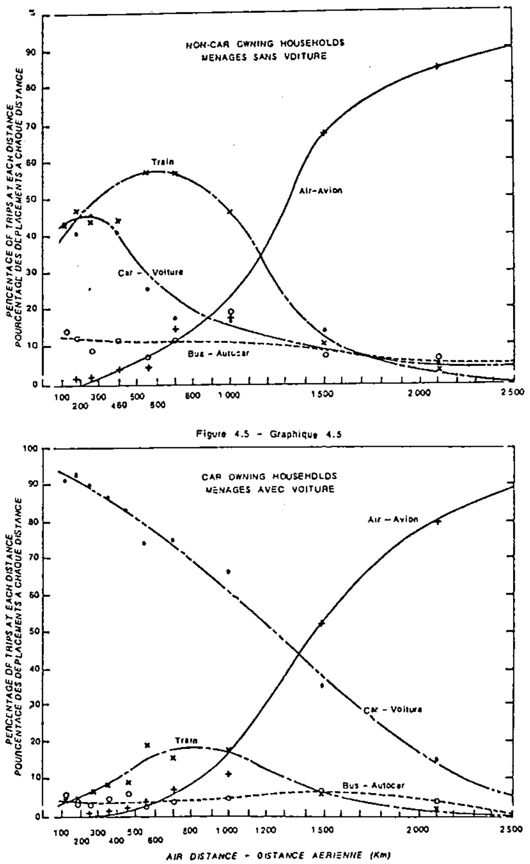

Fig. 4 - Holiday trips - modal split

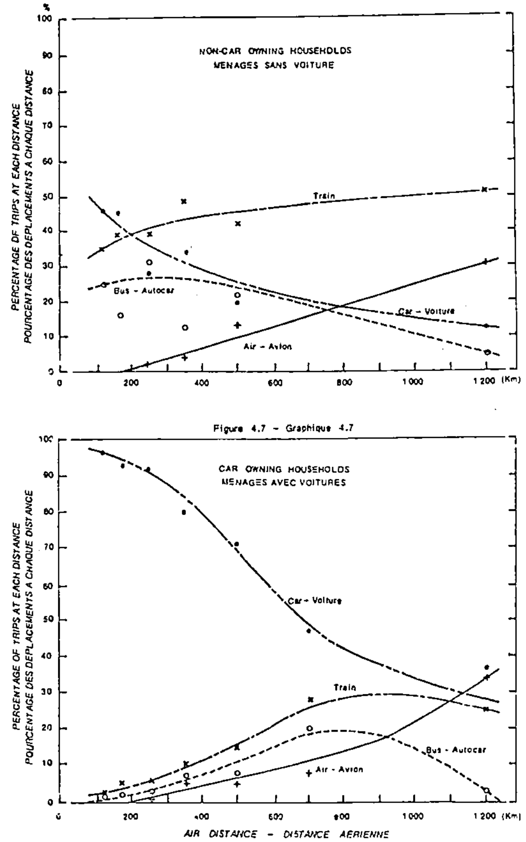

Fig. 5 - Short stay personal trips - modal split

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Fig. 6

CHAMP DE L'ÉTUDE - STUDY AREA

ZONES DE TRAFIC

TRAFFIC ZONES

Trip purpose / Model Phase	Personal trips: Holiday	Personal trips: Short stay personal	Business trips
Trip generation $(t_i = \sum_j t_{ij})$	Category analysis: $t_i = f(ST, I, CO)$ Categories: household structure (ST) household income (I) car ownership (CO)		Gravity function: $t_{ij} = \alpha (GRP_i \cdot GRP_j)^{\beta} \cdot T_{ij}^{\gamma}$ Measures of generation and attraction zonal income, GRP Travel impedance: function of modally weighted travel time (Tij)
Trip distribution $(t_{ij} = \sum_m t_{ij,m})$	Gravity function: $t_{ij,I} = k_i \cdot t_{i,I} \cdot A_j \cdot TI_{ij,I}$ Zonal attraction (Aj): attraction weight Travel impedance ($TI_{ij,I}$): function of min. generalised travel time ($T^*_{ij,I}$) $(T^*_{ij,I} = T_{ij} + C_{ij}/\lambda_I)$		
Modal Split $(t_{ij,m})$	Category analysis: Categories: unimodal, bimodal, multimodal } Modal split function: diversion curves with $P(t_{ij,m}) = f\left(\frac{T^*_{ij,m}}{T^*_{ij,m+1}}\right)$		
Trip Assignment	Route assignment (for each $t_{ij,m}$) → Link and corridor volumes by network		

