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ENVIRONMENT DIRECTORATE
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Working Party on Pollution Prevention and Control
Working Group on Transport

PROJECT ON ENVIRONMENTALLY SUSTAINABLE TRANSPORT (EST)

THE ECONOMIC AND SOCIAL IMPLICATIONS OF SUSTAINABLE TRANSPORTATION

PROCEEDINGS FROM THE OTTAWA WORKSHOP

86453

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FOREWORD

The Environment Directorate of the Organisation for Economic Co-operation and Development (OECD) is conducting a project on Environmentally Sustainable Transport (EST). The project's aims are to characterise EST and to develop policy guidelines for the attainment of EST. As part of the project, a workshop was held on the economic and social implications of sustainable transportation at the Government Centre in Ottawa, Canada, on the 20th and 21st October 1998. The workshop was held in conjunction with Phase 3 (policy instruments and their implications) of the multi-year EST project which is being conducted under the auspices and guidance of the OECD's Working Group on Transport.

The purpose of the workshop was to review and contribute to work in progress rather than to resolve substantive issues about sustainable transportation or to seek solutions to pressing global problems. The workshop was also an occasion for detailed consideration of what lies ahead in Phase 4 of the project, which will concern the development of policy guidelines for the attainment of EST (Phase 4 will be conducted during 1999/2000). The workshop was co-organised and hosted by the Canadian Government to provide an opportunity for substantive North-American input into the project. Project teams include one North American and seven European countries. It was very much a workshop rather than a forum for the presentation of results.

These are the proceedings of that workshop which have been reviewed by the Working Group on Transport. Other EST project-related documentation is available at the Environment Directorate's web page http://www.oecd.org/env/ccst/est.

This report is published on the responsibility of the Secretary-General of the OECD.

ACKNOWLEDGEMENTS

The OECD would like to acknowledge the important support provided by the government of Canada that hosted the workshop. Environment Canada and Transport Canada were the representative bodies and co-organisers who provided additional financial and logistical support for the event. The help and efforts of the staff of these institutions, in particular Julie Charbonneau, Andaleeb Qayyum, Roy Begin and Philip Kurys, is well acknowledged.

Particular thanks go to Richard Gilbert who assumed the principal responsibility for organising the workshop, co-ordinating the input from the different institutions, and setting-up the speakers. He also drafted the summary of the workshop discussions. The participation and contribution by the various speakers, discussion leaders and rapporteurs are also acknowledged.

The final report was reviewed by Peter Wiederkehr of the Pollution Prevention and Control Division of the Environment Directorate. Editing, layout and logistical support was ably provided by Jane Kynaston, Cilla Cerredo-Williamson and Lyndia Levasseur of the Secretariat.

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1. BACKGROUND, SCOPE AND OBJECTIVES OF THE WORKSHOP

The Environment Directorate of the OECD - under the auspices of the Environmental Policy Committee, is conducting a project on Environmentally Sustainable Transport (EST). The project's aims are to characterise EST, construct scenarios, identify policy instruments and to develop policy guidelines for the attainment of EST. As part of the project's phase 3, a workshop was held on the economic and social implications of sustainable transportation at the Government Centre in Ottawa, Canada on the 20th and 21st October 1998.

The workshop was held with the following objectives:

- To review OECD work on the economic and social implications of the environmentally sustainable transport and, in particular, to provide peer review of on-going work on Phase 3 of the EST project concerned with identification and assessment of the economic and social implications of attaining and maintaining EST.

- To provide input on the economic and social implications of EST from a range of perspectives of OECD Member countries, in particular from North America.

- To reach some conclusions as to how the economic and social implications of EST could be taken into account in the development of guidelines for policy development by OECD Member countries towards the attainment of EST.

- To identify gaps in knowledge and understanding and to develop strategies for remedying deficiencies.

The main purpose of the workshop was to review and contribute to work in progress rather than to resolve substantive issues about sustainable transportation or to seek solutions to pressing global problems. The workshop was also an occasion for detailed consideration of what lies ahead in Phase 4 of the project, which will concern the development of policy guidelines for the attainment (Phase 4 will be conducted during 1999/2000). It was very much a workshop rather than a forum for the presentation of results.

Accordingly, as detailed in Section 2 of this report, the format of the workshop allowed more time for structured discussion than for formal presentations. The discussions occurred in English- or French-language breakout sessions or in bilingual plenary sessions.

About 60 persons participated in at least half of the two-day event, roughly two thirds from North America and Japan and one third from Europe. Transport experts, academics, government officials, and environmental groups were well represented. There were fewer representatives of relevant industries than had been expected and fewer participants from the United States.

A particular feature of the workshop was that it was organised almost entirely by e-mail. Every participant who registered more than a week before the event received sufficient workshop-related materials to permit full and informed participation in the discussions.

2. ORGANISATION OF THE WORKSHOP AND OF THIS REPORT

The first and last of the four half days of the workshop were dedicated to plenary sessions involving formal presentations and several opportunities for discussion. During the second and third half days, participants were mostly in breakout sessions that were usually structured by informal presentations by discussion leaders. The final program for the workshop is set out in Table 1.

Table 1. **Overview of the workshop programme**

20 October, morning: Setting the scene - Review and discussion of the OECD studies on economic and social implications of sustainable transport.

Welcome on behalf of the Government of Canada and the OECD:
Vic Shantora, Toxics Pollution Prevention Directorate, Environment Canada; and
Jean Cinq-Mars, Pollution Prevention and Control Division, Environment Directorate, OECD.

Presentations:

- The OECD's Environmentally Sustainable Transport (EST) project
  - Peter Wiederkehr, OECD Environment Directorate, Paris, France.
- Economic Implications of EST scenarios
  - Professor Werner Rothengatter, University of Karlsruhe, Germany; and
- Social Implications of Hypermobility
  - by Professor John Adams, University College London, U.K., followed by discussion.

Critiques of the OECD studies on the economic and social implications of EST:
David Levinson, University of California, Berkeley, U.S.A.; and
Anthony Perl, University of Calgary, Canada, followed by a discussion period.

20 October, afternoon: Parallel breakout sessions on the economic and social implications of EST and on cultural differences in the implications.

A. Economic Implications of EST.
Discussion leader: David Nowlan, University of Toronto, Canada.
Rapporteur: Sue Zielinski, City of Toronto, Canada.

B. Social Implications of EST.
Discussion leader: Donald Chen, Surface Transportation Policy Project, U.S.A.
Rapporteur: Geoffrey Noxon, Region of Ottawa-Carleton, Canada.

C. Cultural Differences in the Economic and Social Implications of EST.
Discussion leader: Martin Lee-Gosselin, Laval University, Canada.
Rapporteur: Romain Molitor, Trafico, Vienna, Austria.

Plenary session:

Presentation and discussion of rapporteurs' reports. Discussion leader, Peter Wiederkehr, OECD.

21 October, morning: Introductory plenary presentation.

"Lessons for the future from the past: How North American transportation got to be the way it is, and what can be done about it,"
Jane Holtz Kay, author of *Asphalt Nation: How the Automobile Took Over America and How We Can Take It Back.*

Breakout sessions on how the economic and social implications might influence development of guidelines for the attainment of EST.

A. Discussion leader: Preston Schiller, Sierra Club, Washington, U.S.A.
Rapporteur: Richard Soberman, University of Toronto.

B. Discussion leader: Neal Irwin, IBI Group, Toronto.
Rapporteur: Ruta Whittaker, Health Canada.

C. Discussion leader: Alain Morcheoine, Agency for the Environment and Energy Saving, France.
Rapporteur. Julie Charbonneau, Environment Canada.

Plenary presentation and discussion of rapporteurs' reports
Discussion leader: Peter Wiederkehr, OECD.

21 October, afternoon: Plenary discussion sessions.

Synthesis
Discussion leader: Richard Gilbert, Director, Centre for Sustainable Transportation, Toronto, Canada.

– Conclusions
Discussion leaders: Brigita Gravitis, Director, International Affairs, Environment Canada, and Jean Cinq-Mars, OECD.

Note: Breakout sessions A and B were conducted in English: Breakout sessions C were conducted in French. The plenary sessions were conducted in English and French.

The following account of the workshop begins with a brief overview of the EST project at the time of the workshop, and the workshop discussions of the project as a whole (Section 3). The subsequent three sections are concerned with the main themes of the workshop presentations and discussions: Section 4—assessment of economic implications of EST; Section 5—assessment of social implications of EST; and Section 6—development of guidelines for the attainment of EST. Section 7 sets outs conclusions, both those drawn at the workshop and those drawn from consideration of what happened at the workshop. Other matters addressed at the workshop—including cultural and historical matters—are noted within the discussions of the themes or in the section containing conclusions.

3. THE EST PROJECT—SYNTHESIS OF THE SCENARIO WORK

It is increasingly clear that current transport systems are not environmentally—and, consequently, not socially or economically—sustainable over the long term[1]. Likely advances in technology will not be sufficient to overcome increased environmental impacts stemming from growing transport demand. Projecting current 'business-as-usual' trends, transport in 2030 for many OECD countries will have reduced polluting emissions, except for carbon dioxide where it will be moving away, rather than toward, environmental sustainability. Extrapolating current estimates of transport's unaccounted costs, transport in 2030 will likely place a significantly large economic and social burden on society.

A new policy approach is needed that gives prominence to environmental criteria along with other policy goals. Recognising this need, the OECD Environmental Policy Committee's Task Force on Transport (now the Working Group on Transport) initiated the EST project in 1995 to give some precision to the concept through the use of quantifiable criteria that have environmental significance. Unlike conventional approaches to transport system development, the EST project uses a "backcasting" (as opposed to "forecasting") methodology; it started with a vision and a series of criteria for environmentally sustainable transport in 2030 (see Figure 1). Teams from eight countries undertook six case studies (Sweden, the Netherlands, Germany, the Quebec-Windsor corridor in Canada, the greater Oslo region, and the Alpine region comprising parts of France, Switzerland, and Austria) to describe how this environmentally desirable future may be achieved. The project includes several phases[2].

Phase 1 involved a review of relevant activities of Member countries as well as the development of the definition and criteria for EST (OECD, 1996).

Phase 2 focused on the identification of the gap between current and projected trends and the EST criteria through scenario development. During this phase, each study team constructed a 'business-as-usual' (BAU) scenario and three scenarios consistent with the EST criteria (OECD, 1998).

Phase 3 is the "backcasting" phase. It comprises the identification of packages of policy instruments whose implementation would result in achieving the EST scenarios constructed during Phase 2. Phase 3 also involves assessment of the social and economic implications of the BAU and EST scenarios.

Phase 4 will refine the criteria for achieving EST and develop policy guidelines.

A study that has adopted essentially the same approach is also in progress for fourteen Central and Eastern European countries through a joint Austrian, UNEP, and OECD effort – *EST in the CEI Countries in Transition (BMUJF/OECD/UNEP, 1999).*

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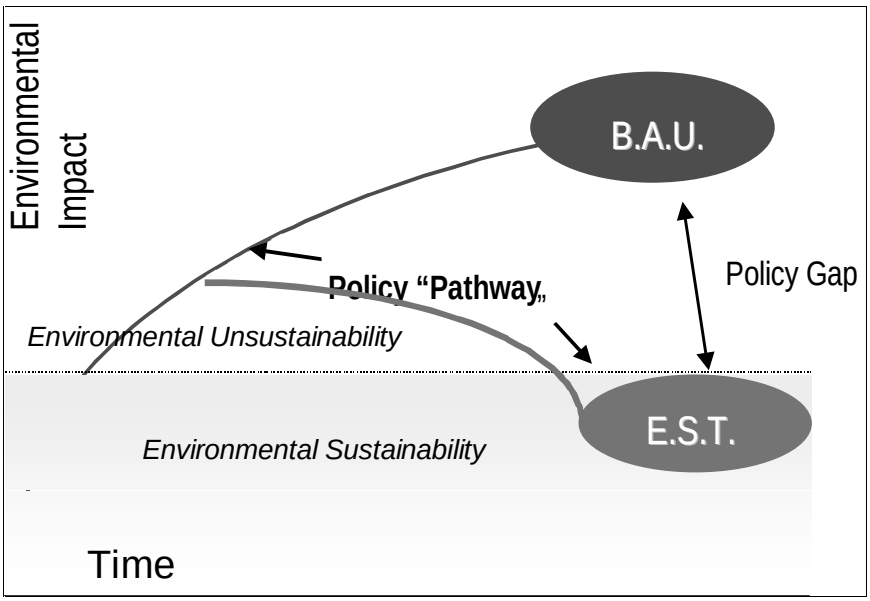
1 For more information on this phase see:
OECD, 1996: Environmental Criteria for Sustainable Transport, OECD, Paris
OECD, 1999: Report on Phase II of the OECD EST Project; Vol. 1, Synthesis of EST Scenarios, Paris

2 Also see the project summary at OECD's Internet site at http://www.oecd.org/env/ccst/est and related documents available online.

Figure 1. **EST approach: BAU forecasting vs. EST backcasting**



The ecological requirements for a sustainable transport system imply that the movement of people and goods occurs in an environmentally, socially, and economically sustainable way; mobility for communication and enabling social contacts as well as for access to goods and services is to be considered as a means rather than an end in itself. Environmentally sustainable mobility will require changes in behaviour and innovative approaches – technological as well as societal - at all levels of society and all sectors of the economy. An important prerequisite for realising an EST system in the long term is to take into account the ecological limits and to prevent and minimise pollution.

A sustainable transport system is one for which (i) generally accepted objectives for health and environmental quality are met (e.g., those proposed by the World Health Organization concerning air pollutants and noise); (ii) ecosystem integrity is not significantly threatened; and (iii) potentially irreversible effects are avoided and adverse global phenomena such as climate change and stratospheric ozone depletion are not aggravated. Therefore, to use the definition developed during Phase 1 of the EST project, an environmentally sustainable transport system is one that *does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes.*

Six EST criteria were developed during the first phase of the project as being the minimum number required to address the wide range of transport impacts. These criteria were selected to take into account and to represent local, regional and global impacts. They concern local air quality (NO_2 and PM), noise, tropospheric ozone, acidification and entrophication, global CO_2 concentrations and land-take. Operative goals and targets have been selected regarding emissions of carbon dioxide, nitrogen oxides, volatile organic compounds, and carcinogenic particulate matter, as well as noise and land take.

Environmentally sustainable transport in 2030 will, by definition, meet all six of the EST project criteria. In building a vision of such a system, two alternative pathways were explored. The first focused on reaching the EST criteria solely through technological means. The second focused on use of demand-side management measures. The project developed a final EST scenario by combining some of the most

promising and currently existing and tested features of the technology scenario with the more politically acceptable features of the demand-side management scenario. In the final EST scenario (known in the project as EST3), transport in 2030 is characterised by the following:

- There is a significant decrease in current forms of individual motorised transport, (i.e., car ownership and use) with many cars running on hybrid-electric engines and fuel cells with significantly less environmental impacts.

- There is a focus on reducing long-distance travel for passenger travel and on much greater use of non-motorised means for short-distance trips together with supporting infrastructure.

- Longer-distance freight movements are significantly decreased; hydrogen will be widely used as a fuel both directly and in fuel cells.

- Rail is all-electric, with increases in speed, efficiency, and capacity.

- More efficient and less polluting inland and coastal shipping vessels will be used; hydrogen may also be used as a fuel.

- Long-distance air travel is substantially reduced. Aircraft in use are more efficient conventional types; rigid airships may be used for specific purposes.

Generally, transport in 2030 is characterised by a massive shift from less sustainable to more sustainable modes accompanied by a relative decrease in transport activity (see Figure 2). Here are some other features:

- Electric power for transport is generated with much greater efficiency than at present, using a high proportion of renewable fuels.

- Relatively small changes in the form of settlements have been implemented in order to reduce the need for movement of people and freight.

- Greater use of telecommunications is made to obviate passenger travel and the movement of goods.

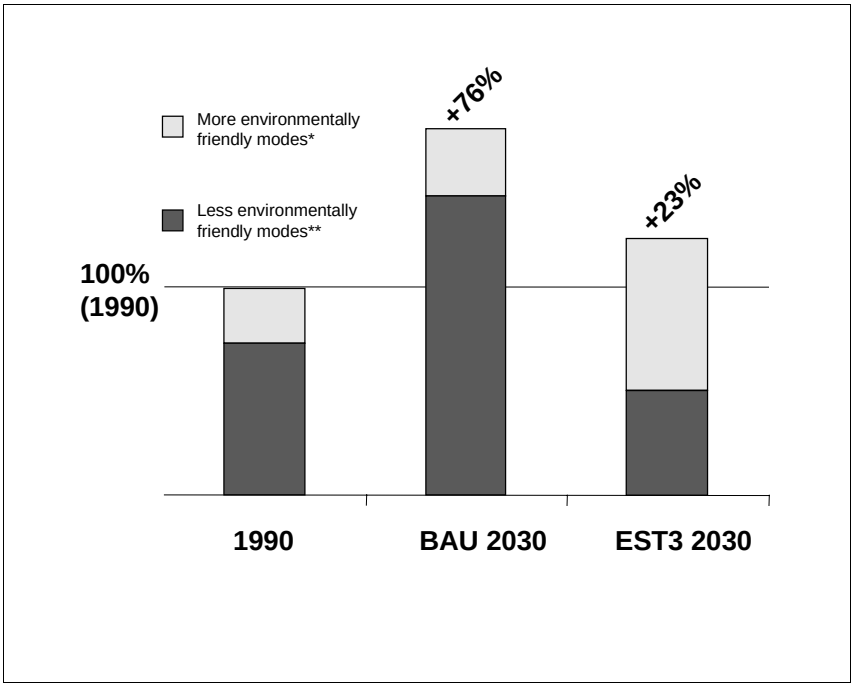
- Regionalisation of production occurs to avoid long distance freight movement; volume of goods transport is reduced; there is a greater focus on service provision.

- Continuing public education campaigns are implemented to help support lower levels of travel, and to lead more environmentally sustainable consumption.

All these policies and measures will support and accompany the shift towards more environmentally sustainable transport, while not necessarily decreasing economic and social welfare.

A key feature of transport under the EST scenario is illustrated in Figure 2. Transport activity, while less than under the BAU, is more in 2030 under the EST scenario than in 1990. This is made possible by much greater use of transport modes that are more respecting of the environment. Thus, attainment of EST does not necessarily mean a reduction in transport activity, only a reduction in certain types of transport activity.

Figure 2. **Modal structure of transport activity for passengers and freight in 1990 and 2030 (BAU and EST3 scenarios) showing use of means of transport more and less respecting of the environment**



*) non motorised, public transport, rail, waterways.
**) individual motorised transport for the movement of passengers and freight.

The EST criteria will likely not be met by technology alone. Indeed, contrary to much of current transport and environment policy, the results of the EST project suggest that attainment environmentally sustainable transport will require at least as much focus on changing transport-related behaviour as on improving vehicles, fuels, and infrastructure (see Figure 5 in the paper on the EST Project). Project participants generally have anticipated that less than half of the effort in meeting the EST criteria will come from technological improvements or from reducing the size and power of vehicles. More than half will come from managing mobility, from using vehicles more efficiently (better occupancy and loading), and from shifts towards more sustainable transport modes (e.g., road freight to rail freight) from reducing the need for physical movements of people and goods. As many countries develop mid- to long-term policy strategies for transport, this finding is important in that it may constructively guide those efforts.

