ABSTRACT

This paper focuses on data collection from the viewpoint of the practitioner. In general, innovation can be considered to be driven by three types of development: (1) exogenous developments in society, (2) policy developments, (3) technical improvements: new modeling techniques, GIS developments, increased computer power, new presentation techniques, etc. The paper will consider each of these developments successively. The paper ends with a “shopping list” of future data needs.

INTRODUCTION

In general, innovation can be considered to be driven by three types of development:

- Exogenous developments in society,
- Policy developments, and
- Technical improvements: new modeling techniques, GIS developments, increased computer power, new presentation techniques, etc.

The paper will consider each of these developments successively. The number of references has deliberately been kept small, because the purpose of the paper is to signal, not to document, relevant developments. The paper will end with a “shopping list” of future data needs.

TRENDS IN SOCIETY

Socio-demographic Trends

Average household size decreases. During a lifetime people spend fewer years in a “family relationship.” More dwellings and more space are needed. More heads of smaller households have to organize their personal life. Hence, distance traveled increases. Educational level and income increase. There is more employment in services, less in production. More people are engaged in paid work, causing larger traffic volumes in the peak and more congestion. Labor participation of women increases, resulting in task combination for which extra flexibility is needed (e.g., escorting children to school). There is also an increasing number of “nomad commuters.” They live in some “pied-a-terre” in the vicinity of their jobs on weekdays and return to their home far away during the weekend. There is a large growth of elderly people. Many of them are mobile people accustomed to using a car.
Increase in Scale

There exists a tendency in firms and institutions to scale-up. For example, the number of schools reduces because of concentration. Out-of-town shopping malls, furniture-store boulevards, and mega-cinemas emerge. In national economies there is a trend toward globalization. The importance of international trade increases. Passenger and freight transports compete for scarce road capacity.

Flexibilization

There is a clear trend to more flexible working hours and shop hours. This may give rise to a better spread of traffic over the day and less congestion. There are also new opportunities such as telecommuting, “satellite offices,” and teleshopping.

Information and Communication Technology

Telecommuting and teleshopping can lead to shifts of traffic over the day and maybe even less traffic. Car ownership, especially of second cars, may be reduced. However, Information and Communication Technology (ICT) can give rise both to substitution (e.g., taking a course at home using a personal computer instead of a classroom course) and to generation (e.g., meeting people in person whom one has got to know via Internet). On balance, generation will probably exceed substitution.

Travel information at home and en route will improve trip planning. Traffic management measures will increase the capacity of existing infrastructure.

Global Information Networks

In the long term the “information society” may deeply affect society (Gates, 1996). For example, the planning economies in Eastern Europe have perished, but most organizations in the Western world still resemble tiny “planning economies.” ICT may facilitate looser organization forms with flexible contracts between firms and employees. Fixed positions and salaries no longer exist. Firms as well as employees are “entrepreneurs,” and this might be the end of the “traditional colleague” and of the “traditional firm” (KPMG-BEA, 1996).

Technology

In the INIT project of the Dutch Ministry of Transport (INIT, 1996), e.g., the following concepts are considered to be promising in solving current transport problems:

Vehicle Redesign

Vehicles dedicated to specific use, e.g., in cities, over long distances, or for use by a limited number of people. New materials, new propulsion systems, and aerodynamic design increase fuel efficiency of private cars, public transport, and freight vehicles. Microcomputers take over driving tasks. Modular vehicles can be coupled to trains, or a passenger and baggage module can be coupled for people taking a holiday. The differences between public and private transport will diminish.
**Intermodal Coupling System**

An electronic market where supply and demand can be matched. Routes and schedules can be optimized, cargo can be monitored en route, and empty trips minimized.

**Dynamic Infrastructure Management**

Information, guidance, and billing of both passenger and freight carriers. Trip-slots can be reserved and billed over the complete intermodal infrastructure. The reverse side of the coin consists of less privacy.

**Intelligent Highway Systems**

Sensors in the vehicle and the infrastructure analyze traffic flows, congestion, traffic behavior, fuel use, and vehicle emissions.

**Integrated Public Transport System**

A system used for public transport, offering similar services as dynamic infrastructure management.

**Integrated Intermodal Packing Units**

Reduces the time needed for transshipment.

**Underground (City) Goods Transport System**

Reduces the nuisance of cars and vans in public streets, especially in city centers.

**Tele-activities**

Tele-rooms both at home and in the office, provide flexibility in working hours and the possibility to control various activities at different locations at the same time.

**Land Use**

Because of individualization, smaller households, higher incomes, and higher quality standards, requirements for space will continue to increase, and this necessarily means continuing dispersion in land use and suburbanization.

On the other hand, existing built-up areas may also flourish. For more and more population groups, high-density areas and city centers may be an attractive living place (at least in Europe). In most cities industrial and office development is still decreasing. But many vacant offices are transformed into dwellings for a growing class of people who are interested in inner-city life: affluent “yuppies” and “dinkies,” students, small households without young children, and elderly people who like to have amenities “around the corner.”
Car restraint in city centers ("car-free" or "car-lean" neighborhoods) may be an attractive option to improve the urban climate, as has been shown especially in Germany. But there are also risks, e.g., for shops, restaurants and cafes, and cultural institutions.

**Changing Attitudes toward Mobility**

Mobility is considered by many to be a basic need and to which there is an inalienable right. More and more people travel to holiday destinations at the other end of the globe, take a 5-day trip to New York, spend the weekend in the countryside, or live in a multiple-worker household with sometimes very long commuting distances.

**New Forms of Car Ownership and Other Transport Modes**

"Call-a-car" is a new form of "time-share" car ownership in, the Netherlands and Switzerland. One agrees on a minimum kilometrage per year with the car-provider, pays a fixed fee per year plus a relatively low, variable amount per kilometer driven. This may be particularly attractive to dwellers in inner cities and other highly urbanized areas with parking problems, who have easy access to walking and public transport and drive relatively little.

Park-and-Ride systems will continue to expand, also in combination with car restraint in inner-city centers.

**Freight Transport: Changing Logistic Processes**

New technologies such as container transport may reduce production costs substantially. Global production becomes a reality. For example, transfer of production takes place to low-wage countries, causing increased transport of semi-finished products. The Netherlands has become an important centralized distribution center for companies from East Asia.