Fig. 7 - Structure of the demand model

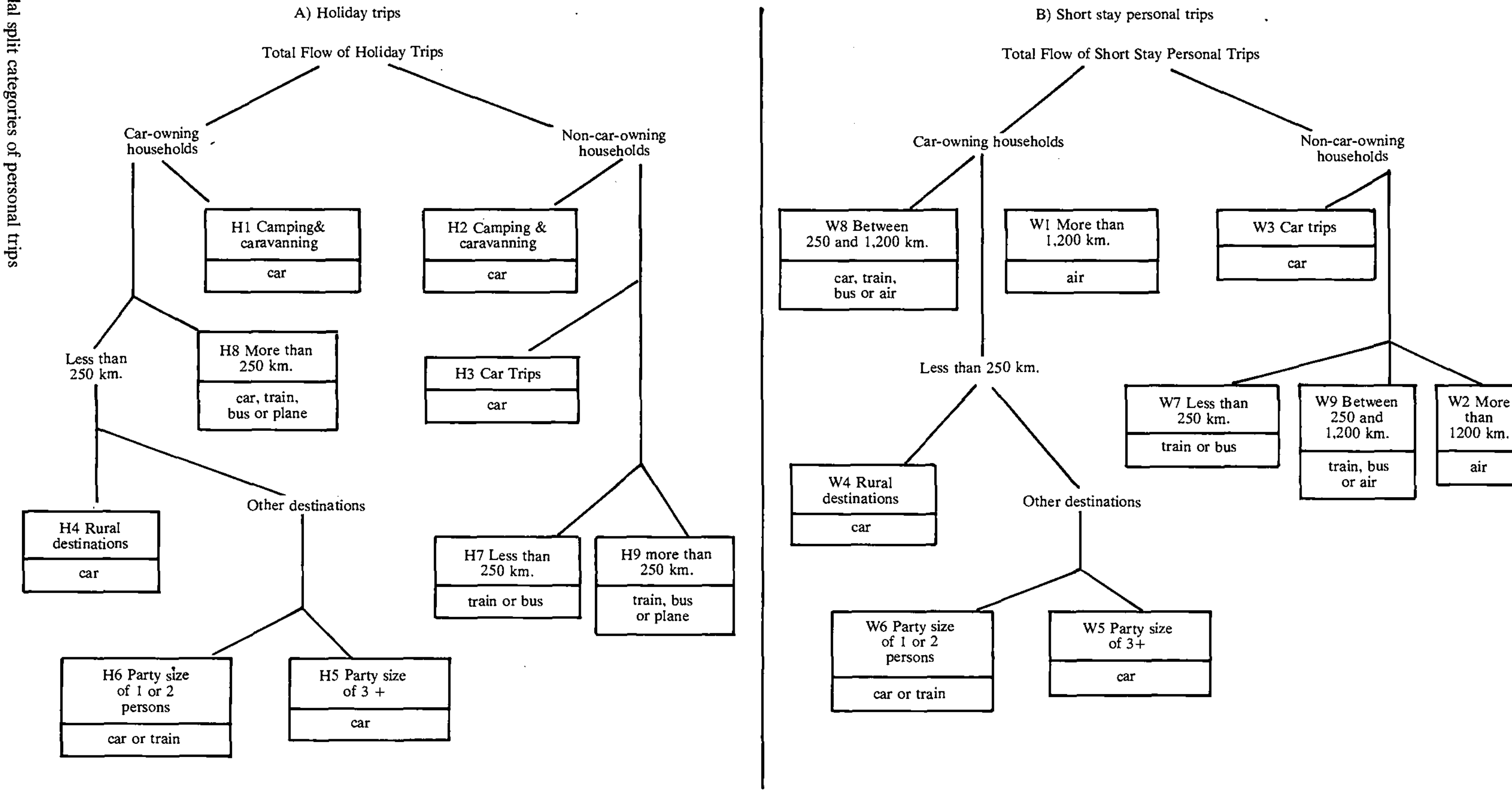

Fig. 8 - Modal split categories of personal trips