Critique

The workshop was not designed to be an assessment of the whole EST project, but nevertheless such assessment comprised a considerable part of what happened at the workshop. The scene for this was set by David Levinson, who was asked to assess the work on economic implications and focussed mostly on what he perceived as the inadequacies of the project as a whole and its conceptual underpinnings.

Levinson began by commenting on the project's definition of EST (see the italicised text on Page 12). He argued that the phrase "does not endanger public health or ecosystems" is too absolute and that one recognising trade-offs with accessibility would be more realistic. He argued that the statement concerning renewable resources "ignores the dynamics of markets" and that the statement concerning non-renewable resources suffers from "comparison of stock and flows." He concluded his discussion of the definition by

asserting the need for scarcity of non-renewable resources so that prices increase and alternatives become attractive: "The right prices reflecting real market conditions (including real externalities) along with property rights will lead to clean transportation."

Levinson continued by proposing that the EST criteria are incomplete. There should be more criteria with more comprehensive definitions. He then suggested that the project's time horizon is unrealistic because "almost nothing can be known about the world in 2030." He continued, "The time horizon involved in this study is simply too long to be meaningful for accurate forecasting." He concluded his paper by claiming that "more is to be gained from technical shifts that accommodate human preferences than from behavioural shifts." To the extent there is a problem, it should be addressed by "setting the prices right, establishing a coherent set of property rights, and letting the market solve the problem."

Discussion

There was little discussion of these comments on the value of the EST project, although this may have in part been because the paper containing them was the only one not available in advance of the meeting. Workshop participants for the most part recognised that the challenge of setting distant goals and working out how to reach them is quite different from the challenge of making accurate predictions about the near future and working out how to prevent them from being realised. In other words, the project was recognised as a ground-breaking backcasting exercise rather than as a routine forecasting exercise.

There was general agreement that the backcasting exercise is valuable as a device both for clarifying the nature of the longer-term problems of transport and environment and for identifying and assessing potential solutions. There were no other criticisms of the project as a whole, only cautions.

The strongest cautions, raised by several participants, concerned how the results of the project will be presented, a matter addressed in each of the following sections. Another caution, raised by Anthony Perl, concerned the extent to which strategies concerning the attainment of sustainable transport can be usefully considered in isolation from sustainability strategies for other sectors of society. Perl asked "whether the transport sector is the place in our economy and society where it is feasible to launch a decisive break with business as usual?" He noted that "most of the time, operating under the politics of constraint, transport policies and projects get advanced and adjusted based on their fit with other policy agendas … transportation is a policy taker, not a policy maker." He proposed that "efforts to advance EST initiatives beyond the politics of constraint must disaggregate the varied economic and social implications with an eye toward finding—and facilitating—a fit between moves towards sustainable development in society and the introduction of new behavioural and technical innovations in the transport sector."

4. ECONOMIC IMPLICATIONS OF EST

Participants reviewed an interim report by Werner Rothengatter, OECD's consultant on economic implications. This report briefly reviewed methods that might be employed to assess the economic implications of EST (i.e., moving towards EST, attaining it, and maintaining it), and provided preliminary results from application of the chosen method.

The review began with a description and comparison of "classical methods" or "conventional methods" for assessing scenarios: cost-benefit analysis, cost-efficiency analysis, and multi-criteria analysis. Rothengatter discussed their most appropriate field of application and concluded that these methods were inappropriate because they were developed for marginal changes in the state of the world and take into account only one-directional impacts, i.e., they do not provide for feedback mechanisms among transport, the socio-economic system, and the ecological system.

The appropriate method in this case was Systems Dynamics Modelling (SDM). In SDM, variables at different levels are interrelated and sometimes linked through feedback. A system is stable to the extent that it is characterised by negative (i.e. corrective) rather than positive feedback loops. Negative feedback results in an equilibrium; positive feedback results in an unstable runaway condition. SDM permits cost-benefit assessments, and 'what-if' modelling that can identify values of external costs necessary for an EST scenario to break even in a cost-benefit analysis. However, SDM requires substantial resources for its implementation and input of data that may not be easily available.

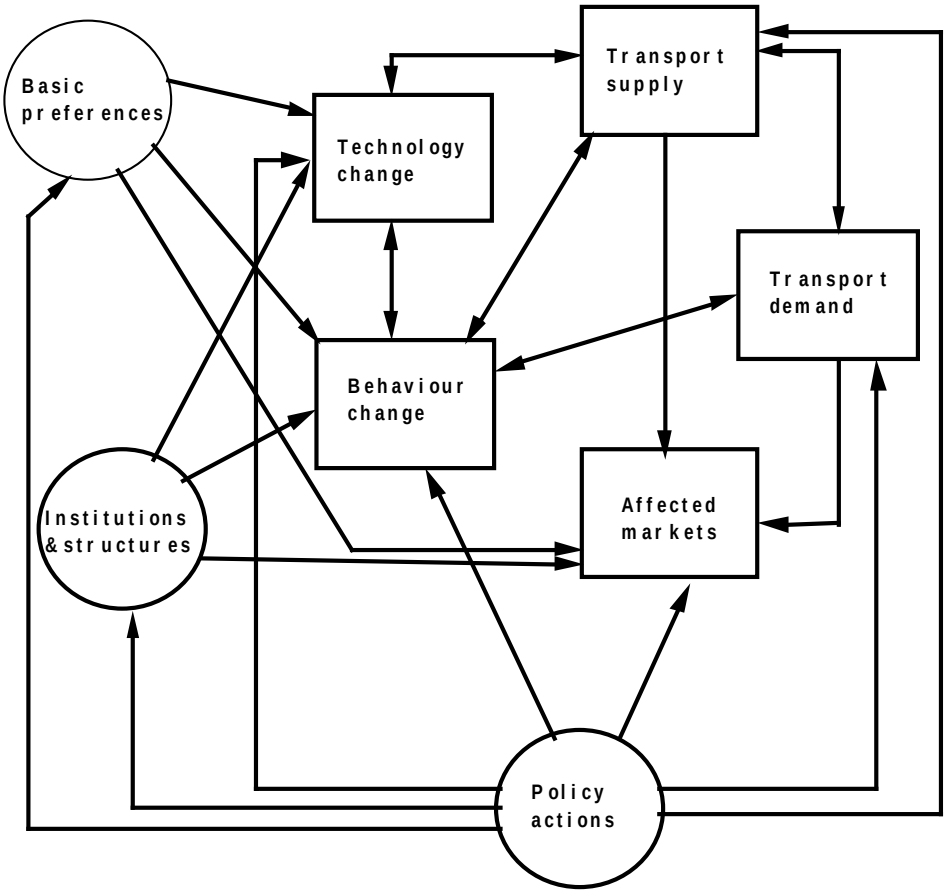
Accordingly, Rothengatter proposed the use of an alternative method—Simplified Cybernetic Modelling (SCM)—based on the 'impact path approach' (IPA), which "is based on the idea that the assessors follow the chain of impacts level by level through the economic system to result finally in aggregate economic indicators and assess the order of magnitude of their changes" (see Rothengatter's interim report, Section 5.1.ff).

The procedure for applying the IPA/SCM method is divided in two parts: (i) *Direct impact assessment*: the aim here is to estimate the impacts of EST following a one-directional impact path; (ii) *Interdependence analysis*: the aim here is to analyse the interdependencies between major variables and the most important feedback mechanisms. Figure 3 illustrates the interdependence analysis among the various levels of instruments.

First results of the application of IPA/SCM were available from an assessment of the German BAU and EST3 scenarios. Rothengatter concluded that compared with BAU in 2030, EST3 would involve five per cent less overall production in Germany, six per cent less material consumption, and three per cent less employment. These reductions could be halved if the German EST3 scenario involved more reliance on technological change rather than behavioural change. Rothengatter also concluded that with stated assumptions about the value of externalities the environmental benefits could be substantially greater than the economic losses, at least for the higher technology variant of the EST3 scenario. The German EST team was proceeding to use the more sophisticated SDM method.

First results were also available from an assessment of the Netherlands scenarios. Here the overall decrease in employment anticipated in the EST3 scenario was estimated to be between five and ten per cent, compared with the BAU scenario in 2030.

Figure 3. **Interdependence analysis: Part 2 of the IPA/SCM method**



Critique

As noted above, the requested criticism of Rothengatter's work by David Levinson turned out to be more a comment on the whole project. In the few paragraphs of his paper that addressed Rothengatter's approach, Levinson argued that Rothengatter had been too dismissive of cost-benefit analyses, and that his IPA/SCM method "is not conducted scientifically in that the assumptions, data, and methods are not clearly stated."

Discussion

Broad methodological questions received little attention during the plenary discussions following Rothengatter's and Levinson's presentations and during the breakout session on economic implications. (This could have been due in part to reluctance among the many economists present to engage in technical discussions in front of non-specialists, and in part to the lack of familiarity with the methods used). The

only substantive question concerned the validity of the analysis over the whole period of the assessment of the scenarios, i.e., until 2030. Rothengatter agreed that even the qualitative IPA/SCM analysis would be robust for no more than 15 years. A complementary point that was raised concerned the need for intermediate targets or milestones, which was agreed. Another point concerned the need to frequently evaluate progress and adjust scenarios and strategies according to the results, which was also agreed.

Several particular points concerning economic implications were raised during the plenary discussions and the breakout session. Some concerned factors that should be part of the assessment, including the following:

- The use and value of time and the use and value of space should be given at least qualitative consideration in the economic assessment.

- There should be consideration of the implications of actions by one or more countries on other countries, and on regions and more local levels within countries

- Several more indicators should be used concerning, among others, household income, compliance costs, and trade and related activity.

- Consideration of distributional effects is essential, i.e., who benefits from EST3 rather than BAU, and who does not.

- More information is need about sensitivity to changes in indicators, particularly whether costs and benefits change with the extent of progress towards attainment of EST (e.g. is the first 20 per cent of the change more or less difficult to achieve than the last 20 per cent of the change?).

Some comments concerned the presentation of the results of the assessment of economic implications, including the following:

- Exact numbers are less important than directions and trends.

- No-regrets or win-win policies and measures should be given prominence; more immediate and tangible impacts.

- Policy instruments resulting in more immediate and tangible impacts should be preferred.

- Economic implications must be linked to social and environmental implications in ways that make sense to decision-makers.

- Economic implications must be presented as simulations based on particular assumptions rather than as forecasts.

- The methodology should be presented clearly and in a manner that permits detailed assessment.

Some of the points raised during the discussions concerned additional work that should be done. These included the following:

- Work should be done on the economic and other advantages of not owning or using an automobile.

- Work should be done on how economic activity and transport activity might be decoupled.

The overall conclusion concerning the project's assessment of the economic implications of the EST3 scenario in comparison with the BAU scenario is that the methods being used for the assessment were considered to be mostly appropriate and the way in which the methods was being used was mostly acceptable. The thrust of the discussions was that the assessment was too limited in scope, but the complexity of the issues and the challenges of resource constraints were fully recognised. The most salient concern of participants was that the results of the economic assessment be reported in a manner that would be meaningful to decision-makers.

5. SOCIAL IMPLICATIONS OF EST

Participants reviewed an interim report by John Adams, OECD's consultant on social implications. This interim report set out a method for assessing the social implications of the BAU and EST3 scenarios and provided initial results from the application of the framework.

The method involved asserting propositions concerning the scenarios, illustrating the propositions where possible with relevant data drawn largely for the U.K., and securing agreement or otherwise from the eight participating Member countries, where possible with quantitative corroboration. At the time of preparation of the interim report, 151 responses had been received from six Member countries, of which more than 80 per cent were expressions of agreement with the respective propositions. The responses are summarised in Table 2, which is a simplified version of the summary of responses provided to participants in the workshop.

Table 2 suggests that, at least at the time of the workshop, there were six topics where there was an expected difference between the social implications of BAU and EST3:

Social polarisation Disparities between rich and poor in terms of access to social and economic opportunities will grow larger in the BAU scenario and diminish in the EST3 scenario.

Land use: Sprawl would continue with the BAU scenario but not so much with the EST3 scenario. As a consequence, there would be more dependence on car use in BAU and increasing disadvantage to those without cars.

Street life: There would be more traffic in the BAU scenario, which would undermine street life; there would be less traffic in the EST3 scenario, with an enhancement of street life.

Communities: The BAU scenario was associated with increased anonymity, with less knowledge of neighbours; the EST3 scenario results in more time being spent in communities, and consequently greater conviviality.

Children: Children are the principle losers in the BAU scenarios and the principle winners in the EST3 scenarios, respectively, on account of the constraints on independent mobility in the former and the safer environment in the latter.

Health: The health of individuals deteriorates in the BAU scenario and improves in the EST3 scenario, on account of the differences in the amount of exercise involved in daily living.

For the other 12 topics in Table 2 (those titles that aren't italicised), it was generally the case that the wording of the questionnaire was ambiguous, or there had been insufficient responses to date, or both.

Table 2. **Summary of preliminary results from the identification and assessment of social implications**

TOPIC	PROPOSITION for the Business-As-Usual Trend	A/R[1]	PROPOSITION for the EST3 Scenario	A/R[1]
Social-polarisation	Disparities between the rich and poor in terms of access to social and economic opportunities will grow larger.	7/7	Disparities between the rich and poor in terms of access to social and economic opportunities will diminish.	4/4
Car dependence	The rate of increase of car dependence will be greatest in the poorest countries.	4/4	If OECD leads by example the prospect of dissuading poor countries from following OECD's unsustainable example is much improved.	6/6
Land use	Land-use sprawl will continue, increasing society's dependence on the car, and increasing the disadvantage of those without cars.	6/6	Land-use patterns will be more "disciplined", and transport policies will promote equity of access for those with and without cars.	7/7
Street life	More traffic undermines street life.	8/8	Less traffic promotes street life.	8/8
Communities	Society becomes more anonymous, fewer people know their neighbours	8/8	More time spent in neighbourhood promotes conviviality.	8/8
Children	Children are the principal losers under BAU, their independent mobility being much constrained	8/8	Children are the principal winners under EST, the safer environment permitting greater independence.	6/8
Telecommun-ications	Increasing electronic mobility will promote further dispersal and encourage more travel.	4/4	Increasing electronic mobility a two-edged sword; it has the potential to promote or destroy community life.	5/5
Uniformity	The world becomes everywhere more the same culturally—the "Hilton-Mc"-Culture effect.	7/7	Cultural diversity is preserved by restraints on cross-cultural contact.	1/5
Safety	Life becomes more dangerous for pedestrians and cyclists, especially children and the elderly.	2/6	Life becomes safer for pedestrians and cyclists, especially children and the elderly.	7/7
Health	Health deteriorates from lack of exercise.	4/6	Life becomes healthier as exercise is incorporated into daily regime.	7/7
Nutrition	Those without cars find access to healthy food increasingly difficult.	5/6	The poor gain better access to healthy food.	1/5
Crime	The threat of crime increases.	3/4	The threat of crime decreases.	2/3
Law enforcement	Numbers of strangers increase, society becomes more paranoid, and law enforcement become Orwellian.	1/4	Societies in which people know their neighbours are mostly self-policing.	5/6
Equality	Access will be rationed by fiat and price, increasingly discriminating against the poor.	4/5	Equitable demand management is assumed, detail of how it will be achieved remains unclear.	2/3
Participation	The scale of government will increase, diminishing the significance of the individual voter.	4/4	Community politics will be revived.	2/2
Democracy	Democracy under threat.	0/3	Democracy under threat.	0/1

1. A/R indicates Agreement Ratio (number of Member country responses in agreement with the proposition/total number of definite responses to the proposition). A proposition is shaded if three quarters of the responses (from a total of eight country team responses) are definite and three quarters of definite responses are in agreement or disagreement. All instances here are of agreement; no disagreements with a proposition met the criterion. Where there is agreement with both of a pair of corresponding propositions for BAU and EST3, the cell in the "topic" column is also shaded.

Critique

Anthony Perl, who had been asked to respond to Adams' work, described the assessment of social implications as "thoughtful and thought-provoking." He then dwelt on related broader issues mostly concerned with how EST3 might be implemented than with how the assessment of social implications should be conducted. Some of Perl's concerns were noted above in Section 3. Other concerns of Perl—the characteristics of "top down" and "bottom up" perspectives in maintaining sustainable transportation initiatives—are addressed in Section 6.

There were no fundamental criticisms of Adams' methodology in the plenary discussions or in the breakout session concerning social implications. Indeed, the list of potential social effects provided by Adams was described as "an excellent starting point." The strongest comment on his work concerned what may be an insufficient regard for the positive social implications of increased mobility. This was translated into a proposal for further work: on identifying the break in the 'mobility curve' where social costs begin to outweigh social benefits—or perhaps where increases in mobility no longer bring increases in access, and may bring reductions in access.

There was agreement that up to a certain level mobility is socially beneficial; increased motorised mobility brings increasingly more social costs than benefits. This crude model reflected the prevalent thinking at the workshop—inspired by Adams—about mobility and social impacts.

Indeed, the need for more investigation was the overwhelming message from the consideration of social implications of attaining and maintaining EST and of what might be called the social aspects of sustainability. There was said to be a need for work on social sustainability to "catch up" with work on environmental and economic sustainability.

As well as the work on the 'mobility curve,' there were several other matters noted as needing detailed attention:

- There should be development of a more formal set of indicators of social sustainability as a prerequisite to a methodical analysis.

- Significant efforts at benchmarking based on the indicators should be made, to enable the monitoring of progress.

- Quantitative assessment of social costs, where possible, would be desirable to facilitate decision-making.

- There should be development of a clearer depiction as to how social capital relates to access, mobility, and EST; in particular, determination as to whether apparently important relationships are causal or coincidental (e.g., between GDP and mobility and between physical and electronic mobility).

- There should be an assessment as to whether mitigation is needed for social areas that may be negatively influenced by sustainability strategies.

- More should be done to identify fundamental barriers to social change that may prevent needed changes in technology or economics.

– Finally, he suggested that urban environmental degradation and resulting public health impacts of BAU trends are most likely forces to generate socio-political initiative and support for EST policies.

Discussion

In part stimulated by Anthony Perl's cautions noted above, much of the discussion about social implications concerned how cultural change with respect to transportation could be achieved. This was along two lines. One was concerned with the cultural manifestations of transport and the differences among and within countries. The other was concerned with how cultural change can be achieved.

Consideration of transport and culture was infused with the historical perspective provided by Jane Holtz Kay. She argued that "examining the automobile on the continent that-culpa Americana-fathered it, gives an ominous warning but also reinforces the possibility of altering that status quo." Kay claimed it was a series of informed and uninformed decisions, many with unintended consequences, that paved the way to the "Asphalt Nation." She claimed, too, that the opposition was formidable "from groups responding to this history and pushing for change." The key, in her view, is land use, about which problems would remain even if the perfect fuel were invented. She concluded, "… if we are to avoid hard-topping our lives and landscape, it is essential to erase our car-bound culture by evoking the very root of transportation in the word 'transport' to carry us to a better place and state of being."