Firms contract out (parts) of the logistic process to reduce total logistic costs and improve customer service. Transport companies change to logistic service providers. There is a tendency toward more deliveries of a smaller size over greater distances.

Road transport will continue to be dominant in freight transport. This creates severe environmental problems, especially in the field of carbon-dioxide emissions. Solutions are sought in the direction of improved vehicle design and the promotion of intermodal transport.

**International Freight Transport**

International transport growth in the past years has been enormous. For example, in the Netherlands the growth between 1986 and 1995 has been 60 percent. Reasons are the removal of the interior borders in the European community, the more intensive trade with Central and Eastern Europe, the economic growth in Asia, the further globalization of the economy, and the growth of population. There has been a further shift to road transport: rail and inland navigation stabilized, while road transport increased. The main reasons are (i) a shift from bulk to (semi) finished products, and (ii) reduction of the maze-size of transport streams, while the freight transport units get smaller.

Freight flows within and to and from Europe will continue to increase. In some segments a doubling of volumes may be expected.
TRENDS IN POLICY

Increasing Citizen Participation

Citizens become much more emancipated. The government is increasingly confronted with conflicting interests and increasingly challenged to justify its policies. The government cannot make decisions before having consulted a host of advisory institutions. In a mature democracy there is not such a simple rule as “half the votes plus one.” Also the interests of minority groups need to be taken care of. It has become more and more important to make objective evaluations, to take account of diverging visions, and to explain the premises for policy decisions.

Some major problems of the Dutch Ministry of Transport are that (i) transport is associated with practically any human activity, (ii) the Netherlands has 15 million inhabitants and also 15 million transport experts, (iii) the field of transport is full of NIMBY (“not in my backyard”) problems and “prisoner’s dilemmas,” (iv) there are few direct steering instruments to influence people’s travel behavior, and (v) the legal planning procedures take very long. Citizen support for the long-term “Transport Structure Plan” (SW-2) is not strong enough, and the Ministry can partly blame itself for this. It should give more attention to the “process,” instead of just to “contents.” Communication does not just mean “explaining,” but also “listening.” The Ministry should move from providing “blueprints” to openness for “not invented here.”

In the planning process for new infrastructure, more insight is, therefore, needed into attitudes, moral principles, threatened interests, and risks incurred by citizen groups concerned.

European Integration, Decentralization, Deregulation, Privatization

National governments are losing part of their powers to supra-national institutions of the European Union (EU) (e.g., vehicle design standards regulation). Other jurisdiction is decentralized to regions, in order to bring government closer to the citizen (e.g., public transport provision). Because of bad experience with government intervention in the seventies and the downfall of the planning economies in Eastern Europe, various government services are privatized and brought into the marketplace. Detailed regulation vanishes: it is more important to define what has to be achieved than how it should be achieved.

Environmental Concerns

The Netherlands has been in the forefront of care for the environment. In the past years, substantial progress in improving the air quality has been made. The main problem at the moment is the rise in CO₂ emission. The concept of a “sustainable society” is rooted in the Netherlands, but technical measures to reduce emissions are preferred over measures to reduce mobility itself. Recently, the priority for the environment has faded away a little bit in public opinion. Economic growth, employment, and traffic jams are higher on the political agenda.

Also in other countries the environment is high on the political agenda. In the United States of America, the Intermodal Surface Transportation Efficiency Act (ISTEA) was established in 1991 and the Clean Air Act Amendments (CAA) in 1990 (Lyons, 1995). These are innovative and aggressive efforts to move U.S. cities toward integrated
transportation and air quality planning. In areas with serious air pollution, air quality will be a major consideration in determining the future shape of urban transportation. The CAAA mandates measurable and enforceable air quality targets. ISTEA includes directions for transportation planners and decision-makers to follow to reach air quality and other goals — transportation planning must emphasize system efficiency, and for cities with severe air pollution, transportation projects are expected to contribute to cleaner air. Each urban area has flexibility in how it applies this framework to reflect its priorities and to solve its problems. Strict federal sanctions provide incentives for compliance with both laws.

**Costs of Mobility**

Prices are of importance for the growth of mobility, both from the viewpoint of equity and of behavior. There is a continuing discussion that the price of mobility (especially car mobility) is too low and that transport does not pay for its external costs (Kinnock, 1995).

In the Netherlands, for example, prices of both the private car and public transport have remained at grossly the same level, in real terms, since 1960. This has helped the increase in car ownership and boosted shifts to larger, less-fuel-efficient cars. Recently, however, to improve the environment by reducing consumption of natural resources, there have been some clear shifts from income tax to tax on consumption, e.g., by increasing the price of heating gas and petrol.

**Congestion**

Because of the large growth in car use and the much smaller extension of infrastructure capacity, congestion has vastly increased. The creation of alternatives for the private car has generally not been very successful, a limited number of cases excepted. Discouraging car use by pricing measures, parking measures, or measures to reduce the competitive speed advantage of the private car can count on stern public and political opposition as soon as really effective levels are proposed.

In spite of its high position on the political agenda, some nuance with respect to congestion is appropriate. Congestion is still by and large a peak problem in urban areas. Outside the peak, owing to the extension of the motorway system, substantial reduction of travel times has been achieved in the past decades, especially for trips between regions and for long-distance trips. Two of the main problems of congestion are its visibility and its unpredictability. Policy should, therefore, not aim at the removal of all traffic jams but at (i) defining acceptable average travel times by car and other transport modes in various area types, (ii) reducing the variance of travel times (e.g., by dynamic traffic management), and (iii) making the waiting time more endurable (e.g., by controlling access to the trunk road system and special waiting locations at the motorway entrance).

**Renewed Interest in Infrastructure**

In most developed countries the investments in transport infrastructure have decreased in the seventies and eighties. There is renewed interest in dealing with the “backlog” thus created. In many countries, e.g., the Netherlands, investment in public transport (passenger transport) and intermodal transport (freight) has a higher priority than investment in new roads.
Private finance and public-private partnerships are seen as a means to finance investments for which public funds are insufficient. This requires different forecasting techniques than traditionally used, because the planning horizon of private financial institutions is much shorter than that of the public sector. Besides societal cost-benefit analyses over a long period (typically 20 years), medium-term forecasts of earnings are needed.

**Preferential Treatment of “Target Groups” and Road Pricing**

Scarce road capacity must be allocated more efficiently by reserving space for “target groups” (business traffic, car-poolers, freight vehicles, buses) and by introducing road pricing in urban areas. All this falls under the heading “selective accessibility.”

Road pricing, however, is unpopular with the general public, because of its perceived “unfairness” and because of privacy considerations.

**Deregulation and Privatization in Public Transport**

In accordance with EU guidelines, railway track and railway operations will be separated. Competition will be introduced and there will be more regional operators. Tendering procedures will be introduced in municipal and regional bus transport.

**POLICY: THE ARDUOUS JOB OF CHANGING PEOPLE’S BEHAVIOR**

Changing people’s behavior can be extremely difficult. For the implementation of policy measures it is, therefore, often needed to collect data about hidden underlying attitudes. A recent Dutch publication (AVV, 1996), intended for policy departments in central and local government, gives very illustrative examples and ends with 10 “golden rules” for promoting reduction of car use:

- **Influencing behavior is more than a funny TV spot.** There exist various ways to influence behavior: technical/infrastructure, regulation, and communication. Try to combine the various means. Inform car users about the existence and attractiveness of alternatives.
- **Acknowledge other people’s feelings like your own.** Do not accuse people of irrational or emotional behavior. The feeling of freedom, the impression that other people look down on bicycle use, the privacy of the car does play an important role.
- **Attitudes can be influenced.** It seems simple: if somebody’s attitude toward the bicycle is positive, (s)he will take the bicycle. However, deeper feelings may be hidden from the interviewer by the respondent. In spite of this, attitudes — both positive and negative — may influence behavior: if people dislike the bus for commuting they will definitely not use it. Attitudes sometimes can be influenced from outside.
- **Make smart use of cognitive dissonance.** The tension between someone’s attitude and behavior may result in rejection of information. For example, when confronted with the real costs of car use, someone may decide not to drive less, but to make an outcry to government that (s)he is used as a “milk cow.” Cognitive dissonance, however, can be used as an instrument to influence behavior. One may force a change in behavior, e.g., by reimbursing travel by public transport solely, after which attitudes will adapt themselves to the changed behavior.
- **Individualize social dilemmas.** People tend to sacrifice the interests of society at large to their own short-term interests. Various mechanisms enforce this tendency; e.g., it is practically impossible to have a feeling of one’s own contribution to large problems (say global warming). The trick here is to reduce the problem. The worldwide increase in car ownership and congestion is not the problem, but the worsened accessibility of the industrial site in your city. And that is caused by you, using your car for commuting.

- **Habit and “catastrophes.”** Many travel behaviors are habitual and this makes people inaccessible for promotion of alternatives. This promotion is welcomed much more in the case of “catastrophes.” Very strong and noticeable changes in external circumstances — for example, a doubling of fuel prices or a reduction by half of public transport fares. Examples of individual “catastrophes” are a change of dwelling or job.

- **Fairness.** Parking charges? OK, but on the condition that a good, preferably guaranteed parking place is provided. If fairness is discarded, the citizen may become very disobedient. It is crucial, therefore, to involve the citizen in the formulation and particularly also in the evaluation of policy.

- **You, too, superior individual.** You think that you are more caring for disfavored people, more environmentally conscious, and more intelligent, in short, better than your neighbor. Unfortunately, in most cases this is a misunderstanding and a self-enforcing illusion. It is, therefore, also your obligation to contribute to a smoother and cleaner traffic system. You, too, should consider a carpool, the bus, and the bicycle.

- **Feelings are facts.** Take account of both the “objective” advantages and the feelings toward the car. Use leverage; e.g., if bicycling during free time has a positive image, use that fact to promote the bicycle in the journey to work.

- **Demand and supply, the double role of communication.** Communication is the exchange of information. Communication is just one means of influencing behavior and publicity is just one form of communication. Communication alone will not do the job. And communication must be two-sided: not just transferring the message to the public, but also listening to the public.

**MODELS AND FORECASTING: THE STATE OF THE ART IN THE NETHERLANDS**

The Netherlands now has a tradition of several decades of use of models in transportation forecasting, both aggregate and disaggregate. The Ministry of Transport also has generously sponsored pilot research into, e.g., panel-based dynamic modeling, activity-based models, dynamic vehicle transaction models, and land-use transportation interaction modeling. But beyond the expertise of mathematical modeling another expertise has been built up over the years: the art of “getting models to work.” There is a long way between the raw model output data and the presentation of the forecasts to the external world.

Experience has taught a couple of important rules to be followed in the translation process from research to policy. The first is that one should not try to answer all questions with one single model or model system. The second rule is that in most cases one cannot expect a model to reproduce the situation in the base year sufficiently correctly. Nowadays, most models are used to describe changes to an empirically observed base situation. This is the so-called “marginal model” approach. Thirdly, the objective of a model is not to forecast the future (the “crystal ball” view), but to assist in reducing uncertainty in policy decisions. A model never gives “the” truth. In the end therefore, information from various
sources—descriptive research, model results, and expert opinions—has to be combined into a “best estimate.” There will always be a lot of subjectivity in that process.

Fourth, policy making is a bargaining process. This means that numerous prospective solutions have to be evaluated before a final compromise is reached. During the last stage of that process, the professional researcher’s model is just far too inflexible and time-consuming to be of help. Therefore, like lifeboats on an ocean steamer, every big model system should have a small counterpart that can be used for sketch planning around a central scenario, using, e.g., elasticities.

Finally, planners must take into account that planning is just one step in the process of implementation of policy measures and creation of new infrastructure. They, too often, assume that the community will make rational decisions on the basis of the predictions, evaluations, and cost-benefit analyses supplied by the planners. However, in the community process there is more than rationality and disinterest; “bargaining” has to come in as well. Attention to the “process” (of community decision making) is as important as to the “contents” (forecasts, alternatives, cost-benefit ratios, etc.).