Cultural manifestations of transport and differences in this respect were the topics of one of the breakout sessions on the first day of the workshop. One starting point was that the similarities in transport behaviour across OECD Member countries are more significant than the differences, and the differences *within* countries are large—particularly between city centres and outer suburbs. But there are nevertheless noticeable differences among countries, particularly between those of North America and Europe. Of note is the stronger disposition in North America to seek technological rather than demand-side management or behavioural solutions.

Regarding how cultural change can be achieved, the discussions focused on the need for dialogue. An important goal of the dialogue should be a coming to terms with the inconsistencies of public policy concerning mobility. Governments at the same time are both encouraging and restraining movement of people and goods. Characterisation of BAU scenarios, particularly their undesirable social effects, is a helpful basis for dialogue. Marketing of sustainability issues can play a role. Research is a useful way to generate credible, repetitive messages in the media.

6. DEVELOPMENT OF GUIDELINES FOR THE ATTAINMENT OF EST

As noted above, one of the main objectives of the EST project is to develop policy guidelines that could be of use to Member countries in their efforts to move towards sustainable transportation. The three breakout sessions and the subsequent plenary sessions that took place during the second day of the workshop addressed how the economic and social implications of EST might be taken into account in the development of guidelines for policy development by OECD Member countries. More specifically, participants were asked to respond to these questions:

- How might the social and economic implications influence whether EST is attained and how it is attained?

- What are the key economic and social implications to consider when proposing guidelines for policy development towards attainment of EST?

- What are the important gaps in our relevant knowledge?

The first task is to specify the nature of policy guidelines for sustainable transportation. They are taken here to be advice as to how to go about developing and setting policies designed to move transportation systems towards environmental sustainability. Policy guidelines can address the following matters:

i) The types of EST policy and approaches that might be deployed (e.g., regulatory, fiscal).

ii) Specific topics that EST policies might address (e.g., road-pricing, fuel taxes, urban policy, land use).

iii) Potential targets of EST policies (e.g., car drivers, children, seniors, freight hauliers).

iv) Background information required for informed EST policy-making (e.g., pollution trends, impacts of specific measures).

v) Processes and approaches that might be appropriate for use in developing EST policies (e.g., participatory or 'bottom-up' vs. directed or 'top-down').

vi) Barriers to the development of EST policies (e.g., stakeholder resistance, governmental structure).

vii) Other matters, including how relevant external trends might be used in the development of EST policies.

Each of the above aspects of policy guidance was touched on during the second day of the workshop. Most of the topics discussed on that day are noted in the listing that follows, which is organised according

to the above seven types of guideline. (Many items that fall into more than one category are confined here to their most appropriate category to conserve space.)

1. Processes and approaches

- Goals for action need to be defined and used to guide all aspects of implementation of EST.

- Within the framework provided by the goals, top-down and bottom-up approaches are needed, but the stronger focus has to be on bottom-up as the better strategy for securing the kinds of societal change that are required.

- However done, the process of policy development should be broadened. It should embrace individuals and organisations who might be disadvantaged by moves towards sustainable transportation such as automobile manufacturers.

- A twofold strategy is important using a "backcasting" approach to achieve a desired future situation: Long-term perspectives are needed, and, given political predilections for short-term fixes, a more immediate set of actions – consistent with longer-term goals - are necessary in the immediate and near-term.

- International co-ordination of the implementation of measures is needed.

- Policy-making and decision-making must have a human face. The economists' view of the world neither excites nor motivates people.

- There must be positive features in what is proposed. Enticing visions of sustainability are needed. Fiscal measures, in particular, must involve carrots (tax reductions and incentives) as well as sticks (taxes and charges).

- Experimentation, trials and tests are important. Policies are often more easily introduced if they are proposed as probationary. "Sneaky" introduction of policies can be justified on the basis of providing a trial.

- Both crisis-driven and incrementalist approaches have their place; but more should be known about the appropriate circumstances for each kind of approach.

2. Types of policy

- As well as focussing on what has to be done, consider also what must not be done. For example, too little attention has been paid to the traffic-inducing role of infrastructure, e.g. numerous studies have found that building or enlarging existing roads generates traffic. There should be a focus on more efficient use of what is in place.

- There should be education about the nature of and need for sustainable transportation from kindergarten onwards. In part this should act to counter the heavy advertising from the automobile industry (one third of advertising in some countries). The education should include stimulating materials, e.g., videos and interactive computer simulations of transport growth and its implications, as well as positive and encouraging alternatives to motorised mobility.

- Synergistically applied programmes of taxation of/charges for activities associated with unsustainable transportation and incentives for activities associated with sustainable transportation should be developed.

3. Policy topics

- The impacts from short-distance air travel, including leisure flying, requires attention as well as longer-distance aviation.

- Land use requires particular attention, perhaps by means of an appropriate taxing or pricing regime. The effective and efficient use of space must be at the heart of any sustainable transportation strategy. Land use arrangements that encourage non-motorised transport and obviate automobile ownership may be of special significance.

- Criteria are required for the selection of policy topics, e.g., areas where demand is high and price is low, or where the environmental impacts are the most significant.

- Reducing the distance per trip and maintaining travel-time budgets in non-traditional ways should be considered as policy objectives.

4. Policy targets

The main beneficiaries of transport policies should be the children and the elderly and others who are disadvantaged by present trends.

- On the other hand, the number of affluent seniors is growing. Their travel habits deserve examination.
- Increasing attention should be given to alternatives of road freight transport, training of truck drivers to improve the efficiency of goods deliveries, especially, in urban areas.

5. Background information

- Much more information is needed about the likely effects of pricing and incentive regimes, and about the costs of continuing current transport trends.

- Serious evaluation of environmental and social externalities stemming from current transport systems is needed in order to better deploy pricing and fiscal policy instruments with a view to internalising these into the costs of transport-related goods and services.

6. Barriers

- Lack of intergovernmental communication and co-operation is a barrier. Key policies are made nationally and internationally, and yet implementation is often local, and often with few means of moving from one area of discourse to the other.

- Local governments' concern about economic competition can be a barrier. Changes to transportation systems are resisted because of their effect on business. Changes in the

direction of less mobility are often perceived as negative for business, even through there is credible evidence the contrary may be true.

- There is resistance to behavioural change generally, and greater comfort with technological solutions that seem to achieve the same end. Therefore, logical assessments of the desirable 'balance-of-effort' may overestimate the value of technology.

- The magnitude of the problem is in itself a barrier. Even the relatively modest challenge of reducing Canadian GHG emissions from transport by six per cent below 1990 levels is "up against a brick wall." The difficulty encourages defeatism and a search for short-term, non-transport solutions.

7. Other matters

- The climate change issue and the probable tightening of oil supply could be used to advantage in moving towards sustainable transportation. Perverse effects should be monitored. For example, an rise in the price of oil could encourage production of oil from oil sands, shale or coal, which can be energy intensive and magnify the adverse effects of oil use. The national processes in place for meeting the Kyoto commitments could provide many opportunities for movement towards sustainable transportation.

- Change can be quick or may come unexpectedly - this possibility should be prepared for.

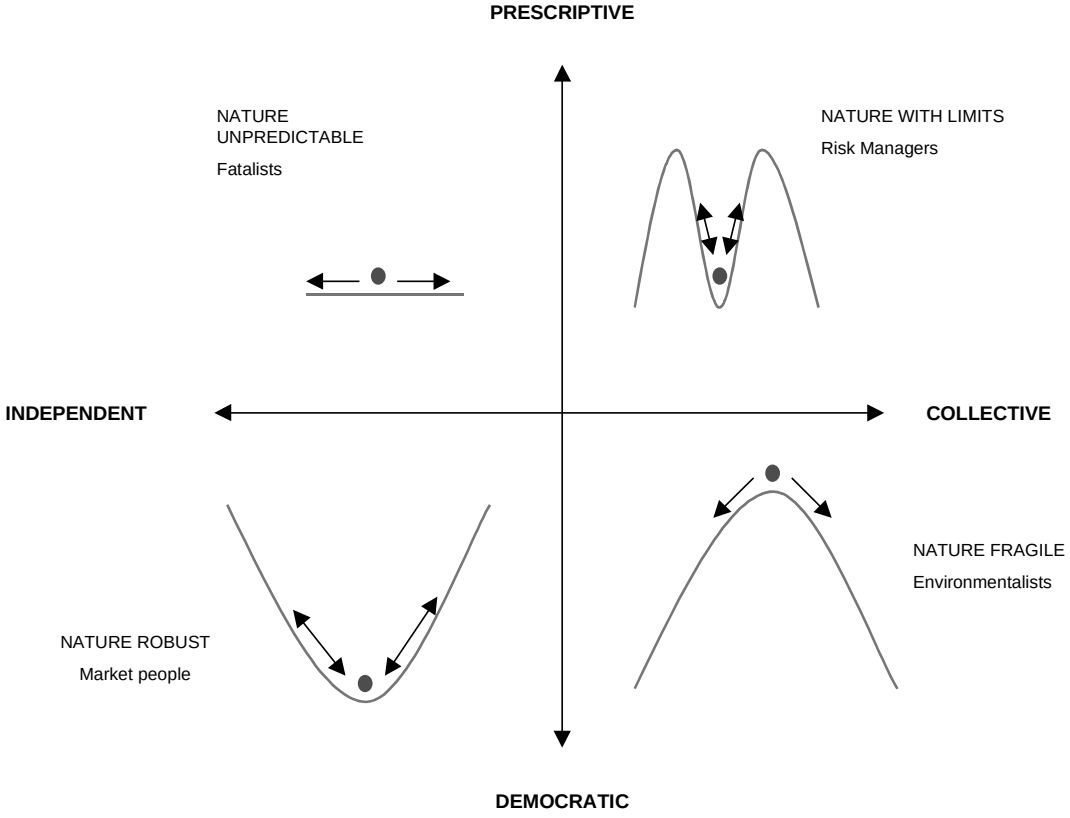
- Understanding of the different approaches to the natural world can help with understanding which messages to fashion and which approaches to make.

This last point was made by John Adams, who illustrated it with the diagram that appears here as Figure 4.

Each quadrant represents an approach to the environment (nature), either as unpredictable, limited, robust, or fragile, all according to the two dimensions of prescriptive/democratic and individual/collective.

People who argue for sustainable transportation are often positioned in the bottom right quadrant. But the majority of peoples' attitudes is usually elsewhere. The exercise would thus appear to be one of moving people's attitudes and behaviour between quadrants or of developing appeals for appropriate action that transcend quadrants.

Figure 4. **Typology of four approaches to transport and other environmental issues**



- represents nature

7. CONCLUSIONS

The overall conclusion of the workshop can be stated as follows:

The approach, methods and objectives of the EST project - including those of the work on economic and social implications - survived the scrutiny afforded them by workshop participants. There were several suggestions for broadening the scope of the project. Much was learned by project participants about the challenges ahead in developing and presenting guidelines and other advice as the outcome of Phase 4 of the project.

The main technical criticism of the work on economic implications concerned the value of looking as far ahead as 2030 rather than the value of the methodology being employed to look so far ahead. However, there was general acceptance at the workshop of the value of backcasting methods that involved concrete goal-setting and working backwards from a time when transport could be sustainable. If anything, the position of participants could be represented as saying that attainment by 2030 is ambitious, and yet it is still valuable to attempt to fashion present strategies in the light of the objectives of sustainability.

The key outcome of the discussions on assessment of economic implications was that no alternative quantitative method of estimation was proposed. Some economists proposed more use of non-quantitative methods, especially for the later years of the attainment period. The disposition of participants in the workshop was to propose a richer, more complex economic assessment, but the technical and resource limitations were understood.

There was comfort with the work on social implications. Again, participants in the workshop were disposed to suggest that the number of factors addressed in the assessment of social implications be increased. Again, there was recognition that there are no adequate methods for assessing implications of events so far into the future and sympathy with the view that there is merit in using the simplest possible approaches.

A controversial point was whether the project is placing too little emphasis on technological contributions to attainment of sustainable transportation. It was pointed out that this is a matter in which there are substantial differences among the Member country project teams. As the project evolves towards a conclusion, there may well be some convergence. However, people who believe that transport can be made sustainable entirely through technology—rather than through a mix of technological improvement and changes in transport activity—are likely to be disappointed.

Regarding the Phase 4 work, which includes the final presentation of the results of the EST project, there was much caution as to how this will be received. Although the process of backcasting is not new, and is well accepted in several businesses, notably electricity generation, its application to transport is problematic. The problems are more emotional than technical. They are more to do with the huge personal investment in particular modes of transportation than with the logic of resolving transport's environmental challenges. Great care must be taken in the explanation of the EST project's approach and the status of its conclusions.

The strongest suggestion was that the portrayal of sustainable transport should have a more human face. This could be achieved by development of several profiles of individuals in different circumstances living under conditions of sustainable transport.

Another strong suggestion concerned to whom the final report on the EST project should be addressed. OECD's 'constituents' are national governments and their policy advisors, but much of the work of attaining sustainable transport will fall to local and other sub-national governments. The report should be written for all who can make an institutional commitment to sustainable transport.

Several participants addressed the importance of meetings and discussions and the value of process involving a wider range of inputs than can be achieved from expert consultation. Often, more attention is paid to these matters in North America than in Europe. The process of the Ottawa workshop itself was regarded as exemplary by many participants.

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ANNEX

WORKSHOP PAPERS

ENVIRONMENTALLY SUSTAINABLE TRANSPORT - INTERNATIONAL PERSPECTIVES

OECD's EST Project

Presented by

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Efficient transport systems are essential for the functioning of modern industrialised economies. Mobility, and in particular, access to people, goods and services are essential for the welfare of people and the society. The tremendous progress in mobility, however, has not occurred without negative effects on man and the environment. Numerous studies of the OECD on the state of the environment in member countries concluded that both passenger and goods transport are contributing increasingly to a number of environmental problems with long term and wide ranging impacts at the local, regional and global level (OECD, 1995). Major environmental issues concern noise, habitat-disrupting land use, air pollutant emissions and the increasing use of fossil fuels by motor vehicles as well as growing environmental impacts from global air traffic. Furthermore, the environmental effects caused by the transport sector are increasing more than any other sector of the economy due to the very strong links with in GDP and the high growth rates of transport activity.

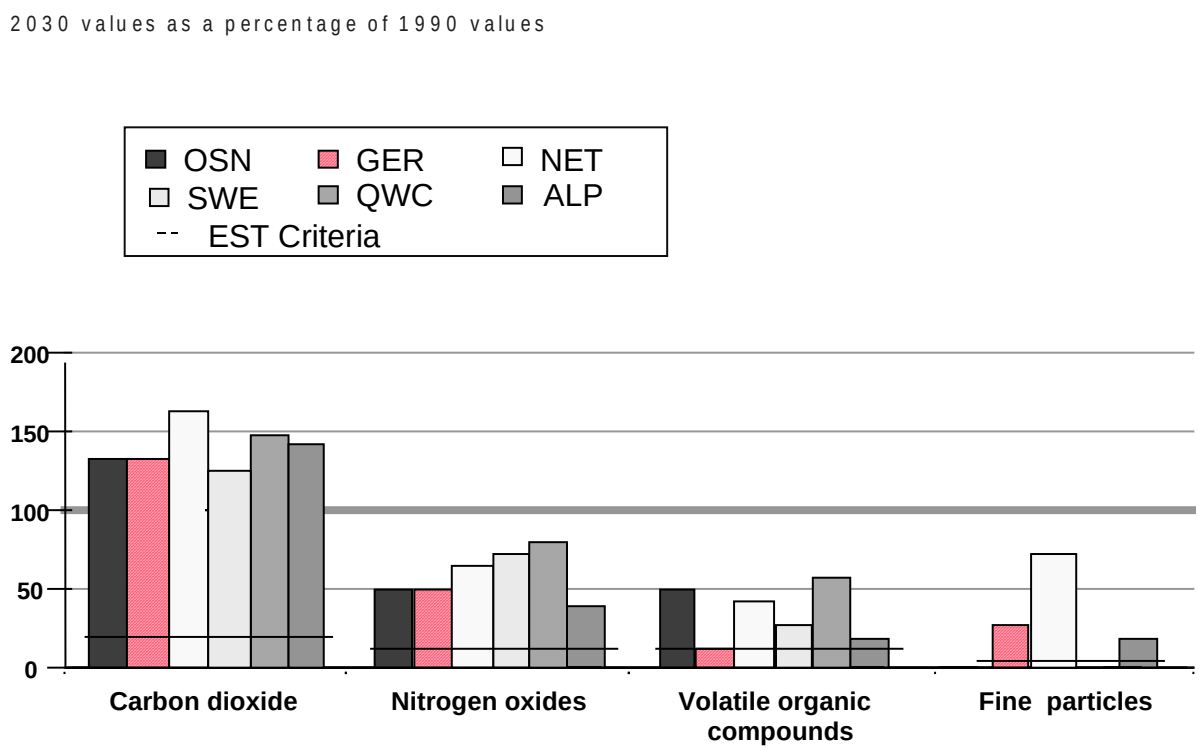
While all sectors of the economy together contribute to environmental pressures, there are considerable differences among the various transport modes. For instance, transport's share of polluting emissions vary from 25% for carbon dioxide to 90% for carbon monoxide with road transport contributing more than 80% of the total emissions in OECD countries. Transport's unaccounted - so-called external or social- costs due to health and environmental effects from noise, air pollution, congestion and time losses have been estimated between 4% to 8% of GDP of OECD countries. Road transport and aviation are primarily responsible for these costs, while rail traffic contributes less than one per cent of the social cost burden (ECMT, 1998).

However, environmental impacts are not caused solely during operation and use of transport means, but also stem from the production and maintenance of vehicles, the construction of infrastructure, the provision of energy and fuels, and disposal and decommissioning of vehicles, i.e., all impacts during the entire life-cycle have to be taken into account (INFRAS, 1997). Such life-cycle assessments and eco-balance studies show that rail transport - including high-speed rail - causes considerably less environmental impacts than road and air traffic. Nevertheless, there are a number of relevant environmental issues related to rail transport. These include noise, land use and polluting emissions from the construction of infrastructure and the production of energy.

Trends are also unsustainable

It is increasingly clear that current transport systems are not environmentally - and consequently, socially or economically - sustainable over the long term. Likely advances in technology will not be sufficient to overcome increased environmental impacts stemming from growing transport demand. Projecting current "business as usual" trends, transport in 2030 for many OECD countries will have reduced polluting emissions, except for carbon dioxide where it will be moving away, rather than toward, environmental sustainability (see Figure 1). Extrapolating current estimates of transport's unaccounted costs, transport in 2030 is likely to place a significantly large economic and social burden on society.