INNOVATION IN MODELS AND FORECASTING

Activity-based Modeling

Recent years have seen a renaissance of activity-based modeling. The first models were developed in the seventies and eighties, but later on they were often considered to be too complicated to be used in operational modeling and forecasting. Presently, the opinion is that we do need them because of the complexity of the transport problems we face. The variety in household types and activity patterns has increased. Solving the transport problem is no longer a matter of just adding infrastructure. The solution of the transport problem may well lie outside the transport system, i.e., in reducing the need for travel altogether (e.g., by reducing the distance between living and working places, flexibilization, telecommuting, etc.). Modeling the link between mobility and the activity pattern is, therefore, essential.

The activity-based approach has many advantages. It can deal with task combinations and activity- and trip chaining. In-home/out-of-home substitution of activities can be examined. Important progress has been made in modeling activity durations. The time-use concept can be used for a user-benefit measure: the value of, e.g., X minutes saved commuting can be evaluated by observing how those X minutes are used.

It is, however, crucial that workable systems are set up. The potential of activity-based models must be sought in the addition (qualitatively or quantitatively) to existing conventional models and not in the replacement of the latter.

An example of the new generation of activity-based models is Sequenced Activity-Mobility Simulator (SAMS) (Kitamura et al., 1995 and 1996). The persistence of environmental problems in urban areas and the prospect of increasing congestion have precipitated a variety of new policies in the USA, with concomitant analytical and modeling requirements for transportation planning. The SAMS has been developed as a dynamic and integrated microsimulation forecasting system for transportation, land use, and air quality, designed to overcome the deficiencies of conventional four-step travel demand forecasting systems. The SAMS framework represents a departure from many of the conventional paradigms in travel demand forecasting. In particular, it aims at
replicating the adaptive dynamics underlying transport phenomena; explicitly incorporates the time-of-day dimension; represents human behavior based on the satisficing, as opposed to optimizing, principle; and enclogenously forecasts socio-demographic, land use, vehicle fleet mix, and other variables that have traditionally been projected externally to be input into the forecasting process. Urban residents’ responses to travel demand model (TDM) measures are conceptualized as an adaptation process that involves experimentation with alternative travel modification schemes. Parameters of the model system are estimated using revealed-preference data from trip diaries and data collected through stated-preference surveys specifically designed to incorporate a wide range of TDM measures and travel responses.

Another interesting effort is currently taking place in the Netherlands. EIRASS (part of the Technical University of Eindhoven) developed an activity-based model for the Ministry of Transport that is based on “genetic algorithms.” The basic idea is to develop rules for activity scheduling and apply them to activity patterns as observed in a survey. “Successful” rules in explaining activity behavior will be preserved, “unsuccessful” rules will be eliminated. The rules have the form of decision-tables with yes/no branches.

Dynamic Longitudinal Panel-Models

The dynamic longitudinal approach overcomes the limitations of standard cross-sectional approaches. Dynamic models can differentiate between age effects and cohort effects, can resolve ambiguities in causalities, and can provide methods to consider observable or unobservable omitted variables. They are more accurate in describing the behavioral effect of policy changes by being able to incorporate phenomena such as habit and inertia in response to change, incomplete information, and learning behavior. An example for the Netherlands is the model for vehicle holding duration, type choice, and use, developed by de Jong (1996).

But, for everything there is a price, in this case substantially more complexity. The major problem is the volume of data required, both for the base year and — even more importantly — for the forecasting year.

Medium-term forecasts, say 5 years ahead, become more important and the most prospective application for dynamic models in forecasting may be over that horizon. Medium-term forecasts can increase the credibility of long-term forecasts. They are also important in the context of private infrastructure financing, because private banks have much interest in the time-path of investments and earnings. Finally, medium-term forecasts serve a role in forecasting government expenditure on subsidies and grants to local government, because many of these grants are based on the growth in mobility.

Land-Use Transportation Interaction Models

Because of the objective to reduce traffic growth, there is a renewed interest in land-use transportation interaction (LUTS) models. After opening of new transport infrastructure (both road and rail), new activities will be attracted to its vicinity. This will cause new traffic. This is one particular form of “induced demand” (Hills, 1996) and will partly offset the benefits of increased accessibility. LUTS models are also important to model the effects of congestion. When in a region congestion increases, economic activities may move elsewhere.
Many of these effects spread over a (very) long term. It is, therefore, crucial to conduct before-and-after studies on the effects of opening of new infrastructure. An example is the study of the Amsterdam orbital motorway (Loos et al., 1991). These studies should be repeated periodically every few years.

**Equity Considerations**

Transport infrastructure construction has to find a balance between increasingly conflicting interests: accessibility, environment, land requirements, etc. In many cases, the benefits are enjoyed by a large group of anonymous travelers, while the disbenefits are borne by a restricted group of people in a limited geographical area, who can easily organize themselves into opposition groups. Even when an infrastructure project has a large benefit/cost ratio, it is very important to investigate the distribution of costs and benefits. Disaggregate models, especially when using “artificial sample enumeration” in forecasting applications can ease this task (Ortuzar, Willumsen, 1994). The procedure is used in the Dutch National Model (Gunn, 1985) and preserves much of the disaggregate detail in aggregate forecasting.

**Sketch Planning Models**

Ideally, every large model system should have a small counterpart that can be used for sketch planning around a central scenario. It could be based on elasticities derived from the large model. Alternatively, it could use a database with pre-stored results from a large number of model runs. To evaluate a set of policy measures, the sketch-planning model would look for a pre-stored scenario resembling the proposed policy measures as much as possible.

**The Travel Model Improvement Program in the United States**

To remedy current U.S. model deficiencies, the federal Travel Model Improvement Program (TMIP, 1996) was initiated to enhance current models and develop new procedures. TMIP is a cooperative effort among organizations involved in transportation, land development, and environmental protection. It will seek active technical involvement and financial participation from state departments of transportation (DOTs), local governments and metropolitan planning organizations (MPOs), environmental agencies, and private sector entities.

The overriding goal of this program is to develop travel models that accurately replicate and reliably forecast travel by a broad range of modes. The modes to be included are passenger vehicles with different levels of occupancy, various kinds of trucks, HOV lanes with several levels of vehicle occupancy, different kinds and levels of transit service, bicycles, and walking. The travel models should accurately assess the regional and localized effects of these models on congestion, air quality, and urban development. The models should also identify the feasibility and effectiveness of policy actions. The policy actions assessed should include demand management, road and parking pricing, traffic and transit operations, transit fares, telecommuting, and land use controls.

The sensitivities of different socioeconomic groups to travel costs and changes in scope and level of transit service should be determined by the travel models. The factors and conditions that affect the amount, timing, and mode of discretionary travel should be
included in the travel models. Factors to consider include land use and development density, urban design, trip chaining, peak spreading, off-peak travel, and recreational travel. The effects of technology advances for improving congestion and air quality should be accommodated in the models. Among the developments to consider are vehicle and highway automation and telecommunications. Other factors likely to affect travel behavior and that should be considered for inclusion in the travel models are catalogue shopping, sidewalk and bikeway improvements, traffic calming, and various economic and social factors. Activity patterns of travelers as precursors to trips should be considered for the travel model improvements.

Simulation models should be considered to represent small increments of travel throughout the day. Conditions on the transportation system at small time increments could be used to determine travel decisions. As the transportation network loads and unloads incrementally, the simulation model would modify travelers’ decisions in response to those conditions. This approach may offer an improved representation of desires and constraints that dictate travel patterns and mode selection. The travel models should provide sufficiently disaggregated and detailed travel forecast information for air quality analysis. The needed information will include the time, location, and duration of various operating conditions for all types of motor vehicles. The travel models should provide information about the effectiveness for improving air quality of various transportation developments. These should include adding capacity and improving operations of roadways and transit, high occupancy vehicle lanes at different levels of occupancy, intermodal improvements, transportation control measures such as demand management, and bicycle and pedestrian facilities.

The linkage between travel models and land use models needs to be strengthened. The research should better define the interactive effects among traffic conditions, transportation improvements, urban development patterns, transit accessibility, and air quality.

INNOVATION IN DATA COLLECTION

Extended Data Needs as Expressed in the TMIP Program in the United States

An extensive inventory of the needed data should be conducted early in the TMIP program to provide a sound, comprehensive database for model improvement and development. That should be followed by continuous sampling of key travel and system performance indicators for trend analysis and perspective for travel model forecasts. Periodic, more extensive, updates of a broader set of factors that influence model parameters should be conducted for updating and revalidating travel models. A continuously updated national longitudinal travel panel survey should also be considered. The following are specific recommendations. Information on travel behavior within households should be collected, including how choices and negotiations occur to determine vehicle ownership and use. Improved information is needed on driver characteristics that affect emissions. These include factors in travelers’ decisions regarding timing and length of trips, travel variations during and between days, driving (not travel) characteristics, and trip chaining.

Information on the effects of policies should be gathered. Quantitative assessments are possible for policies such as parking restrictions; commute options; and road, parking, and fuel pricing. Qualitative information should be obtained on the effects of actions such
as widened sidewalks, protected crosswalks, median removal and insertion, and building setbacks. Information should be obtained on the performance of demand management actions and other transportation control measures. Demographic trends and urban development patterns should be monitored for changes that affect travel; particularly variations from assumptions used in travel forecasting. Changes noted should be incorporated as revisions in the models.

The potential for using advanced technologies to collect data should be assessed. Remote sensing, automatic vehicle locating technologies, and global positioning systems (GPS) appear to have potential for tracking vehicles. These techniques may be useful for travel model validation, goods movement analysis, vehicle classification studies, and intermodal studies. The products of the data collection activity should be available in a national database, accessible by agencies nationwide for evaluation of reasonableness of local results.

**Global Positioning Systems**

GPS might be useful to improve data collection for activity-based and other models and might partly replace conventional trip diaries. Experiments are underway in the Netherlands.

**Personal Computers and Internet**

About 40 percent of Dutch households own a personal computer and 10 percent own a modem (GfK Interact, 1996). The establishment of consumer panels may be greatly facilitated by this: a same group of people can be interviewed periodically on the same subject, or incidentally on special subjects.

**Stated Preference**

Stated Preference (SP) techniques (e.g., Richardson et al., 1995 or Ortuzar, Willumsen, 1994) have become extremely popular for a variety of reasons:

- They can deal with situations in which a substantially new alternative is being introduced and there is little or no historical evidence of how people might react to this new alternative.
- They can be helpful when the investigator is trying to determine the separate effects of two variables on consumers’ choices, but where these two variables are highly correlated in practice.
- The variability in observed choices and in the exogenous variables can be controlled and can be made larger than in revealed preference surveys.
- They can be particularly effective in cases where the derivation of sensitivities and elasticities is more important than forecasts of absolute mobility levels.
- The survey costs will often be smaller.

There are many examples of good successful applications of the technique, for example in value-of-time research (HCG, 1990). However, one of the main dangers for SP techniques is a questionnaire with a long series of tedious boring questions to fit the needs of the researcher’s advanced mathematical model.
To deal with the problem that people do not always do what they say, and to increase the credibility of SP results, techniques using mixed Stated Preference and Revealed Preference data are highly desirable (Ortuzar, Willumsen, 1994).

**Data to Assist the Process of Political Decision Making Data Derived from “Games”**

In many cases the political process is far from rational. Objective forecasts are not enough; insight is also needed in the “process.” For this, “games” can be useful. Representatives of parties concerned are brought together to play a “game,” during which they are confronted with the consequences of the choices they make as predicted by a “sketch-planning model.” The study of the interactions between the parties as they develop may be very useful to increase the level of support of policy measures.

**The “Choice-Questionnaire”**

An important objection often raised against civil participation is that “ordinary people” have insufficient knowledge to make responsible choices. Besides, we know from descriptive decision-research that people who have to make a decision often do not consider all alternatives of a choice-problem, can overlook important consequences, or cannot estimate the chances of certain outcomes very well. An instrument developed to meet these objections, which can be used to generate detailed information with regard to the opinions about the various aspects of a problem (for instance consequences in relation to economy, health, environment and society) is the choice-questionnaire (Neijens, 1987).

The choice-questionnaire is a questionnaire in which information about the choice-problem is offered. This information consists of the alternatives from which a choice must be made and the consequences related to these alternatives. For a number of reasons, the choice-questionnaire is interesting from a political point of view:

- **Policy-makers gain better insight into the considerations of the citizen.** The information obtained from choice-questionnaires is very detailed, because insight is not only gained into the choices that people make, but also into the opinions about the problem.