Figure 1. **Long-term Projections of Transport Emissions in Eight OECD Member Countries**



OECD's Environmentally Sustainable Transport (EST) Project

A new policy approach is needed which places environmental criteria up front along with other policy goals. Recognising this need, the OECD Environmental Policy Committee's Working Group on Transport initiated in 1994 the project on Environmentally Sustainable Transport (EST) to give some precision to the concept through the use of criteria which can be quantified and have environmental significance. Unlike conventional approaches to transport system development, the EST project has started with a vision and a series of criteria for environmentally sustainable transport in 2030. Teams from eight countries undertook six case studies (Sweden, the Netherlands, Germany, the Quebec-Windsor corridor in Canada, the greater Oslo region and the Alpine region comprising parts of France, Switzerland and Austria) to describe how this environmentally desirable future may be achieved. The project includes several phases (see also the project summary at OECD's Internet site on http://www.oecd.org/env/ccst/est):

Phase 1 involved a review of relevant activities of Member countries as well as the development of the definition and criteria for EST (OECD, 1996).

Phase 2 has focused on the identification of the gap between current and projected trends and the EST criteria through scenario-development. During this phase participants have constructed a "business-as-usual" (BAU) trend scenario and three scenarios consistent with the EST criteria (OECD, 1998/1999).

Phase 3 is to be the "back-casting" phase. It will comprise the identification of packages of policy instruments whose implementation would result in achieving the EST scenarios constructed during Phase 2. Phase 3 will also involve the assessment of the social and economic implications of the BAU and EST scenarios.

Phase 4 will refine the criteria for achieving EST and develop policy guidelines.

A study that has adopted essentially the same approach has also been completed for the Central and Eastern European countries through a joint Austrian, UNEP and OECD effort.

Definition of Environmentally Sustainable Transport

The ecological requirements for a sustainable transport system imply that the movement of people and goods are provided in an environmentally, socially and economically sustainable way; - mobility for communication and enabling social contacts as well as access to goods and services is to be considered as a means rather than the aim in itself. Environmentally sustainable mobility will require changes in behaviour and new innovative approaches at all levels of society and all sectors of the economy. An important prerequisite for realising an EST system in the long term is to take into account the ecological limits and to prevent and minimise pollution.

A sustainable transport system is one where i) generally accepted objectives for health and environmental quality (e.g. such as those set forward by the World Health Organization concerning air pollutants and noise) are met, ii) where ecosystem integrity is not significantly threatened (i.e. critical loads and levels, as adopted by the UNECE, for acidification, eutrophication and ground-level ozone are meet), and iii) where potentially adverse global phenomena such as climate change and stratospheric ozone depletion are not aggravated. Therefore, an environmentally sustainable transport system is one where *transportation does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes.*

Criteria for EST

Six criteria have been developed during the first phase of the EST project as being the minimum number required to address the wide range of health and environmental impacts from transport. These criteria have been selected so that local, regional and global concerns are addressed, notably noise, air quality, acidification and eutrophication, tropospheric ozone, climate change and land use. Using international goals, guidelines and standards for these impacts a number of indicators have been derived which concern emissions of carbon dioxide, nitrogen oxides and volatile organic compounds, carcinogenic particulate matter, noise and land use.

CO_2
Climate change is prevented by reducing carbon-dioxide emissions from transport such that atmospheric concentrations of CO_2 are stabilised at or below their 1990 levels. Accordingly, total emissions of CO_2 should not exceed 20% of total CO_2 emissions in 1990.

VOCs
Damage from carcinogenic VOCs and ozone is greatly reduced meeting WHO Air Quality Guidelines for human health and ecotoxicity. Total emissions of transport-related VOCs should not exceed 10% (or less for extremely toxic VOCs) of total transport-related VOC emissions in 1990.

Noise
Noise caused by transport no longer results in outdoor noise levels which present a health concern or serious nuisance. Depending on local and regional conditions, this may entail a reduction of transport noise to no more than a maximum of 55-65 decibels during the day and 45 decibels at night and indoors.

NO_x
Damage from ambient NO_2 and ozone levels and nitrogen deposition is greatly reduced meeting WHO Air Quality Guidelines for human health and eco-toxicity. Total emissions of NO_x from transport should not exceed 10% of total transport-related NO_x emissions in 1990.

Particulates
Harmful ambient air levels are avoided by reduced emissions of fine particulates (especially those less than 10 microns in size). Depending on local and regional conditions, this may entail a reduction of 55% to 99% of fine particulate (PM_{10}) emissions from transport.

Land-Use/Land Take
Infrastructure for the movement, maintenance, and storage of all transport vehicles is developed in such a way that local and regional objectives for air, water and eco-system protection are met. Compared to 1990 levels, this is likely to entail a smaller proportion of urban land devoted to transport infrastructure.

A Vision of EST in 2030

Environmentally sustainable transport in 2030 will, by definition, meet all six of the EST project criteria. In building a vision of such a system, two alternate pathways were explored: the first focused on reaching the EST criteria solely through technological means, while the second used primarily demand-side management measures. The project developed a final EST scenario by combining some of the most promising currently existing and tested technological features of the technology scenario with the more politically acceptable features of the demand-side management scenario. In the final EST scenario, transport in 2030 is characterised by the following (see Figures 2 and 3):

- There is a significant decrease in car ownership and use with many cars running on hybrid-electric engines.
- There is a focus on reducing long distance travel for passenger travel and on much greater use of non-motorised means for short distance trips together with supporting infrastructure.
- Longer distance freight movements are significantly decreased - hydrogen will be widely used as a fuel both directly and in fuel cells.
- Rail is all electric, with increases in high speed modes, efficiency and capacity.
- More efficient and less polluting inland and coastal shipping vessels will be used – hydrogen may also be used as a fuel.
- Long-distance air travel is substantially reduced. Aircraft in use are more efficient, conventional types, and rigid airships may be used for specific purposes.

Figure 2. **EST3 Combination Scenario for Passenger Transport. Situation in 2030 compared to the expected trend ("Business-as-usual")**

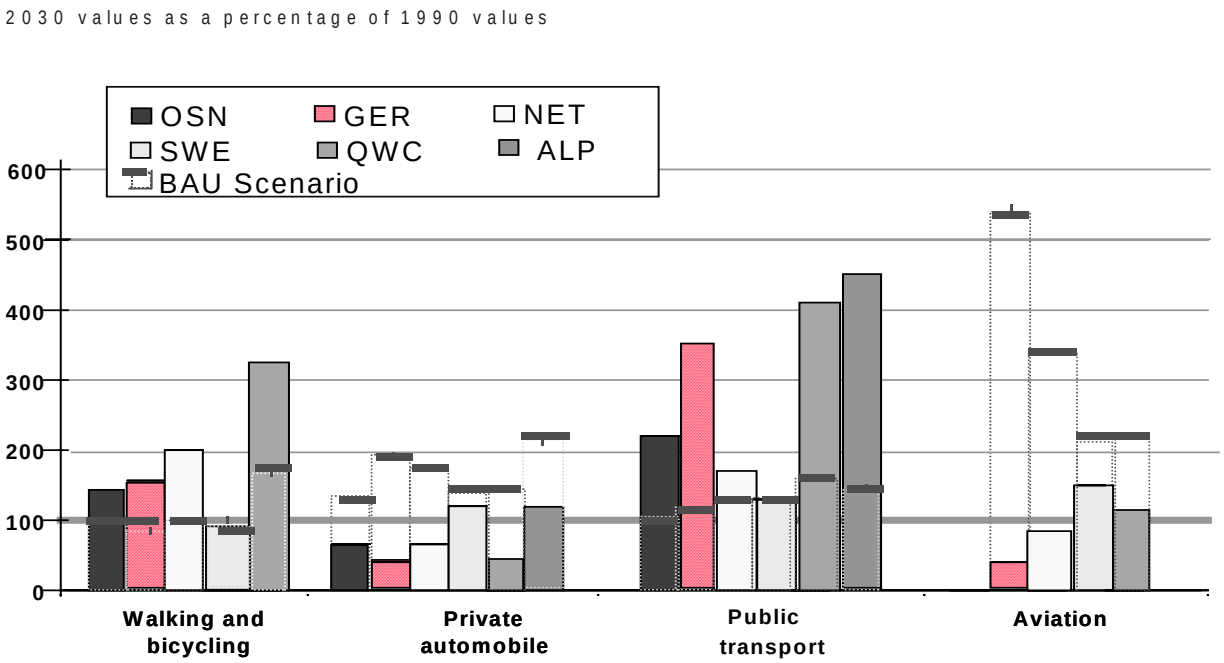
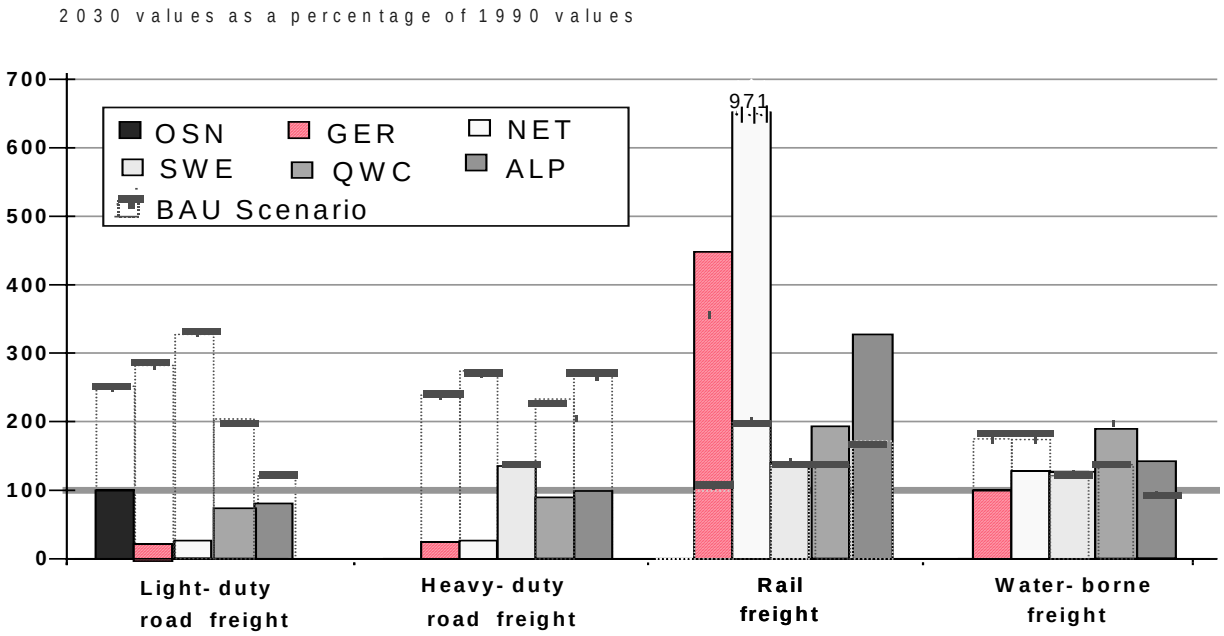


Figure 3. **EST3 Combination Scenario for Freight Transport. Situation in 2030 compared to the expected trend ("Business-as-usual")**



Generally, transport in 2030 is characterised by a massive shift from less sustainable to more sustainable modes accompanied by a relative decrease in transport activity.

- Electric power for transport is generated with much greater efficiency than at present, using a high proportion of renewable fuels.

- Relatively small changes in the form of settlements have been implemented in order to reduce the need for movement of people and freight.

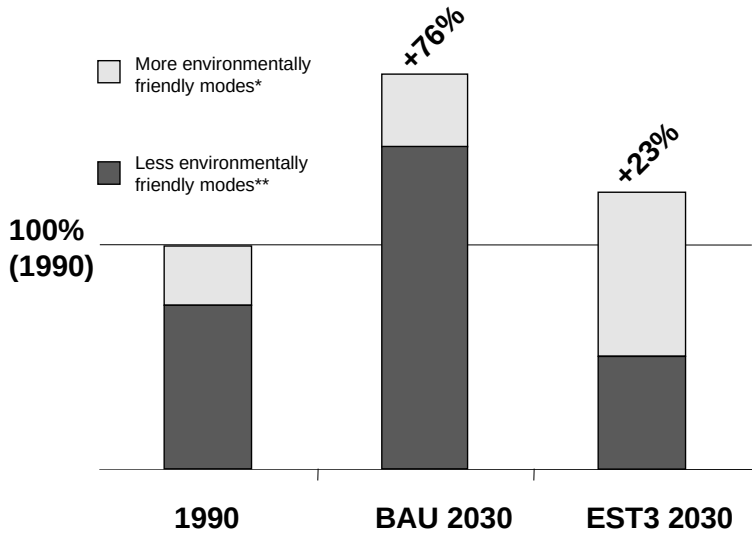
- Greater use of telecommunications is made to avoid passenger travel and the movement of goods.

- Regionalisation of production occurs to avoid long distance freight movement; volume of goods transport is reduced; greater focus on service provision.

- Continuing public education campaigns are implemented to help support lower levels of travel, and to lead more environmentally sustainable consumption.

All these policies and measures will support and accompany the shift towards more environmentally sustainable transport, while not necessarily decreasing economic and social welfare (see Figure 4). It is worth noting the EST3 scenario assumes a growth in transport activity of some 23%, but with emphasis on more environmentally sound modes.

Figure 4. **Comparison of Transport Activity Changes in the EST3 Scenario and the expected trend ("Business-as-usual") in 2030 compared to the situation in 1990**

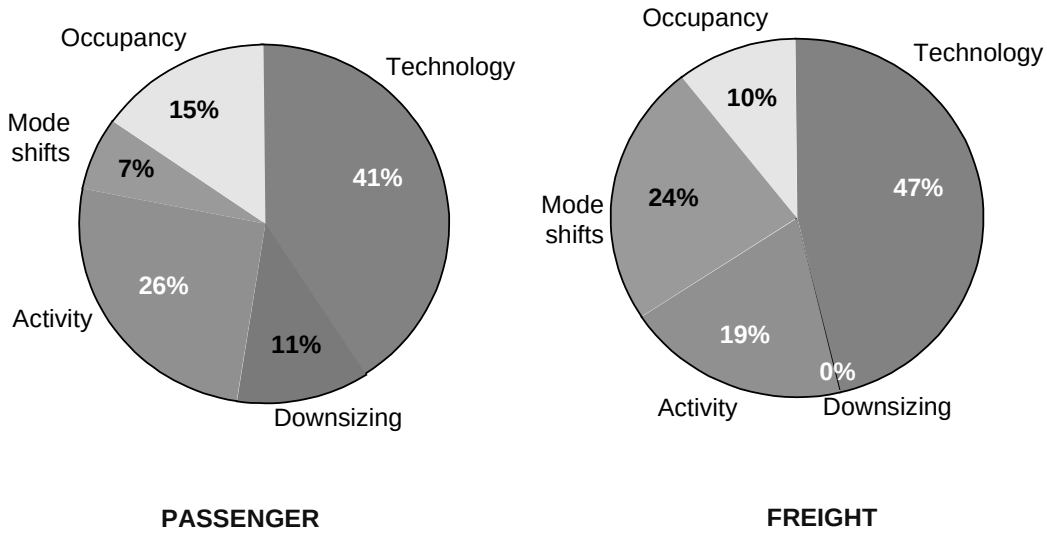


*) non motorised, public transport, rail, waterways.
**) individual motorised transport for the movement of passengers and freight.

Closing the Gap: the Critical Path to EST

The EST criteria will likely not be met by technology alone. Indeed, contrary to much of current transport and environment policy, achieving environmentally sustainable transport will require greater demand-side than supply-side measures. The project participants generally have anticipated that some forty to fifty per cent of the effort necessary to meet the EST criteria will come from technology and between fifty and sixty per cent from demand-side management and a shift towards more sustainable transport modes (see Figure 5). As many countries develop mid- to long-term policy strategies for transport, this finding is important in that it may constructively guide those efforts.

Figure 5. **Contribution of Technology and Demand-side Management Measures to EST in 2030**



The EST project has uncovered a substantial gap between those conditions likely to come about as a result of current and future transport trends, on the one hand, and the conditions necessary for achieving environmentally sustainable transport on the other. International co-operation within the OECD framework will assist member countries in the development of innovative methods and policy approaches towards sustainable transportation that will be environmentally responsible, socially acceptable and economically viable. Reaching such a transport system is one of the principal transport policy challenges facing many countries at the outset of the 21st century.

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ECONOMIC ASSESSMENT OF EST - SCENARIOS OF THE OECD

by

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1. Introduction

The OECD's project on Environmentally Sustainable Transport (EST) has involved three phases so far. In the first phase, a definition of environmental criteria for sustainable transport has been provided as a basis for developing different scenarios and approaches for achieving EST in the long-term. Phase 2 focused primarily on the detailed construction of a reference scenario (business-as-usual trend) and three EST scenarios for the year 2030. The economic assessment of these scenarios is part of the Phase 3 which is on social and economic assessment and on devising packages of instruments that - if implemented - would result in attainment of EST. Six expert teams from eight countries have developed scenarios, which are homogenous with respect to the general methodology - the backcasting approach - and the set of targets which describe EST. The scenarios differ however, with respect to the geographical scope and the mix of features which are considered necessary to achieve the targets. The results from the scenario work has shown that under the business-as-usual (BAU) conditions the defined EST target levels will not be achieved.

Three EST scenarios have been constructed for the year 2030 which contrast the BAU scenario. EST1 is a *"Technological Progress"* scenario assuming that the EST criteria can be achieved by technological change alone. EST2 is a "*Mobility Management"* scenario which assumes that the EST criteria can be achieved by influencing transport demand and change in travel behaviour. EST3 is a *"Combination Scenario"* comprising a policy mix of technological and demand-side management measures. While EST1 and EST2 are extreme scenarios and thus highly unrealistic, EST3 is closer to reality.

The main focus of the economic assessment is to evaluate the impacts of a transition from BAU to EST3 in economic terms. This means:

i) evaluating the impacts on indicators *of material wealth* such as consumption or employment, and;

ii) evaluating the impacts on indicators of *non-material wealth* such as lives saved, health improved or natural resources preserved.

The terms of reference for the economic assessment study have been formulated to provide answers to four questions:

1. In what ways would the economy be different if the EST3 scenario were attained rather than the BAU scenario?
2. What would be the relative economic costs and benefits of the two scenarios for individuals and households, for businesses of all sizes, and for local, regional, and national governments?
3. How would employment levels and other indicators of interest differ between the BAU and EST3 scenarios?
4. In economic terms, who would be winners and who would be losers if the EST3 rather than the BAU scenario were attained, particularly in terms of age groups, income groups, and geographic regions?

The very preliminary approaches to partially answering these questions are presented in the conclusions of this report. What should be clear from the scenario definition and the time horizon considered is that the economic assessment will be far from being a definitive account of what might be the economic implications of moving towards and maintaining environmentally sustainable transportation in terms of detailed measures of all costs and benefits. As noted, the focus of the EST project is on meeting environmental criteria. Economic implications will be explored to help develop realistic EST scenarios and identify realistic and acceptable means of achieving EST.