- **The choice-questionnaire is an expedient to the communication of government policy to the general public.** For example, during the “comprehensive societal discussion” on nuclear energy in the Netherlands, it appeared to be possible to formulate a complex problem in such a way that people from all strata of society could participate. In the choice-questionnaire a complex problem is unraveled into a number of smaller problems, by which the whole problem becomes much clearer.

- **The choice-questionnaire can contribute to the creation of a societal basis for government policy.** By supplying respondents with necessary information about the consequences of different choice-alternatives, they will gain better insight into all aspects of the problem, by which resistance might be taken away.

The methodology has recently been applied in the Netherlands to the introduction of a paid-parking system in certain districts in a medium-sized town (Leiden). To demonstrate its utility, a comparison was made with a standard questionnaire. The choice-questionnaire was submitted to half of the respondents, the standard questionnaire to the other half (Saris, van der Put, 1996). In 1994 Rijkswaterstaat, the public works
department of the Ministry of Transport, started an experiment, “Infralab.” Its mission is to find and test new ways which Rijkswaterstaat, together with the society at large, can create an adequate national transport infrastructure. There are two main objectives. The first is to bridge the gap between government and the citizen. Rijkswaterstaat should not define the problem, make blueprints for solutions, and then “go outside.” Instead, Rijkswaterstaat should cooperate with the problem owners right from the beginning. The second objective is to find new solutions for the infrastructure problems. Not “more of the same,” but other and smarter proposals. Many ideas show a large similarity to those developed in Susskind and Field (1996).

The most important elements of the methodology are

- The opinion of the end user serves as premise of the process.
- Government and citizens work together during the complete process.
- The process has a short duration (1 year as a maximum) and is transparently structured.
- All participants (road users, policy makers, and parties concerned) are challenged for active participation and creativity.

The working methods knows three phases:

- **Phase 1:** “The stakeholders’ voice.” Infralab engages all stakeholders to state a common problem definition. The result is an ordering of possible problem definitions. The phase ends with a decision moment. The relevant authority (municipal alderman, provincial commissioner of the queen, or national minister) takes his or her responsibility and lays down the problem definition and premises.
- **Phase 2:** “The Agora.” In this phase, Infralab engages all available creativity, both with the citizens and the professional experts, to find tentative solutions. Also this phase ends with a decision moment. The relevant authority, after evaluation and possibly feedback to the stakeholders, makes a statement on the desired solution.
- **Phase 3:** “Action.” Together the stakeholders give form to the chosen solution by drafting an action list. Furthermore, the stakeholders commit themselves to get support from their own group. The relevant authority formalizes the agreements, e.g., in the form of a convenant.

The Infralab methodology may seem trivial, but it is not. It is striking to see how often basic requirements in social planning processes are neglected. There is a natural tendency for experts to think immediately in terms of solutions, while elaborating the problem definition might lead to a much larger “solution space” and thus to much less “yes/no” debates.

**CONCLUSION: PRIORITIES FOR FUTURE DATA COLLECTION**

The following four tables constitute a summary of the trends to be expected and give a “shopping list” of future data needs (Tables 1-4).
<table>
<thead>
<tr>
<th>TREND</th>
<th>EXAMPLES</th>
<th>FUTURE DATA NEEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in scale</td>
<td>Concentration of facilities. Globalization. Preferences for amenities close by versus for concentrated mega-facilities.</td>
<td>Changes in organization of firms, and in the production process and logistics.</td>
</tr>
<tr>
<td>Flexibilization</td>
<td>Flexible workplaces, work hours, shop hours.</td>
<td>Degree of flexibility in space and time for households and firms.</td>
</tr>
<tr>
<td>Telecommunication and information</td>
<td>Improved trip planning, shifts in traffic, and less traffic, improved traffic management.</td>
<td>Availability of telecommunication and information technology facilities.</td>
</tr>
<tr>
<td>Global information networks</td>
<td>Availability of information and communication at any time or place. Changes in activity patterns of individuals and households.</td>
<td>Changes in organization of firms, labor relations, and in the production process and logistics.</td>
</tr>
<tr>
<td>Changing attitudes toward mobility</td>
<td>“Mobility goes for itself”.</td>
<td>Deeper attitudes, travel time budgets, and cost sensitivity.</td>
</tr>
<tr>
<td>New forms of car ownership and other transport modes</td>
<td>“Call-a-car” and other forms of shared car ownership.</td>
<td>Market potential as a function of available technology on the supply side and changing activity patterns and land use on the demand side.</td>
</tr>
<tr>
<td>TREND</td>
<td>EXAMPLES</td>
<td>FUTURE DATA NEEDS</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Increasing citizen participation</td>
<td>Consultation of citizen groups and advisory institutions. Long planning procedures. NIMBY problems and “prisoner’s dilemmas.” More concern for the “process” needed.</td>
<td>Insight into attitudes, moral principles, threatened interests, risks incurred by citizen groups concerned. “Management games.” Insight into the process, both from the “rational” and the “bargaining” viewpoint.</td>
</tr>
<tr>
<td>European integration, decentralization, deregulation, privatization</td>
<td>Transfer of power of national governments to supra-national institutions and regions.</td>
<td>How to maintain a dialogue with citizens concerned.</td>
</tr>
<tr>
<td>Environmental concern</td>
<td>Concern for a “sustainable society” at the local, national, and global level.</td>
<td>Priority of the environment on the political agenda, measures which are acceptable and which are not. Costs of mobility. Actual pricing levels, external costs of transport. Acceptance of tax and other policy measures.</td>
</tr>
<tr>
<td>Congestion</td>
<td>Preferential treatment of “target groups” and road pricing. Increasing congestion. HOV lanes. Toll roads.</td>
<td>How to make congestion “endurable,” given that it cannot vanish completely.</td>
</tr>
<tr>
<td>Renewed interest in infrastructure, and (private) finance</td>
<td>Increased government budgets. BOT schemes.</td>
<td>Medium-term forecasts for government and private sector.</td>
</tr>
<tr>
<td>Deregulation and privatization in public transport</td>
<td>Rail, local public transport, tendering by regional authorities.</td>
<td>More reliable forecasts of profitable and non-profitable services.</td>
</tr>
</tbody>
</table>
### TABLE 3 Innovation in Models and Forecasting

<table>
<thead>
<tr>
<th>INNOVATION</th>
<th>EXAMPLES</th>
<th>FUTURE DATA NEEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity-based models</td>
<td>Dealing with task combinations, activity- and trip chaining, in home/out-of-home substitution of activities, modeling activity durations, user-benefit measures. Models based on artificial intelligence, genetic modeling, and satisficing instead of optimizing behavior.</td>
<td>Data about activity patterns without unduly placing burden upon respondents.</td>
</tr>
<tr>
<td>Dynamic longitudinal panel-models</td>
<td>Vehicle holding model; medium-term models for infrastructure construction.</td>
<td>Panel data.</td>
</tr>
<tr>
<td>Land-use transportation models</td>
<td>Effects of congestion and of opening of new infrastructure upon regions.</td>
<td>Before-and-after studies with several measurements over the long-term.</td>
</tr>
<tr>
<td>Equity considerations</td>
<td>Distribution of costs and benefits.</td>
<td>Disaggregate models and evaluation procedures.</td>
</tr>
<tr>
<td>Sketch planning models</td>
<td>See text.</td>
<td>See text.</td>
</tr>
<tr>
<td>TMIP Program USA</td>
<td>Compendium of large elaborate model systems.</td>
<td>Derivation of elasticities.</td>
</tr>
</tbody>
</table>

### TABLE 4 Innovations in Data Collection

<table>
<thead>
<tr>
<th>INNOVATION</th>
<th>EXAMPLES</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMIP Program USA</td>
<td>See text.</td>
<td>See text.</td>
</tr>
<tr>
<td>Global Positioning Systems</td>
<td>Replacement of trip diaries.</td>
<td></td>
</tr>
<tr>
<td>Personal Computers and Internet</td>
<td>Online interviewing. Experiments.</td>
<td>Reduced fieldwork costs; better data quality; faster response.</td>
</tr>
<tr>
<td>Stated Preference</td>
<td>Many.</td>
<td>Mixed RP/SP data needed.</td>
</tr>
<tr>
<td>Management games</td>
<td>Choice-questionnaire; INFRALAB Study of interaction between parties in transport planning.</td>
<td>Insight into attitudes, moral principles, threatened interests, risks incurred by citizen groups concerned. Insight into the process, both from the “rational” and the “bargaining” viewpoint.</td>
</tr>
</tbody>
</table>
WRKSHP SUMMARY

Susan Liss
U.S. Federal Highway Administration

THE WORKSHOP PROCESS

There was some concern about how we should develop guidelines for our topic area, and we decided, as a group, that we should identify topic areas that we need to know more about, or at which we need a different look. An example is the area of “stated preference,” which we renamed “the potential market for…” Most of us in the workshop recognized a very real need for data that would perform this function, while acknowledging some of the weaknesses in the current state of the practice in stated preference data collection.

RECOMMENDATION FOR COGNIZANT AGENCY

While much time and effort were spent deliberating on subject or topic areas, the most significant recommendation from our workshop is that an international organization serve as a cognizant agency for establishing non-mandatory standards and advocating survey research. The conference participants, as practitioners in the field of transport surveys, recognize the need to spend the resources to address the issues of survey quality, conduct research, and attempt innovative solutions to maintain quality. As practitioners, we do not have the funds required for survey research and development. The clients who will use the data do not see the need for survey research and development. A cognizant agency could, by establishing non-mandatory standards, serve as a focal point for quality and reliability in the survey research field. A cognizant agency for transport surveys could play a role similar to that of the World Tourism Organization in maintaining standards and credibility in tourism data and surveys. The Organization for Economic Cooperation and Development (OECD), or OECD with a linkage to the European Council of Ministers of Transport (ECMT), were mentioned as possible candidates for the cognizant agency. Certainly, the Grainau conference confirmed that the quality issues we have in common far outweigh the issues that are unique to our own countries.

TOPIC AREAS

In determining the topic areas, we relied heavily on Toon van der Hoorn’s thought-provoking and well-written resource paper. Our discussions and deliberations resulted in the identification of the 15 topic areas listed below. We asked that each workshop member rank their priority items using 10 points each. The 10 points could be distributed to 10 different items, several items could get multiple points or a combination of multiple and one point voting, or all 10 points could be assigned to one item. The topics below are listed in the priority order that resulted from our voting. There was a break in the scores after the top 9, so we developed those 9 with recommendations, as follows.

**Congestion**

- Derive data systematically from traffic reporting systems
- Combine congestion reporting with air pollution reporting
• Make full use of Global Positioning Systems (GPS), video detectors, and telemetrics
  • Use queuing theory to define congestion measures
  • Develop a classification of congestion attributes, including indicators such as the depth and breadth
• Define recurring and nonrecurring delay
• Establish the probability of nonrecurring congestion, based on specific attributes of the transport system
• Determine the public’s attitudes toward congestion

**Determine the Market for Potential Passenger Transport System Change**

• Must include a thorough measure of consumer attitudes toward system change
• Make it clear to others that forecasts are limited in their reliability to a range of current alternatives
  • Use input from the social and political sciences
  • We must make the case for the resources needed to study new alternatives
  • Monitor changes in attitudes
  • Include both expanded and reduced choice sets
  • Understand more about elasticities
  • More detailed definition of “modes” and “vehicles”
  • More information on the interaction of transportation and communications, including substitution of telecommuting for travel

**Long-distance Travel Surveys**

• Establish a continuing system of monitoring long-distance travel—this is of particular importance on a European scale (COST 305 recommendations, EUROSTAT/MEST)
  • Collect price data in a consistent way for all modes
  • Provide a bridge between short- and long-distance travel
  • Define the sampling frame and any use of oversampling
  • Be aware of potential for invasion of privacy in license plate surveys
  • Adopt World Tourism Organization definitions and classifications
  • Develop price and spending measures for trips and activities at the destination
  • Develop data on the social and economic impacts of transportation investments for tourism