Attainment of environmentally sustainable transport will likely assume a more prominent role in policy-making within OECD Member countries. Assessment of the economic implications of implementing particular instruments as well as attaining and maintaining particular kinds of transportation systems would then become more urgent. The present, rather preliminary assessment may well be of use in helping to identify matters that require rigorous treatment.

The report is organised as follows. In section 2 the characteristics of EST scenarios are recalled to illustrate that standard methodology for scenario assessment is most likely to fail and that the development of a tailored assessment methodology is necessary. Section 3 presents the conventional instruments of economic assessment as for instance, cost-benefit analysis. In section 4 alternative approaches are discussed which are based on the system dynamics modelling (SDM) concept. As it will not be possible to apply a complex system dynamics model to all case studies, a simplified method has been developed which is called IPA (Impact Path Analysis); it is described in section 5. In section 6, the results of first experimental assessments are presented and interpreted. Section 7 gives preliminary conclusions on the approach used.

2. Characteristics of EST scenarios

Six case studies for EST have been worked out for the year 2030 and six geographical areas: the Quebec-Windsor corridor (QWC) in Canada, the greater Oslo region (OSN), Germany (GER), The Netherlands (NET), Sweden (SWE), and the Transalpine corridor (ALP). QWC and ALP are corridors, OSN is a modestly congested urban area and GER, NET and SWE concern the entire country. The **regional scope** and the nature of environmental problems vary considerably among these areas. Traffic activity is described covering six modes: non-motorised, road (private, public), rail, air, waterways. Exogenous factors influencing traffic activity are the related transport infrastructure, fuel prices, traffic and environmental regulation and land use patterns. Six criteria have also been defined that determine traffic emissions and other related environmental impacts. Growth ratios are given for the traffic activities and the associated emissions (by type of effects). It is worth noting however, that not all assumptions have been derived from a carefully elaborated scenario framework, and not all assumptions are homogenous.

Given these conditions, the scope of possible assessment schemes to be developed will be limited by the following aspects:

- Although no optimality calculus has been used for designing the assessment scheme, it should be flexible enough to allow for checking whether EST3 will meet the environmental targets at sufficiently low economic costs.

- As the case studies address different regional areas, the assessment scheme should allow for a zooming from country to corridor/regional scale.

- Given the rough scenario assumptions and their partly speculative nature, accurate forecasting of economic impacts seems to be impossible. The assessment method therefore should focus more on analysing the direction of changes induced by the EST stimuli rather than on accurately calculating specified performance criteria.

- For the same reason, the procedure of assessment should motivate the study groups to enter into a feedback process between the assumptions made and the EST results expected.

3. Classical assessment methods (CBA, MCA, CEA)

In this paper three possible approaches for assessing scenarios will be discussed:

- classical methods such as cost-benefit analysis (CBA), cost-efficiency analysis (CEA) or multi-criteria analysis (MCA);

- computer-based system dynamics modelling (SDM); and

- qualitative evaluation based on a simplified cybernetic model (SCM).

The classical methods are based on a clear definition of **"With" and "Without" cases** concerning a set of measures of which the impacts are forecasted for a given point of time in the future. Traffic has to be forecasted for the year concerned and an impact analysis performed with respect to defined economic and ecological criteria. According to the different purposes of decision making a combination of different methods can be applied to generate a set of evaluation criteria, e.g.

- private rate of return (PRR);

- benefit-cost analysis (CBA);

- multi-criteria analysis with cardinal scales (MCAC) or ordinal scales (MCAO);

- cost-efficiency analysis (CEA) as a variant of CBA and MCA.

Due to the underlying complexity of decision-making, the application of several different criteria in the assessment procedure is highly demanding. Table 1 gives a list of valuation methods and impact criteria used for PRR, CBA or MCA.

Table 1. **Economic Valuation Methods and Criteria for Transport Projects**

Type of assessment		Economic Impacts [1]					Regional/ Urban Impacts [2]					Environmental Sustainability and Safety Impacts [3]					Valuation Method			
		E1	E2	E3	E4	E5	R1	R2	R3	R4	R5	S1	S2	S3	S4	S5				
Monetary	dir	X	X	X	X	X											PRR			
Evaluation	ind							X			X	X	X	X				CBA		
Quantitative Evaluation *card. ut. index*									X						X				MCAC	
Qualitative Evaluation *ord. ut. index*							X			X						X				MCAO

Notes:

1) Economic Impacts

Construction costs (E1);
Maintenance costs (E2);
Rolling stock and operation costs (E3);
Revenue (E4);
Generalised costs (E5).

2) Regional and Urban Impacts

Concordance with regional land use planning [development axes/corridors] (R1);
Contribution to regional economic balance (R2);
Contribution to multi-centre oriented spatial organisation (R3);
Improvement of urban settlement structure (R4);
Improvement of the structure of employment sectors (R5).

3) Environmental Sustainability and Safety Impacts

Accidents/Safety (S1);
Noise impacts (S2);
Local pollution of air, soil and water (S3);
Global and large-scale impacts on the environment (S4);
Land take and separation effects (S5).

In this example, the criteria are categorised by economic impacts, safety/environmental impacts and regional/urban impacts. The first example for an assessment method is **monetary valuation** using either private rate of return (PRR) or cost-benefit analysis (CBA) methods. It is necessary to distinguish between *direct* and *indirect* effects. PRR methods can be used when evaluating direct effects, revenues, and costs, which are the inputs for calculating the PRR. The *indirect* effects are relevant when using CBA, as they don't occur to the users of the transport system and no financial contribution can be expected; therefore, these effects are not part of the private rentability calculus. When summarising the direct and indirect effects measured in monetary terms, a figure for the social net benefits or the social rate of return results.

The first possibility to assess *indirect* impacts is the CBA which presupposes a **monetary valuation** of all effects. A correct application of this assessment scheme to EST would require a projection of the affected demand and supply functions in order to derive the consumer and producer surpluses (positive or negative) for every market concerned. A major problem to be tackled is that all measures based on willingness-to-pay evaluations (and other methods of estimating the reaction of consumers to changes of the state of the world) are calibrated on the basis of surveys of the past which can hardly be projected over very long time periods.

The second type of assessment is the quantitative evaluation method, where a subset of impacts might be evaluated, but not in monetary terms. In this category all impacts are analysed that can be assessed by using **cardinal scales**. Summarising all monetary and cardinal evaluations will result in a cardinal measure of utility: multi-criteria analysis with cardinal scales (MCAC) is the method used.

Finally, there might be effects which cannot be measured in terms of money and cardinal utility. One example is visual intrusion in urban environments or in landscape. If such effects play a role for decision-making, assessment methods using only **nominal or ordinal scales** (e.g. judgements like better, equal or worse) can be applied. As the final aggregation of individual impacts has to be performed in this case using ordinal scales, the method used is multi-criteria analysis with ordinal scales (MCAO). Examples for such ordinal assessment methods are given in Saaty and Vargas (1985).

If monetary valuation is not possible for reasons of data availability or ethical problems, MCA can be applied using cardinal or ordinal scales. A utility index is constructed which allows for ranking the alternatives for decision making. In this case the problem of generating the right values is solved by expert judgements.

Cost-Efficiency Analysis (CEA) is a variant of CBA or MCA. If one subdivides the set of objectives into cost-related and efficiency-related objectives, one can construct two indicators, a cost and an efficiency indicator. If the alternatives show the same costs, then the alternative associated with the maximal efficiency is chosen. If the efficiency indicators are equal, the alternative with minimum costs is the rational choice. If both, costs and efficiency indicators vary, the alternatives are ranked according to efficiency over costs.

In general, conventional assessment methods like CBA, MCA or CEA are based on **"point forecasts"** for the year of projection and are applied to marginal changes of the state of the world. As they are usually applied to a time horizon between 10 and 20 years they only consider a **one-directional impact process** (e.g. policy action $\rightarrow$ traffic behaviour $\rightarrow$ physical impacts $\rightarrow$ evaluation) and do not include feedback mechanisms between transport, the socio-economic system and the ecological system.

The time horizon considered in the BAU and EST scenarios, however, is about 35 years, and could easily be extended to 50 years. The hypotheses with respect to technology or behaviour are speculative in the sense that they reflect major - instead of marginal - changes of existing transport patterns and structures, without precisely describing the action-reaction mechanisms which could induce such changes. The policy actions which are necessary to achieve EST can not be regarded to be once-and-for-all measures. On the contrary they spread over time and will have different intensities, most probably low intensities at the beginning and high intensities at the end of the process.

In the light of these properties of the evaluation problem (e.g. dynamics, feedback, uncertainties), it does not seem appropriate to apply one of the conventional assessment methods that assume a static world, with one-directional and determined impacts. Therefore, alternative methods and approaches have to be examined.

4. System dynamics modelling (SDM)

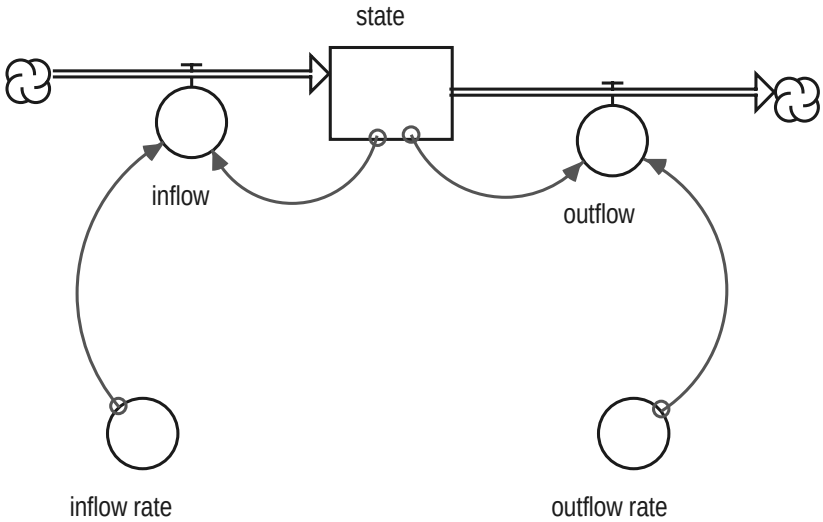
4.1 Basic structure

The **system dynamics approach** is a methodology used to simulate the dynamic behaviour of complex biological, bio-physical and social (i.e. bio-cybernetic) systems (Forrester, 1962; 1971; Bockstael, Costanza, *et al*., 1995). It has been applied in the long-term forecasts of the Club of Rome as well as the bio-cybernetic experiments of F. Vester (1995) concerning the social impacts of industrial or transport development. There is a growing international research activity for applying this method to problems of integrated assessments of policy strategies (Kuchenbecker and Rothengatter, 1998).

The basic elements of a system dynamics model include *state variables* (levels, reservoirs; e.g. population), *flow variables* (rates, changes; e.g. population growth) and *auxiliary variables* which are used to establish dynamic relationships (e.g. mobility rates of cohorts of population). The dynamic relationships are represented in terms of **feedback loops** which can be positive (self-enforcing) or negative (dampening). For instance, the relationships between transport infrastructure, traffic growth and change of spatial patterns can be modelled through positive feedback loops. As in the natural environment no biological system can survive which experiences a permanent positive feedback, Vester (1995) draws the conclusion that man-made systems with only positive feedback are exponentially expanding, and thus, cannot be sustainable in the long term.

Figure 1 shows a simple dynamic relationship including one state variable and two flow variables (inflow and outflow). Inflow and outflow are controlled by the associated inflow and outflow rates (see the so-called "converters" in the lower part of the figure).

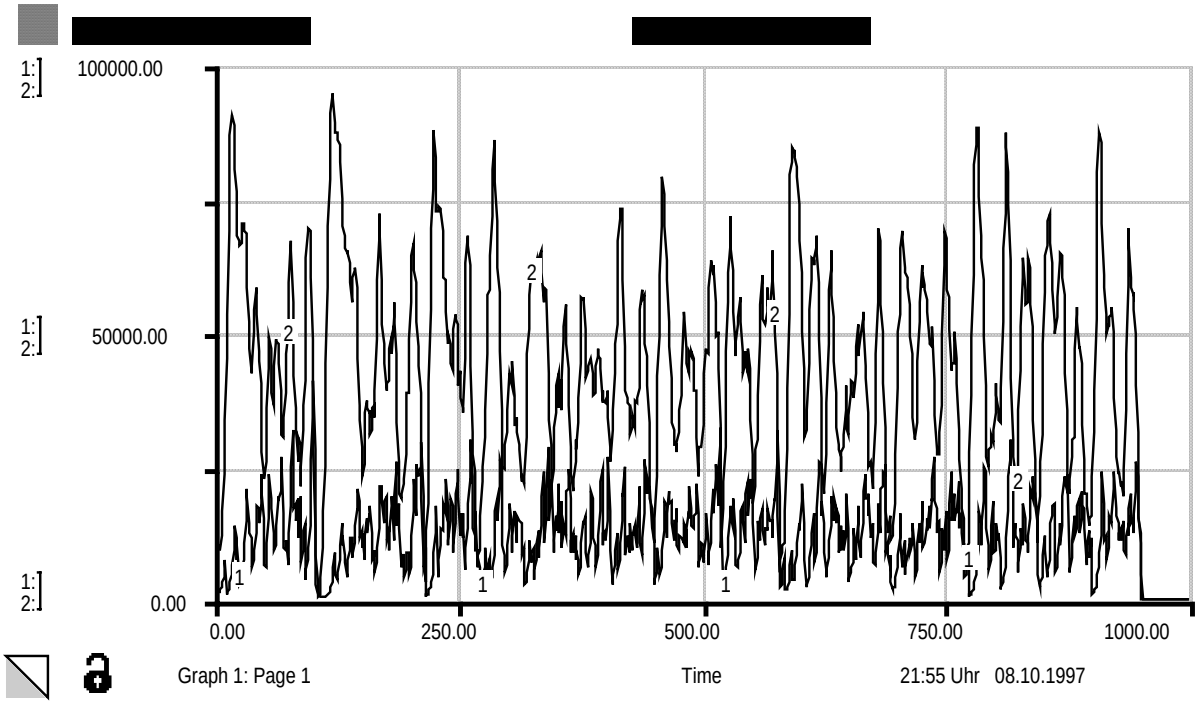
Figure 1. **Simplified Scheme of Dynamic Variables in System Dynamics Models**



Note:
state(t) = state(t - dt) + (inflow - outflow) * dt
initial state = 0
Inflow = inflow_rate*state
Outflow = outflow_rate*state

Figure 2 gives as an example of a system dynamics model applied to population dynamics: the dynamic interactions between a predator and a prey population. Such a system is composed of a large number of linear feedback mechanisms. Although every relationship is represented by a linear function, the system oscillates in a non-regular way. While the system seems to be predictable (the mean values for the predator and the prey population for the period 500 to 900 can be estimated on the base of the mean values of the period 0 to 499), the population dynamic breaks down in the period 901. Critical value analysis shows that in this biocybernetic system the ratio "birth rate of prey over birth rate of predators" is a key variable for long-term sustainability. This critical value is not met in the period 901, and thus, the system breaks down.

Figure 2. **Illustration of Population Dynamics: Predator-Prey Model** (Software: STELLA)



Notes:
1: predator population (lower curve)
2: prey population (upper curve)

Complex dynamic relationships can be *decomposed* into subsystems. This allows for an independent testing of all subsystems to check the plausibility of the inputs chosen. In a final step the links between the subsystems have to be defined and the total system compiled.

In the ASTRA project of the EU's 4th Framework Research Programme (ASTRA, 1998) a first attempt is being made to apply SDM to long-term strategic evaluation of the EU common transport policy. Given the general framework of ASTRA one can subdivide the system into four **subsystems**: population/society, economy, spatial patterns and transport. Population can be classified by age, sex and employment. Changes of **population** are induced by natural factors (births and deaths) and migration. While natural factors can be regarded to be exogenous, migration is heavily dependent on economic differentials, and thus, related to the economic subsystem. It is possible to develop an interface to the socio-economic assessment part so that the interactions between the economic development and the social patterns can be incorporated. The **economy** is represented by the various sectors according to the NACE classification.

The EST scenarios emphasize both major changes of technology and behaviour in the transport sector. These will strongly affect the energy production sector, the industrial sector and parts of the service sector; all of these impacts will have to be estimated. Due to the drastic changes which are assumed in the EST scenarios, it is likely that changes of the **spatial patterns** are induced. This may happen at the urban/regional level (changes of location choices) as well as the inter-urban levels (changes of industrial location and sourcing). Such issues would be addressed by the module of regional and spatial economics. In the case of the EST scenarios in the Norwegian case study for the greater Oslo area, the subsystem for spatial patterns could be included in the regional impact analysis. In national or international studies, however, it would be difficult to deal with such complexities. Therefore, the application of SDM to these levels would be reduced to three subsystems: the macroeconomic, transport and environment modules.

All changes mentioned originate from changes of the **transport sector** which can be modelled by a simplified four stage traffic behaviour approach with supplementary modules for vehicle ownership or drivers of mobility and logistics. The structure of the SDM that has been developed by the Institute for Economic Policy Research (IWW), University of Karlsruhe, for the EU ASTRA project looks as follows:

Table 2. **Components of the ASTRA SDM for Assessing EU Transport Policies and Strategies**

1	Macroeconomics
1.1	Supply side: labour, capital, natural resources, technical progress, gross value added
1.2	Demand side: consumption, investment, foreign traded, government
1.3	National income: GDP, private disposable income
2	Regional and Spatial Economics
2.1	Population: population by age classes, migration
2.2	Employment: regional and sectoral employment, wages
2.3	Regional economy: regional GVA
2.4	Land use: land allocation, social infrastructure, accessibility, car ownership
3	Transport
3.1	Vehicles: number of cars, buses and trucks
3.2	Infrastructure: network length, capacity, quality indicators
3.3	Loads: average daily traffic, speeds
3.4	Travel impedance: travel time, distances, costs, changes of vehicles
3.5	Level of behaviour: generation, distribution, mode choice, assignment
4	Environment
4.1	Emissions: CO_2, NO_x, CO, VOC, particulate matter, benzene
4.2	Externalities: noise, safety, biodiversity, sealing of land

Source: ASTRA, 1998.

Several software packages (such as STELLA, ITHINK, SIMPAS or POWERSIM) exist on the market to solve system dynamics problems efficiently. Working with these software packages is easy and intuitive. It is possible to decompose models into different types of aggregation so that they can be analysed effectively. This makes it possible to work with the same software for projects at **different geographical levels**, as, for instance, given in the six case studies of the EST project. This means that the same software could be used for each study to perform the assessment. The assessment procedure would be co-ordinated by a supervisor who would run the model with the highest level of aggregation (Europe or World). The

software provides tools for graphical presentation of the results. Trajectories for dynamic adjustments can be plotted for long-term time periods which allows to control the dynamic development of critical variables with respect to sustainability benchmarks. By means of sensitivity analyses, the user can define critical ranges for the variables considered so that exceeding critical thresholds would indicate an undesired future state of the economic or ecological system.

An example of a typical SDM approach to assess EST scenarios is given in Figure A2 of Appendix IV. It shows the functional diagram which consists of simple models of population, the supply side and the demand side of the economy and the transport sector. The environmental sector has been left out to keep the picture as simple as possible. The system components have been constructed to model the assumptions of the German case study in a most simple way and generate information which can be used for assessing the scenario. In figure A3 some results of the model are given; selected time profiles for the variables GDP, motorisation and road/rail freight are exhibited. The SDM software (here: ITHINK 5 Analyst) allows to construct the time profiles for all variables defined in the system. These variables can also be shown by ordinary tables.

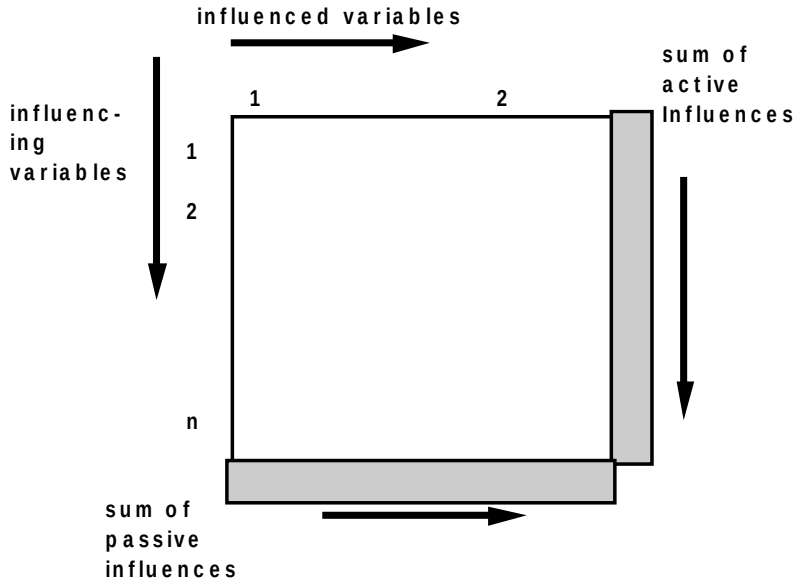
While an economic assessment is usually summarised by an appraisal, it is possible to aggregate the dynamic profiles generated by the system dynamics model into a small set of performance indicators. For instance, an approximate dynamic **cost-benefit calculation** scheme can be developed that evaluates infrastructure and operation costs, time consumption, internal traffic activity benefits and external costs of accidents and the environment. As the valuation of external costs is subject to a high degree of uncertainty, one could start from a conservative valuation base (e.g. derived from the UIC study on external costs of transport: INFRAS, IWW, 1995) and extend the range of possible valuations by using more recent figures from the countries participating in the EST project. The evaluation scheme will allow to determine the figure of external costs of the EST scenario that will correspond to the break-even point in a cost-benefit analysis.

4.2 Simplified cybernetic modelling (SCM)

SDM is based on a mathematical system of dynamic equations. Missing information regarding the shape of economic functions can be substituted by the modeller through introducing more vague data, for instance, curves which represent observations of the past or information in terms of subjective value judgements. However, if many inputs have to be generated in this way, then the quantitative property of SDM is lost, and data are produced that cannot be interpreted in a quantitative manner. The application of a simpler tool should therefore be considered: simplified cybernetic modelling (SCM).

The first part of the SCM analysis consists of increasing the level of aggregation of subsystems so that the complexity of the system is reduced. It requires also the development of a functional diagram of all feedback relationships among the system variables at different levels (micro-, meso- or macroeconomic level.) Instead of introducing mathematical functions for describing these relationships in the second part of SCM, a qualitative analytical method (the “manual computer” as introduced by F. Vester) could be used. The strength of each relationship or influence among the different variables would be valued by a ranking scale (from 0,1,2,...,n) where a zero value indicates “no influence” and the number n indicates a “very strong influence”. Several experts could be involved in the ranking procedure with a view to compiling their judgements. Such a process is often used in management seminars to summarise qualitative judgements by participants. When this is performed for all the impacts (both felt and generated) of the system variables, a matrix of impact indicators for these variables results. This impact matrix can be analysed to find out the most relevant factors and relationships among these variables (see Figure 3).

Figure 3. **Impact Matrix of system variables and their interactions (active or passive influences)**



Note: Passive influences = felt impacts
Active influences = generated impacts

In a system describing transport, economy and ecology, Vester (1995) had constructed a model with some 100 feedback loops. Using the described simplified impact analysis, he showed that *human behaviour is the key variable, because it is an element of many "positive" (reinforcing) feedback loops*. Influencing behaviour consequently is the most important policy action to find the right trajectory towards sustainability of the transport system. Relying on the change through technological progress is not enough, on the contrary, without a change of values, technical progress might reinforce activities that are depleting natural resources further.

Obviously, the results of the SCM cannot be used for a quantitative evaluation in terms of social profitability. However, it is possible to find out whether economic objectives are seriously jeopardised by EST policies and what measures should be introduced to manage economic risk. Finally, the interpretation of the results will require a high degree of expert knowledge in order to develop a final evaluation of the scenarios.

5. Assessment Methodology for EST Scenarios

The SDM approach seems to be most appropriate to assess the economic impact of EST-type scenarios. However, the development of an assessment model based on SDM will require considerable input, in terms of the amount of time and resources for generating the data. Therefore, it doesn't seem to be feasible to apply it to each case study. Nevertheless, the German Umweltbundesamt (Federal Environmental Agency) has decided to develop a sophisticated SDM for evaluating the German case study and compare the results with those from the simplified assessment method (SCM). It appears reasonable to apply the model also to the Netherlands because of similar economic conditions.

In other countries, existing econometric models may be used; for instance, for the greater Oslo region where a general equilibrium model exists to assess environmental policies. This model may be applied, although it raises questions as to whether equilibrium models, which are presupposing marginal changes of the initial conditions, can be adjusted properly to address the drastic changes assumed in the EST scenarios.

Given the heterogeneous conditions for assessing the six different case studies, it is therefore proposed to define a common assessment platform which can be used both for a simplified approach (if more sophisticated methods are available in a country), and as a final model, if no other evaluation tool can be applied.

5.1 Basic Idea of Impact Path Analysis (IPA)

As a result of the discussion from the EST experts meetings at the OECD, it was concluded that conventional cost-benefit analysis was not the preferred method on the one hand, while on the other hand, preparing the data and functional inputs for an SDM would require considerable additional work and bring about problems of handling the complex structure of system dynamics modelling. Therefore, the **simplified cybernetic model** (SCM) was proposed as the preferred solution.

SCM can be reduced to a method that solely generates qualitative rankings based on expert judgements and evaluates the results by active/passive influence indicators or by positive/negative feedback analysis. An example is the "manual computer" of F. Vester which allows for a simple evaluation of an impact matrix of the type exhibited in Figure 3. Looking at the detailed quantitative scenarios in the EST case studies, the most simple version of SCM (using values -, 0,+) could be applied. However, this would remove all cardinal information which has been generated by the scenarios. Therefore, a variant of an SCM is suggested in the following section that provides the opportunity to use as far as possible all information generated in the scenarios and that is consistent with the method used in a full SDM for selected case studies. We will call this method the **impact path analysis (IPA)** because it is based on the idea that the assessors follow the sequence of impacts level-by-level through the economic system in order to determine aggregate economic indicators. This approach will allow to assess the order of magnitude of the changes induced by the EST Scenarios.

5.2 Assumptions and Macro-structure of the IPA

The following assumptions are made for developing the IPA method:

1. All EST3 country scenarios will achieve the environmental targets in the year of projection, i.e. by 2030.

   Under this assumption the environmental sector can be ruled out of the interactive part of the assessment, as the levels of environmental indicators are fixed from the beginning of the process.

2. The policy actions are defined exogeneously and do not vary according to the impacts assessed.

   In this case it is not necessary to foresee a feedback mechanism in which the policy actions are flexible and could be adjusted in the course of an interactive assessment scheme.

3. There are no negative side effects of control technologies.

A big portion of the reduction needs has to be met by new technologies. It is assumed that these technologies do not produce additional environmental or social harm (e.g. the use of hydrogen technology will not introduce negative environmental impacts).

4. The assessment teams evaluate changes on a percent scale starting from a defined base level for the variables (e.g. from BAU scenario).

   To exploit the cardinal information of the scenario studies, the assessors will be asked to estimate changes in percentage and to estimate the influence.

5. Aggregation from micro to meso levels and from meso to macro levels is possible through expert judgements and econometric key-relationships.

   As the changes in the scenario are trajectories that deviate substantially from a trend path, the final outcome of the assessment should consist of macro indicators of the economic and ecological performance (the ecological being considered exogenous). Consequently, all expected changes on the micro level (individual decision level) and meso level (sector) have to be translated into aggregate indicators.

6. The analysis is restricted to economic impacts.

   Although this type of assessment allows in principle to include social impacts and their interrelationships with economic and ecological indicators (according to the concept of sustainability), the analysis will focus on economic impacts, in order to reduce complexity of the procedure.

Given these assumptions, the assessment procedure is subdivided in two parts:

- Part 1: Direct impact path analysis (IPA). The aim of this part is to estimate the impacts of EST at the various levels following a one-directional impact path.

- Part 2: Interdependence analysis. The aim of this second part is to analyse the interdependencies between major variables and influences, and to identify the most important feedback mechanisms.

5.3 Direct Impact Path Analysis

The flowchart of the basic part of the IPA method is exhibited in Figure 4. The mainstream of the analysis is represented by the thick solid lines in the Figure. Each level of the analysis will be described by a set of variables (e.g., actions, instruments). The process starts with impact level 0 for which a set of policy variables is defined and the dose or intensity is determined for every instrument based on the environmental sustainability indicators/criteria (level 6). The assessment follows a one-directional path determining the impacts from the micro, meso to the macro levels; it starts from concrete specifications of the policy actions and the intensities with which these should be applied. As IPA is not a dynamic scheme and can not simulate the effects of gradually intensifying policy actions over time, all policy instruments are listed assuming that the intensities are sufficient to achieve the EST targets and criteria at the end of the entire adjustment processes (see assumption #2 in section 5.2). The assessment addresses six different levels covering the micro-, meso-, and macro-economic realm:

- At micro level the analysis focuses on changes of transport technology and individual travel behaviour (level 1) as well as supply changes of the transport market (level 2);

- At meso level, changes in transport demand (level 3) and affected markets (level4) are analysed;

- At macro level, the changes from lower level are aggregated into macro-economic indicators (level 5) and the overall environmental impacts estimated (level 6).

In addition, the dotted lines are shown in the figure that indicate additional relationships between the levels. These might be relevant, but have to be ignored at this stage of the IPA analysis in order to reduce complexity.

The different levels of the analysis for which the impacts have to be assessed have the following features (see also detailed description of the evaluation procedure in Appendix I):

- **Level 0: Political actions to achieve EST**

  This is the base level of the analysis where the sustainability performance criteria (EST criteria) set by the EST research teams have to be translated into policy actions which are designed in a way that the sustainability goals are achieved. In some case studies the necessary policy instruments are listed roughly, in others more details have been given. The Swedish study even includes 25 different targets and policy instruments for three clearly distinct phases: the "acceptance", adjustment" and "implementation" phase. In the context of IPA it is crucially important to start the analysis with an appropriate and comparable design of the policy instruments.

  It is evident that all policy schemes which require drastic changes of individual behaviour through state control might constrain economic activities and imply higher risks for economic prosperity. Therefore, it is recommended to include a learning process (e.g. workshops on policy design and impact estimation for the EST research teams) to tailor the design of instruments; this is also important for public acceptability and successful implementation.

Micro level of the analysis

- **Level 1: Changes in transport technology and individual travel behaviour**

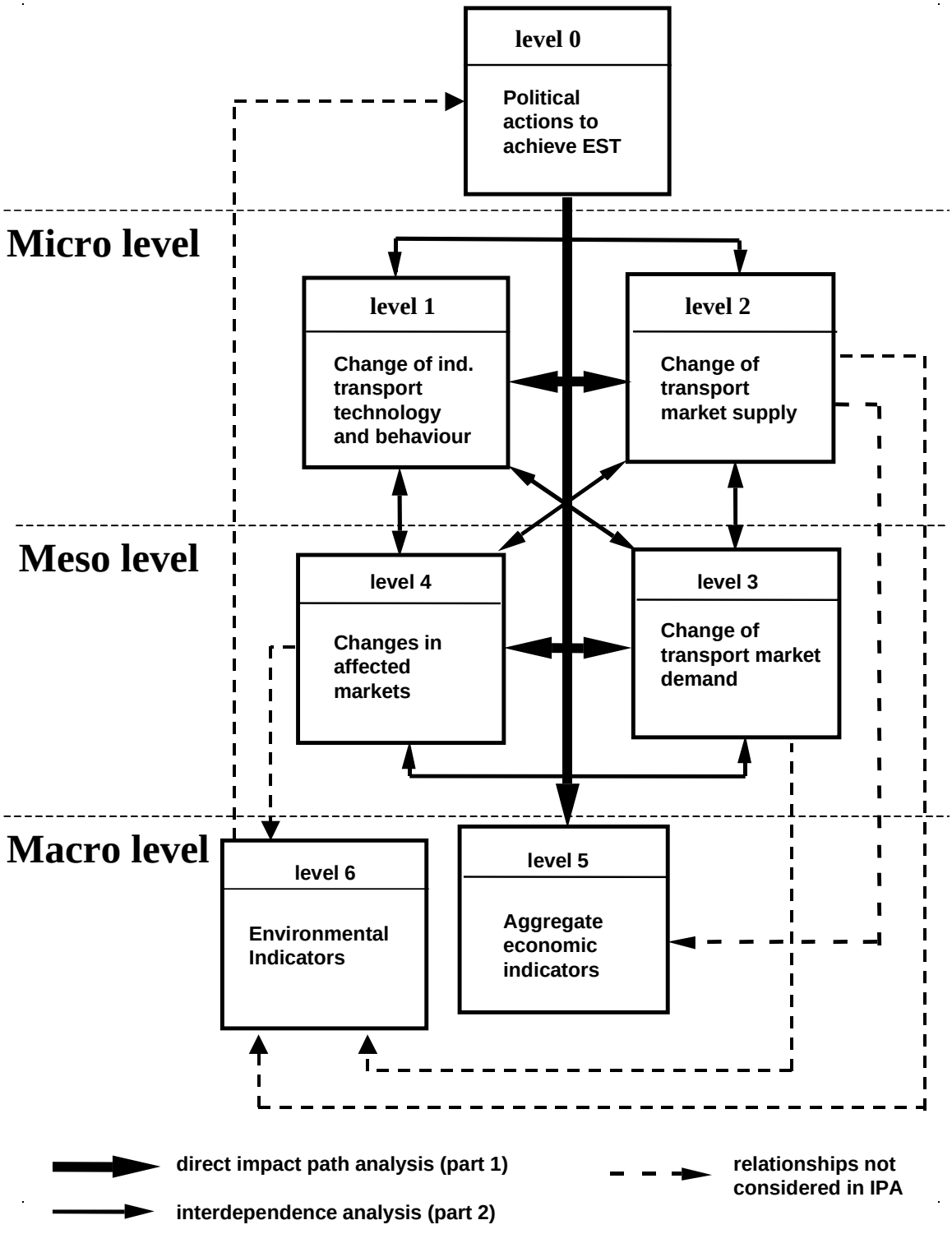
  Level 1 of the analysis focuses on the micro-world of decision making by individual consumers and producers. The individuals affected by the policy actions will respond according to their preferences and production technologies. It will be important to know, whether individuals react in a conventional way (e.g., restructuring their portfolios according to the change of relative prices) or in an unconventional manner following a change of preferences/technologies (e.g. change of values of the consumers; change of production technologies, new direction for innovations of the producers). The EST scenarios include a number of assumptions with respect to the change of transport technology and transport behaviour. Changes in technology are so substantial, that other sectors, i.e. energy production, might be significantly affected.

- **Level 2: Changes of transport market supply**

  Changes of technology will set new conditions for the supply side of the transport market. Furthermore, the expected changes of transport demand will stimulate adjustments of the supply side of the market. These changes affect the cost, time, reliability, convenience and safety conditions of the transport systems, i.e., the degree of quality of the different transport modes. The supply side will

therefore be described by quality indicators which represent the average level-of-service for the customers: generalised costs (e.g. average cost or average time consumption per unit of distance). These consist of all impedances felt by users as costs stemming from operating, infrastructure, time and inconvenience.

Figure 4. **Flow Diagram of the Direct Impact Path Analysis (IPA)**



Meso level of the analysis

- **Level 3: Changes of transport market demand**

  It is the primary task of the scenarios to construct a world of transport technology and transport demand which is consistent with the environmental sustainability goals (dotted arrows from level 3 to level 6). The result of the changes in technology and individual travel behaviour assumed by the EST scenarios are evaluated in terms of their impact on transport demand. The previous levels of the assessment process help to make the evaluations of impacts on the demand side of the transport market consistent and to allow for internal plausibility checks. Of course, transport demand is related to supply side conditions (level 2) and the situation in other markets (level 4) for which transport is a complementary or a substituting good or service. As the environmental targets are assumed to be achieved, no further analysis on the relationship between level 3 and level 6 is foreseen.

- **Level 4: Changes in affected markets**

  Besides the transport market, a number of other markets and industries are affected by the technological and behavioural changes, e.g. the markets for land use (industrial sites, residential areas), retail business in cities, telecommunications, labour, leisure and tourist markets. Attention has to be paid to the expected changes in these markets and the substitution effects that are to be estimated (e.g. lower sales of some consumer goods, while others increase like telecommunication). Effects can be positive (e.g. growing railway industry due to increased modal shift from road to rail) or negative (e.g. reduced motor vehicle manufacturing or aircraft production due to transport demand changes). For example, if the starting point is the estimation of price increases for transport, this then translates into a sequence of reactions which can be followed using economic input-output tables.

Macro-economic level

- **Level 5: Changes in aggregate economic indicators**

  Some assumptions for aggregating the results have to be made to translate the market results from level 4 into aggregated macro-economic indicators (e.g. share of GDP for influenced markets; multiplier effects). As IPA is not an econometric analysis, the result will not be measured in terms of accurate absolute changes of domestic consumption, capital formation or production value. However, the analysis should be detailed enough to generate information in the order of magnitude of the expected changes from the BAU figures and their directions. From this assessment, it should be possible to determine whether EST will have major effects on GDP growth. It is important to note that GDP is not a welfare measure in itself. A correction of GDP will be necessary based on the replacement investments needed to cover the damage caused by the system (e.g. repair of historical buildings destroyed by air pollution; repair of material damage and health damage caused by traffic accidents).

- **Level 6: Changes of environmental indicators**

  Right from the beginning of the analysis, environmental indicators are set according to the targets for environmental sustainability (EST criteria). These targets are not questioned in the economic assessment process. As there is no feedback interaction included in the IPA between policy actions and environmental indicators, it will not be possible to use IPA to determine least-cost policy actions, i.e. to design policy instruments in a way that the environmental goals are achieved at minimum economic costs. In a complete SDM assessment procedure, level 6 would have to be included in the interaction scheme (dotted lines).