**Costs and Benefits of Transport**

• Include external costs of transport
• Quantify benefits of transport
• Use financial measures of physical damage and transport benefits
• Harmonize definitions for accidents and emissions
• Communicate cost/benefit analysis to the public
• Need better definitions/specifications for value of accessibility and mobility
• Use multi-criteria analysis rather than cost/benefit ratios
Decision-Making by Others Who Impact Transport (e.g., Employers, School Systems, Developers, Health Care Providers, Also Includes Legislative and Regulatory Change)

- Survey employers to establish attitudes toward teleworking, carpooling, transit, flextime and traffic demand management schemes
- Survey employers to establish value of employees’ working time savings
- Require a transportation impact statement for certain types of changes (e.g., a school system allowing secondary students to attend any school within a certain geographic area)

Freight Transport

- Follow recommendations on long-distance surveys (see above)
- Focus on the shippers, not the vehicles
- Get information on non-reporting enterprises in current freight surveys
- Use stated preference/revealed preference shipper surveys to deal with the full chain of movements, not just modal segments
- Determine who is the decision-maker in the logistics chain—distinguish between own account (private carrier) and hire-and-reward (common carrier)
- Develop stated preference methods to determine the market potential for freight movement
- Establish freight generation rates by commodity type and industry type, which will assist in developing a linkage to economic surveys
- Establish mechanisms to use standard administrative records
- Develop methods to encourage public/private participation in freight data collection
- Establish the distribution of the size of transport enterprises, including individual truckers
- Use vehicle registration population to identify single-unit operators
- Make better use of truck 1-week diary survey done in Europe (EUROSTAT Truck Survey)
- Need for harmonized freight classification system

Sketch Planning Models

- Evaluate value of elasticities
- Need to have cross-country transferability

Land Use

- Invest more in GIS-based collection of land-use data
- Programs for regular updating of land-use data
- Need for consistency checking, especially for commercial activities
- Need information on land prices as a function of accessibility
- Before-and-after information—intentions of actors and subsequent actions, also attitudes
• Capture people when making land use transactions—use this to keep system updated
  • Develop measures of urban sprawl
  • Need to develop neighborhood descriptors—residential and commercial

**Cost and Revenue Allocation**

• Consistent system for public transport revenue allocation
• Need to use surveys to allocate costs and benefits
• Increase sample size
• Survey on a continual basis, plus seasonal variation
• Greater level of disaggregation
• GIS processing of locational data
• Validate information with external network and supply data
• Independent auditing of companies
• Precise methods to split farebox revenues to operators, given trends toward more competition
• Better procedures to allocate demand to services
• Distribution of parking facilities and prices

The remaining seven topic areas were simply listed. We did not have the time to develop them:

• Loss of regulatory data
• Longitudinal (panel) surveys
• Public consultation procedures
• Short-term forecasts, including ITS
• Synthesis of operational data
• Congestion pricing data
• External costs of transportation

**SUMMARY**

The workshop provided the opportunity to define our needs to advance the state of the practice in transport survey planning, design, application and uses of transport survey data. The needs, of course, are much greater than we can realistically expect to meet. Designation of a cognizant agency will raise the level of awareness of the issues faced in transport surveys and the need for resources to address those issues.
## Appendix A: Structuring of Practitioner’s Needs

<table>
<thead>
<tr>
<th>Practitioner/Client</th>
<th>Transportation Planner</th>
<th>Road Administrator</th>
<th>Politician (e.g., on City Council)</th>
<th>Transportation Economist</th>
<th>Public Transit Operator</th>
<th>Manager of Mobility</th>
<th>Society</th>
<th>Journalist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>His/Her Tasks/Aims</strong></td>
<td>Prepare transportation master plan</td>
<td>Improve long-distance travel</td>
<td>Create approved transportation policy at the local level</td>
<td>Determine the efficiency of transport investment</td>
<td>Increase revenues (reduce subsidies)</td>
<td>Reduce travel</td>
<td>Accept new road construction</td>
<td>Educate/form sustainable transportation behaviors</td>
</tr>
<tr>
<td><strong>Instruments/Means to Fulfill the Aims</strong></td>
<td>-Development of street network -Development of public transport system</td>
<td>Build toll motorway</td>
<td>Define and evaluate the options of transport system development</td>
<td>Cost/benefit analysis - including external costs</td>
<td>-Increase fares -Increase passenger volume due to improving service level</td>
<td>Telematics (for example)</td>
<td>Public participation procedures: -consultation -referendum</td>
<td>TV, Newspaper</td>
</tr>
<tr>
<td><strong>Practitioner’s Needs Met by Tools (including models)</strong></td>
<td>-Integrated travel model (land use /modal split/trip distribution/traffic assignment)</td>
<td>-Model for willingness to pay for motorway - Model for forecasting traffic volume</td>
<td>-Simple travel forecasting model -Relationship between structure of transport and environmental impacts -Relative weights of criteria</td>
<td>Results of travel surveys and simulation - average travel time - ridership - traffic volume - environmental impacts</td>
<td>-Modal split model -Elasticity rates of demand versus cost/supply</td>
<td>Model for willingness to use: - tele-working - tele-education, and - tele-shopping</td>
<td>Model for predicting future travel -Relationship between traffic volume and environmental impacts -Multi-criteria weighting</td>
<td>Relationship between motivation level, density of street network, car use and environmental impacts (congestion, road accidents, noise, pollution)</td>
</tr>
<tr>
<td><strong>Database</strong></td>
<td>-Features of actual transport network -Traffic counting -Questionnaire for mobility, modal split -Actual O-D matrix</td>
<td>-Results of traffic counting -Roadside interviewing</td>
<td>-Actual mobility and modal split -Actual environmental impacts of traffic -Validation of criteria</td>
<td>-Traffic counting -Passenger flow counting -Questionnaires of transport system users</td>
<td>-Questionnaires to investigate change in demand -Actual demand and supply of public transport system</td>
<td>-Socio-demographic data - Questionnaires to determine willingness of tele-activity</td>
<td>-Traffic counting in the network -Actual environmental impacts of traffic -Questionnaires for criteria evaluation</td>
<td>-Motivation level -Actual density of street network -Environmental impacts</td>
</tr>
</tbody>
</table>