For each case study, the direct impact analysis can be performed by filling out the "evaluation forms" of each level (1-6) using the results of their scenarios (see examples in Appendix I). Taking the BAU scenario as a reference case, the evaluations for the EST scenario can be given in terms of *percentage changes from BAU*. As a consequence, the BAU scenario cannot be assessed independently using the IPA method, unless another reference scenario is defined. Keeping in mind the idea of the backcasting concept, this property of the IPA method is not a disadvantage. The reason for this lies in the backcasting concept, which originates from the idea that BAU is not sustainable due to a number of environmental and social problems, resulting from the environmental and social world of BAU that should not become reality. The BAU properties, therefore, are in any case inferior compared to EST. However, the aggregate economic figures of BAU are considered to be acceptable to be used as reference values for assessing the EST scenarios.

In the course of the direct assessment work, the EST study groups may have good reasons to expect that the economy will not suffer substantially from environmental policy and that structural changes are induced, which in the end are not detrimental to the welfare situation of the society. Eventually, material welfare might be reduced slightly, which would be compensated, however, by better environmental and social conditions. The detailed evaluation at the different levels of the impact path will then provide a rational basis for the general expectation with respect to the economic impacts of EST. If significant differences are found in the evaluations between the study groups, a learning mechanism (e.g. in terms of a Delphi-type feedback process or a workshop discussion on impact evaluation), might be useful to *stabilise the variability of the results*.

5.4 Interdependence Analysis

The interdependence analysis is part 2 of the assessment process and is intended to determine the **interactions** between all levels of the analysis and their exposure to exogenous influences (e.g. policy actions, institutions, the interference of lobby groups). The objectives of the interdependence analysis are threefold: Firstly, it has to be examined whether the expectations of the research groups are realistic or set too high; (i.e., the vision of conscious individual behaviour under EST where a perfect regime of altruism is assumed to substitute the present regime of individual utility maximisation from the beginning). Secondly, major interactions among the economic system should be explored to identify key variables which have to be controlled over time by policy makers to direct the system towards the sustainability path. Thirdly, critical factors are to be identified which could act in a counterproductive manner, and prevent the system from moving towards sustainability.

It is clear that the activities of the levels 1-4 are closely interrelated, since they involve different levels of impacts from the micro to the macro-economic level and vice-versa. There are three types of forces which influence from outside these interrelationships:

(1) **Policy actions**

The influence of policy actions on the levels 1 - 4 has already been assessed in part 1. It is assumed that policy actions also can influence institutions/structures and basic preferences.

(2) **Institutions and structures**

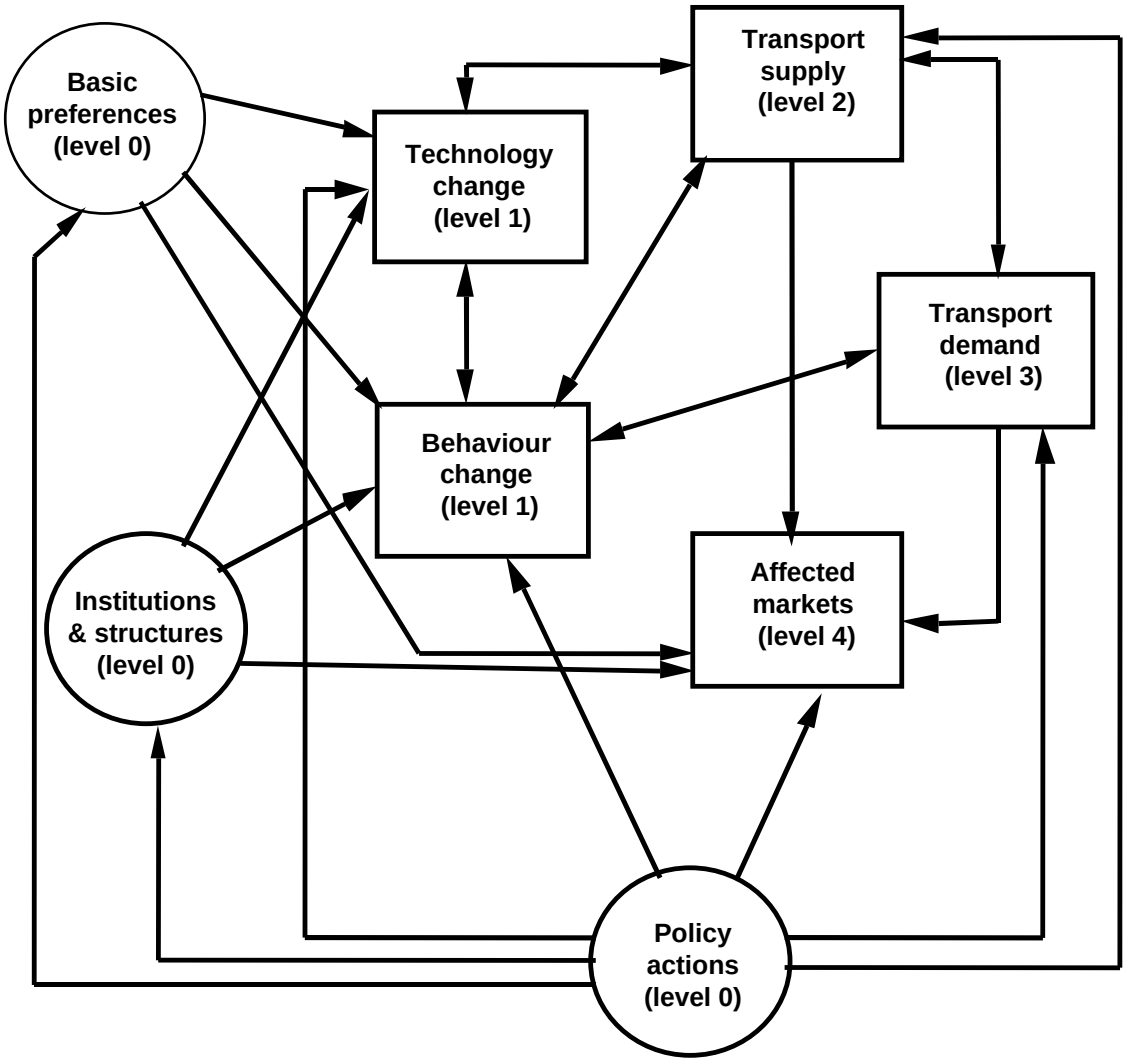
Factors like the influence of lobby groups, the structure and organisation of the industry, or the relevance of environmentally oriented production for the GVA of an economy, determine the diffusion of new technology and individual behaviour. These factors differ from country to country depending on their political and economic situation.

(3) **Basic preferences**

Basic preferences of consumers and producers determine the elasticities of reactions of demand and supply. Examples for such decision factors are the awareness of social risk, altruism, or preference for material consumption on the consumer side and short/long-run behaviour for profit maximisation on the producer side.

These three categories of forces strongly influence the other levels of the system. Policy actions by governments are regarded completely exogeneous to the transport system. They gradually influence basic preferences and the institutions/structures. Figure 5 depicts the macro structure of the interdependence analysis. Policy actions, basic preferences and institutions/structures are exogenous to the levels 1 to 4. The **level 1-3** variables are assumed to interact in **both directions**. This means that micro and meso spheres of the transport system are closely interrelated. For example, the introduction of new car technology with fuel cell propulsion systems might lead to lower average speed in intercity car travel, and thus, to reduced average distance (level 1). This will result in an increase of generalised costs (level 2) and a reduction of car km travelled (level 3). All **level 4** variables are assumed to be entirely passive, which means that related markets react to changes on the transport market, but there is no feedback to the transport system.

Figure 5. **Macro-structure of the interdependence analysis in IPA**



Using this approach, the variables included in the interdependence analysis can be grouped into 8 categories according to those introduced for the levels 0-4 in Table 3. These variables can be ordered in terms of a **matrix** as presented earlier in Figure 3. All variables that have "active" impacts (generating influences) on other variables are shown in the matrix cells of the respective row [e.g. variable user pricing (#1 listed in the matrix) influences the level of motorisation (variable #39)]. The "passive" (felt influence) variables are listed in the columns of the matrix with the respective impacts felt from other variables [e.g. motorisation (#39) is influenced by variable user pricing (#1)]. The intensity of the impact is defined by a scale from 0 to 5 (low to high) where a negative impact (e.g. higher prices reduce motorisation) is marked as a negative figure.

Table 3. **Influencing and influenced variables in the interdependence analysis**

Category level	Category	Active influence	Passive influence
0.1	Policy actions	completely exogenous	
0.2	Institutions/structures	to levels: 1.1, 1.2, and 4	from level 0.1
0.3	Basic preferences	to levels: 1.1, 1.2, and 4	from level 0.1
1.1	Indiv. transport technology	to levels: 1.2, 2, 3 and 4	from levels 0 to 4
1.2	Indiv. transport behaviour	to levels: 1.1, 2, 3, and 4	from levels 0 to 4
2	Transport supply	to levels: 1.1, 1.2, 3, and 4	from levels 0 to 4
3	Transport demand	to levels: 1.1, 1.2, 2, and 4	from levels 0 to 4
4	Affected markets		completely endogenous (passive)

The setting-up of this ordering procedure for the different variables leads to a matrix structure as presented in Appendix II. In the present example 66 variables are used to describe the system leading to a total of 4290 (i.e. 66 x 65) possible interactions. However, this number can be reduced to about half the amount by examining the variables in the matrix and their interrelationships. The shaded areas in Table AII.2 are excluded from the analysis of interdependent relationships to simplify the procedure. Further reductions of the size of the matrix should be considered by carefully examining the relevant interactions to keep the number of interrelationships below a thousand.

The analysis of the interdependence matrix will produce two types of information:

- identification of most active, passive or influenced (i.e., weighted combination of active and passive influences) variables;

- identification of positive and negative feedback loops and the variables which contribute most to positive (reinforcing) or negative (dampening) feedback interactions.

Therefore, the final outcome of the interdependence analysis is a set of policy variables or measures which are necessary to bring the system to the sustainability trajectory, and those variables that have to be controlled most actively to prevent the system from departing from a sustainability path.

6. Preliminary Applications of the IPA

The IPA method has been tentatively applied to the German and Netherlands case studies to illustrate the assessment procedure. Both applications are preliminary and should serve as examples without overinterpreting the results of the analysis. A full account of the assessment including comparisons with SDM and other models will be given in the report of Phase 3 of the EST project, where all the instruments will be discussed.

6.1 Example of the German case study

The assumptions and results of the German scenario have been presented in reports of the Umweltbundesamt and the Wuppertal Institute in 1997 and 1998 (revised version). It should be noted that these results stem from a rough expert evaluation of the scenario assumptions of the German case study. They will be fully evaluated together with the results of the SDM at a later stage of the EST project. A first evaluation for all levels of the IPA assessment has led to the following results (see also Appendix IV).

Level 1 (changes in transport technology and travel behaviour): Looking at the assumptions of the German study in some detail, one can draw the following conclusions:

- On the technological side the scenario puts much emphasis on alternative transport modes like rail and waterway transport. Attractiveness and efficiency of alternative modes have to be increased significantly, partly by better use of telematics. A change of car technology also plays an important role, but is by far insufficient to achieve the overall goals.

- On the behavioural side, the major issue is a reduction of current forms of motorised transport by car and truck use as well as air travel.

- Setting conditions to reduce the need for individual motorised travel, inducing change in behaviour and improving education, training, information and moral persuasion are most important policy actions. Fostering alternative modes of transport by public investment planning and support of their technological development are very effective complementary activities. The efficiency of the measures can be increased by an appropriate pricing policy for environmental costs.

- Comparing the influence of behavioural versus technological changes, behaviour measures outweighs the technological ones.

Level 2 (changes in transport market supply): The change of generalised costs indicates the intensity of public measures which is necessary to achieve the changes of technology and behaviour assumed at level 1 of the assessment. The German case study didn't provide figures for the changes of generalised costs. Thus, figures for changes of traffic activities have been used; these are discussed in level 3, insofar as level 2 has to be treated simultaneously with level 3. The results of this part of the assessment are:

- The real generalised costs of car travel have to increase by at least 100% compared with BAU.

- In the case of trucking an even higher increase of generalised costs, in the order of 175%, would be a pre-condition for the drastic changes to be achieved.

- The highest changes of generalised costs would be necessary in the sector of air transport. To stop the fast growth of air travel and achieve a most drastic reduction compared to the BAU situation, the generalised costs of air traffic would have to be increased by at least 400% (e.g. a 5 times increase of air fares of BAU).

Level 3 (changes in transport market demand): The German team has assumed the following changes of traffic indicators to occur as a consequence to EST measures, compared to BAU in 2030:

– Non- motorised transport	+ 78% (pkm).
– Light rail/bus transport	+ 170% (pkm).
– Heavy rail, passengers	+ 247% (pkm).
– Cars, motor bikes	- 69% (pkm).
– Rail freight	+ 348% (tkm).
– Inl. Waterway	+ 24% (tkm).
– Trucking	- 87% (tkm).
– Air traffic	- 93% (pkm).

Level 4 (changes in affected markets): The economic sectors, which are influenced in the first instance by the assumed measures, are road vehicle manufacturing industry, related secondary business (energy, repair, accessories), the railway industry, the airline industry, tourism and the retail business. Losses of demand in the first two sectors can be partly offset by gains in other sectors, depending on the substitution effects from changes in behaviour of customers. The overall consequences can be estimated by "Input-Output" analysis. The preliminary results are:

- As the road vehicle industry in Germany plays an important role (manufacturing plus secondary businesses contribute about 8% to the GVA, not considering the indirect effects on other sectors), there is a strong impact on the GVA in the first round of the implementation of measures. Road vehicle manufacturing is estimated to lose about 45% and secondary businesses 60% of their original GVA.

- Airline industry even is expected to lose 90% of their production compared with BAU.

- These losses can be partly offset by increases in the environmentally more friendly transport industries. The railway industry for instance gains 120%.

- The second and third type of consequences to the economic adjustment process include the effects of demand diversions to other sectors. The national tourist industry and also the retail businesses could profit by about 10% each.

Level 5 (change of macro-economic indicators): The sectoral effects examined on level 4 are analysed with respect to the overall multiplier effect at the macro-level, considering the interdependence and mutual impacts between all sectors. This results in the estimation of overall production and employment effects. The above analysis is based on the present "Input-Output" figures. It can be assumed, however, that during the phase of transition to EST, production technology will adjust and technological progress will be accelerated; strengthening an economy which in the long term will be exposed to rising energy prices. Such a process of technological adjustment has been simulated on the basis of a production function approach.

- Summing up the preliminary assessment: there remains a loss of national production value in material terms. It is associated with a reduction of final demand (gross social

product) which is estimated at about 5% of the BAU value. The reduction of private consumption which indicates material well-being of consumers is slightly higher at about 6%.

- Based on the projected development of labour productivity one can estimate the change of employment, which is an important indicator in countries with high unemployment. The result is an expected loss of employment of about 3%. This figure is significantly lower than the percentage reduction of gross production value, which indicates that production is shifted from sectors with higher labour productivity to sectors with lower labour productivity.

- Feedback between the change of transport technology and the acceleration of technical progress has been taken into account through the technical progress term λ of the standard Cobb-Douglas function for the gross domestic product $P(t) = c \bullet \exp(\lambda \bullet t) \bullet L(t)^{\alpha} \bullet K(t)^{\beta}$, where L is the Labour and K the capital function; α, β are production elasticities, and c is a constant.

Under more modest assumptions for the effects of technological change, the above figures of production and employment losses result in less than half of the previous figures, i.e. technological change can partly offset the negative demand side effects.

Preliminary conclusions with respect to the changes of material welfare are as follows:

- As the German EST scenario includes drastic restrictions on economic behaviour, it has to be expected that economic disadvantages in terms of production losses and employment losses result. These can be reduced by half by accelerating technical progress through stimuli in the transport sector. Finally, the expected production losses might be about 2.5%; losses of material consumption 3%, and the employment losses 1.5% compared to the business-as-usual scenario (which is considerably higher than current levels).

- Although this might give rise to some concern for an economy which presently suffers from a high rate of unemployment, the results show that there is little reason to expect an EST policy would cause economic disaster. But it is important to schedule EST policy in a way that consumers and producers are able to adjust gradually to the conditions set by EST policy.

- Finally, the analysis is in line with the outcome of previous studies which suggest that gradual and modest steps towards EST even might increase gross domestic product (GDP) and employment (see references, e.g. Öko-Institut/VCD, 1998). The German EST scenario could be oriented towards a more positive assessment result, if the behavioural constraints assumed could be substituted by technological assumptions, i.e. by introducing more technological optimism.

Estimation of the monetary value for achieving EST

The figures given above are based on the statistics of national accounts. It is well known that these statistics, such as GDP or national income, do not give a complete representation of overall welfare, or in other words of the quality of life. Obviously the evaluation of the change of human and environmental capital is of a similar importance compared to the change of material welfare and should be estimated despite all difficulties of monetisation. In the following such an estimation is given based on monetary

values which have been presented in a study of INFRAS/IWW (1995) for the UIC. The external health costs considered in the study are:

- costs of traffic accidents;
- costs of noise abatement and prevention;
- costs of air pollution abatement and prevention; and
- costs for preventing climate change.

Meanwhile there are also estimations of the monetary value of other effects from other air pollutants, such as benzene or particulate matter. They have been quantified by IWW et al (1998) in a study for the Umweltbundesamt (Federal Environmental Agency, Berlin). Using these sources, a rough monetary evaluation of environmental externalities will be given, based on the cost changes induced only by the road sector (see Table 4).

The sum of external cost savings is between 4.5 and 6.5% of GDP in Germany, taking into account the EST assumptions and scenario results. These figures add up to the same amount as the estimated loss of demand-induced material production. After correcting the demand-induced losses by the benefits stemming from an acceleration of technical progress, one can draw the conclusion that the environmental benefits are substantially higher than the losses of material production. Of course, this conclusion is subject to the result of the monetary evaluation of the environmental effects.

Table 4. **Estimation of external costs for the German case study**

	NOx Emissions	VOC Emissions	PM Emissions	CO2 Emissions	Transport by car		Transport by truck		Transport by air
Difference between BAU and EST	kt	kt	kt	mt	bill pkm		bill tkm		bill pkm
	651	78	15	216	712		423		489
Abatement costs	NOx	VOC	PM	CO2	Noise from cars	Accidents by car	Noise from trucks	Accidents by trucks	Noise from aircraft
	DM / t	DM / t	DM / t	DM / t	DM / pkm	DM / pkm	DM / tkm	DM / tkm	DM / pkm
	6500	6500	65000	400*	0,009	0,064	0,025	0,044	0,033
Cost savings (in billion DM)	4,232	0,507	0,975	86,4*	6,41	10,575	19,8	56,32	16,137
Sum									201,356

*) Note: if the CO_2 cost factor is assumed to be only DM 100/t, the costs from CO_2 impacts will amount to 21.6 billion DM; this will result in reduced external costs of 136.556 billion DM instead.

Interdependence analysis

The interdependence analysis has been done only for the German case study. The results of this analysis are:

Active or influencing variables

- The most active policy variables are "Constraints on individual behaviour" and "Education/moral persuasion". This means that the German EST is based very much on a change of values of individuals.

- Regarding institutions and structures a more efficient railway organisation is very important. The activities of the road lobby is regarded very influential with respect to the chances to implement EST policy.

- What concerns basic preferences the most influential variable seems to be the "awareness of social risk", followed by the "education level of individuals" in the society.

- From the technological point of view the scenario presupposes a drastic increase of the efficiency of railways.

- Transportation behaviour has to change in the first instance with respect to motorised transport by car and truck and in the second with respect to air travel.

- On the supply side car and truck costs have to be increased a lot, cost of rail has to go down in the relative sense.

- In concordance with the behavioural change the demand for road and air transport has to be reduced and partly replaced, as a precondition for a transition to EST.

Passive or influenced variables

- The most influenced "passive variable" is the "education level of the individuals".

- Regarding transport technology, the efficiency of railways is dominant.

- The variable of transport behaviour that is strongly affected is the "change of loading factors".

- A change of generalised costs of trucking is a most influenced passive indicator from active policy measures.

- The propensity of shippers to prefer environmentally friendly rail and waterway transport is strongly influenced from transport demand.

All markets related to the transport sector are passively influenced. The strongest influence is exercised in the market for road vehicles and the related service markets.

6.2 Example of the Dutch case study

The Dutch expert team has applied the IPA method in a first preliminary assessment of their EST3 scenario. The results are as follows:

Level 1 (changes of technology and travel behaviour): At the micro level of decision making both influences have been assessed.

- On the technological side, the scenario puts much emphasis on innovative vehicle technology.
- On the behavioural side, the major issue is to reduce the need for motorised transport by car and truck. Air traffic is less affected compared with the German EST scenario.
- Setting prices right through a tradable permit system is the main instrument for achieving EST.
- Comparing the influence of behavioural versus technological changes, technological slightly outweighs behavioural.

Level 2 (change of transport market supply): The change of generalised costs has been assumed according to the German example.

Level 3 (changes of transport market demand): The Dutch group has assumed the following changes of traffic indicators to occur as a consequence of EST measures, compared with BAU:

- Non- motorised transport	+ 100% (pkm).
- Light rail/bus transport	+ 102% (pkm).
- Heavy rail, passengers	+- 0% (pkm).
- Cars, motor bikes	- 50% (pkm).
- Rail freight	+ 383% (tkm).
- Inland Waterway	- 27% (tkm).
- Trucking	- 75% (tkm).
- Air traffic	- 76% (pkm).

Level 4 (changes of affected market): The economic sectors which are influenced in the first instance by the measures undertaken are the *transport and storage sector*, the *industry and trade sector* and the *retail trade and wholesale business*.

According to the sectoral analysis the following changes are expected:

- transport and storage sector:	- 62%
- industry and trade sector	- 33%
- retail and wholesale business	+ 6%.

The consequences are stronger, compared to the German case study, although the vehicle manufacturing industry does not play such a dominant role in the Netherlands. It is important to note that the Dutch road haulage industry contributes a higher share to the gross value added so that the modal shift from road to rail will affect this service sector seriously. On the other hand, some positive impacts are expected for the rail industry and for the retail trade business. The national tourist industry in the Netherlands is not expected to benefit significantly from EST.

Level 5 (change of macro-economic indicators): The losses of GVA in the transport and industry sectors cannot be offset by substitution effects in the other sectors considered. This leads to an overall decrease of employment in the order of magnitude of 5% to 10% of total Dutch employment compared to the business-as-usual scenario. In particular the Dutch transport service sector is negatively affected.

The economic structure of the Dutch economy is not too different from the German. The same applies to labour productivity. Therefore, it is not surprising that the overall results with respect to the loss of production value and of employment look very similar to the German case. The loss of employment is slightly higher, because the production losses in Dutch haulage industry generate more employment reductions per unit of GVA compared with the production losses in the German vehicle manufacturing industry.

6.3 Further Assessments

The proposed IPA method evaluates changes in economic sectors based on data provided by "input-output" tables of national accounts. As the geographic scope of some case studies is sub-national, regional or transport "corridor" level, it can be questioned whether the method is appropriate also for these cases. Concerning regional applications, the approach is valid as long as the sectoral structures in the analysed region is not too different from the national situation. In this case, the IPA approach gives an approximation of the regional changes, provided that there are no further feedback mechanisms with other regions.

A particular problem with macro-economic assessment, arises in the trans-alpine corridor study. A number of countries are affected, so that a European input-output table, split-up by countries, would be necessary to capture the macro-economic effects. Looking at the heterogeneous situation of European "input-output" models, an application of the standard IPA approach cannot be recommended for the corridor study. The assessment would be limited to micro- and meso-level changes, and does not allow their translation into macro-economic indicators.

7. Preliminary Conclusions

The conclusions, which can be drawn from the preliminary assessment, are:

- EST will lead to substantial structural changes in some production and service sectors. In the first round of implementing the measures for EST, final demand will be influenced negatively, so that a reduction of production value, material consumption and employment will result compared to the business-as-usual scenario (BAU).

- Under pessimistic assumptions for the impacts of EST measures, there could be a loss of material consumption of about 6% compared to BAU. For the timeframe considered, this would imply a yearly loss of growth of 0.002% p.a. This means that the effect would hardly be observed in the growth process, provided, it would spread equally over time.

- In the following rounds of impact evaluation of measures, two types of effects might occur which can at least partly offset the negative initial effects. On the demand side, there will occur substitution effects, i.e. consumers will react with restructuring their budgets. On the supply side, technological progress is enhanced, so that new production technologies and new consumer products are introduced earlier into the market, than under the BAU conditions. This is a benefit for the economy in itself and, furthermore, will be of high importance when

future energy prices rise - a development which is expected by many experts. EST will help the economy to adjust more smoothly to a growth path, which is associated with a much lower consumption of fossil energy resources.

- An EST policy cannot be implemented by one single action or measure, but rather by a sequence of a number of consistent and targeted policy actions, with increasing intensity over time. This will give the economic decision-makers the possibility to adjust production technology and consumption plans over time.

- While modest reductions of material consumption might occur compared to BAU, there will be certainly a substantial improvement of the quality of life through safer transport and lower depletion of environmental resources. In economies which have reached a high standard of material endowments, future quality of life will crucially depend on the environmental situation in such a way that the overall impacts (including material and immaterial components) are positive, provided that the immaterial components are valued in appropriate economic terms.

- Compared with other studies from environmental institutes, the results of the economic assessment might look too negative. The Öko-Institut/VCD (1998) study for instance, comes to the conclusion that an overall increase of employment would be the probable outcome of a strict environmental transport policy. Also the German Institute for Economic Research (DIW,1994), forecasts positive prospects of green policies. However, the assumptions of the studies look different and show much optimism with respect to the responses of demand and supply to environmental stimuli. The main reasons for the positive results of these studies are: (i) less challenging criteria for EST (e.g. only 30% CO_2 reduction); (ii) the hypothesis that final demand is restructured towards more environmentally friendly activities, but not reduced; and (iii) the hypothesis that exchange with other countries is reduced, resulting in lower imports without changing exports.

- In the IPA assessment, a conservative starting point has been taken, notably to assume a scenario which includes a rather pessimistic view concerning the development of industry and technology, and consequently their future impacts on the environment. The aim was to show that even in the worst case there would be no risk of an economic disaster. This point of view, of course, is subject to discussion and refinement when reviewing the scenarios and their assessment.

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APPENDIX

APPENDIX I

Evaluation for Part 1: Mainstream assessment of the IPA

Please note that the *evaluation sheets exhibited in the Appendix I are examples to be used by the EST project teams.* They are working aids for the assessment process.

I.1 Description of evaluation sheets

Each level of the analysis will be described by a set of variables. The process starts with level 0 for which a set of policy variables (actions, instruments) is defined and the dose or intensity is determined for every instrument based on the environmental sustainability criteria (level 6). As IPA is not a dynamic scheme and can not simulate the effects of gradually intensifying policy actions over time, all policy instruments are listed assuming that the intensities are sufficient to achieve the EST result at the end of the entire adjustment processes (see assumption #2 in section 5.2).

Evaluation sheet for level 0 (policy action): it's purpose is to describe a consistent set of policy instruments and to define the intensity levels. In the first column the targets of the environmental indicators are listed. The second column contains policy actions which help to achieve these targets. It summarises the assumptions regarding the policy instruments considered. In a third column the intensity of each policy action is described. If a policy variable can be measured on a cardinal scale, the evaluators are asked to quantify the percentage difference between the BAU situation and the EST situation (e.g. fuel tax increase). As there might be synergistic effects of policies and also adverse influences, the links between the policies are characterised in a fourth column. Overall, this will lead to a readjustment of policies and intensities which is described in columns five and six. These two columns summarise the types of policy actions; they are grouped according to the EST criteria used in the assessment. Columns 1 to 4 are designed to facilitate the generation of the final information in columns 5 and 6 which will be used further in evaluation sheet 2.

Evaluation sheet for level 1 (micro level: changes in transport technology and individual travel behaviour) is to translate the policy actions into changes of the transportation technology and of the transportation behaviour. The case study teams have performed this step already in the EST 1 (technology) and EST 2 (mobility management and behavioural change) scenarios, and combined the results in the EST 3 scenario. In this step of the analysis the evaluators are asked to do two global assessment steps: First to indicate the magnitude of the technology and behavioural changes as a percentage of the figures for the BAU scenario. Secondly to roughly describe to which extent a specific technology change or a behavioural change contribute to achieving the defined environmental targets and criteria.

Evaluation sheet for level 2 (micro level: changes of transport market supply) summarises the influence of technological and individual travel behaviour changes on the supply side of the transport system. The supply side is characterised by changes of generalised costs. The generalised costs consist of all impedances of the users stemming from operating costs, infrastructure costing, time costs and inconvenience. It is expected that variable user costs increase but less than the price increases for fuel and

other resources because of the better technology. Investment costs for the transport networks might decrease because of decreasing traffic activities for road and air transport, although this effect is partly compensated by increasing investments for public transport. The estimations are given in percentage changes versus the BAU scenario.

Evaluation sheet for level 3 (meso level: changes in transport demand) translates the technological and behavioural changes into the categories of transport demand for passengers and freight. Effects are measured in pass. km or tonne km, respectively, and given in percent compared to the BAU scenario. These transport data are taken from the scenario developments. All case studies provided figures for the "sum of effects" for the different transport categories as exhibited in the lowest row of the table. If qualitative estimations for the influence of the technological and behavioural changes have been given, the additional work which the groups are asked to do is to allocate the changes of traffic demand to the influencing factors of technology and traffic behaviour.

Evaluation sheet for level 4 (meso level: changes in affected markets) exhibits the relationships between the changes of transport demand and the industries affected. The effects can be positive (e.g. railway industry) or negative (road vehicle manufacturing or airline industry). Substitutional effects may occur (lower sales of cars, higher sales of other consumption goods such as telecommunication products. The idea of this evaluation is to make the transition from the BAU consumption/production world to the EST consumption/production world transparent. Evaluators are asked to give their judgement in percentage change of value added in the markets addressed.

Evaluation sheet for level 5 (macro level: aggregated economic indicators) starts from the results of the previous evaluation levels and draws a projection to aggregate economic indicators such as gross domestic product or employment. This projection has to include - at least implicitly - the public budget position and the balance of income and expenditures. It is highly probable that charging and taxation will lead to a higher public income even after considering the additional expenditures for transport investments. In this case it will be assumed that the net budget surplus is used to lower existing taxation on labour. A guideline will be elaborated for this step to support the evaluators and to preserve consistency of the single evaluations for the case studies.

I.2 Templates of evaluation sheets for level 0 to level 5

a) Evaluation Sheet for Level 0: Political actions to achieve EST			
Target	Instrument I	Doses I	Links
CO2	- fuel tax - emission certificates - standards for fuel consumption - subsidies of alternative technology (fuel cell) - land use planning - information systems - road pricing	(+) x% BAU ton/capita x l/100km (fleet average) x % of price differential reduction of mileage investment ECU/km	(+) NOx (+) land use
NOx, VOC, PAH, PM	- standards - diesel tax - environmental charge - subsidies of alternative modes	EURO 5 + Norm (+) x% BAU ECU/km	(+) CO2 instr. (-)Biodivers.
Noise	Environmental charge	65/55 dB(A)	(+) veh. tax
Biodiversity	Environmental law	no road inv. in sens. areas	(-) CO2
Accidents	speed limits comp. Insurance	(-) x% BAU (+) x% BAU	(+) CO2, NOx noise
Land use	planning, road pricing	(+) x% BAU	(+) CO2

b) Summary of instruments and their effects: [aggregated table from (a)]		
Target	Instrument II	Doses II
CO2	Pricing policy use dependent Pricing policy (fixed) Standards on fuel Standards on emissions Standards on noise	(+) x% BAU variable cost (+) x% BAU fixed cost (-) x% BAU (-) x% BAU (-) x% BAU
NOx, VOC, PAH, PM	Standards for behaviour	(-) x% BAU
Noise	Mobility management and efficiency gains	(+) x % BAU
Biodiversity	Land use / reduced mileage	(-) x% BAU
Accidents	Technology subsidy Investment of alternative modes	(+) x% BAU (+) x% BAU
Land use	Education / Moral suasion	(+) x% BAU

Evaluation Sheet for Level 1 (Micro level): Change of Indiv. Transport *Technology*							
Policy instrument	*conv. car technol.*	*innov.car technol.*	*(+)effic. rail*	*(+)effic. waterw.*	*(+)effic. air*	*(+) tele-matics*	*(+)second. energ.cons.*
Pricing policy use depend.	x%	x%	°	°			
Pricing policy fixed							
Standards for fuel							
Standards for emissions							
Standards for noise							
Standards for behaviour							
Mobility management and efficiency gains							
Land use reduced mileage							
Techn. Subsidy							
Invest. alt. Modes							
Education Moral Suasion							
% of target achievement							

Evaluation Sheet for Level 1 (Micro level): Change of Individual Transport *Behaviour*							
Policy instrument	*reduced motorisation*	*red. c. travel distance*	*red. use of air travel*	*red. air tr. distance*	*env. logistics*	*higher loading f.*	*sum*
Pricing policy use depend.	x%	x%			°	°	100%
Pricing policy fixed							
Standards for fuel							
Standards for emissions							
Standards for noise							
Standards for behaviour							
Mobility management and efficiency gains							
Land use reduced mileage							
Techn. Subsidy							
Invest. alt. Modes							
Education Moral Suasion							
% of target achievement							100%

Evaluation Sheet for Level 2 (Micro level): Impact on Transport *Supply*						
Policy instrument	*gen. cost/ car km*	*gen. cost/ truck km*	*gen. cost/ rail km p.*	*gen. cost/ rail km f.*	*gen cost/ wat.w. km*	*gen cost/ air km*
Pricing policy use depend.						
Pricing policy fixed						
Standards for fuel						
Standards for emissions						
Standards for noise						
Standards for behaviour						
Mobility management and efficiency gains						
Land use reduced mileage						
Techn. Subsidy						
Invest. alt. Modes						
Education Moral Suasion						
(+) % BAU						

Evaluation Sheet for Level 3 (Meso level): Impact on Transport *Demand*								
change of pkm or tkm versus BAU								
Policy instrument	*walking/ cycling*	*light rail/ buses*	*railway passage*	*cars motorcycl*	*railway/ freight*	*Inl. Waterway*	*trucking*	*air traffic*
Pricing policy use depend.								
Pricing policy fixed								
Standards for fuel								
Standards for emissions								
Standards for noise								
Standards for behaviour								
Mobility management and efficiency gains								
Land use reduced mileage								
Techn. Subsidy								
Invest. alt. Modes								
Education Moral Suasion								
Total change (+-)% BAU								

Evaluation Sheet for Level 4 (Meso level): Change in affected markets								
	% change of value added in the markets							
Policy instrument	*road vehicle manufact.*	*railway industry*	*secondary car bus*	*airline industry*	*touristic industry*	*local business*	*other cons goods*	*% domest productio*
Pricing policy use depend.								
Pricing policy fixed								
Standards for fuel								
Standards for emissions								
Standards for noise								
Standards for behaviour								
Mobility management and efficiency gains								
Land use reduced mileage								
Techn. Subsidy								
Invest. alt. Modes								
Education Moral Suasion								
(+) % BAU								

Evaluation Sheet for Level 5 (Macro level): Aggregate Economic Indicators							
	Macro Supply			Macro demand			
Policy instrument	*technical progress*	*capital stock*	*labour input*	*Consump-tion*	*investment*	*state expenditure*	*net exports*
Pricing policy use depend.							
Pricing policy fixed							
Standards for fuel							
Standards for emissions							
Standards for noise							
Standards for behaviour							
Mobility management and efficiency gains							
Land use reduced mileage							
Techn. Subsidy							
Invest. alt. Modes							
Education Moral Suasion							
(+) % BAU							

APPENDIX II

Evaluation for Part 2: Interdependence analysis

II.1 Construction of the impact matrix

The interdependence analysis will consist of two parts:

- identification of **active and passive** influences of the variables, and
- identification of **positive and negative** feedback and the range of critical variables to ensure sustainable development.

The variables of the system are grouped according to Table 3 (section 5.4), altogether there are 8 different categories:

Category level	***Category of measures***	***Measures/Investments***
0.1	policy actions	pricing variable pricing, fixed standards on fuel standards for exhausts standards for noise standards for behaviour mobility management gains market regulation land use technology development subsidy investment on alternative modes education and moral suasion
0.2	institutions/structures	influence of road lobby share of abatement expenditure share of GDP share of environmental industry share of owner/operator market concentration commercial organisation of rail liberalisation effects of CEE
0.3	basic preferences	education level awareness of social risk future organisational thinking altruism preferred material consumption shareholder volume maximisation long-term maximisation risk aversion

		disposable sourcing logistics bundling stable network
1.1	indiv. transport technology	conventional car technology innovative car technology efficient rail efficient waterways efficient air transport telematics secondary energy conservation
1.2	indiv. transport behaviour	reduced motorisation reduced car travel distances reduced air travel volumes reduced air travel distances environmental logistics loading factors
2	transport supply	general cost/carkm general cost/trucking km general cost/rail p-km general cost/rail t-km general cost/waterway tkm general cost/air p-km
3	transport demand	walking/cycling light rail/buses railway pass. car/motorcycle railway freight inl. waterway trucking air traffic
4	affected markets	road vehicle manufacturing railway industry secondary car bus airline industry touristic industry local business other conservative goods service sectors

The impact values of the policy variables at the levels 1 to 4 are given by expert judgements. The relationships between the basic preference variables of consumers and producers, the institutions/structures and the other variables of the system have to be introduced by experts assessing a set of assumptions based on the situation in the respective country.

The variables grouped in a general way in the Table above can be detailed further. In the following table a first suggestion has been made which results in altogether 66 variables describing the interdependence in the system. A matrix can be constructed in which the variables are introduced in the rows and the columns: the impact matrix.

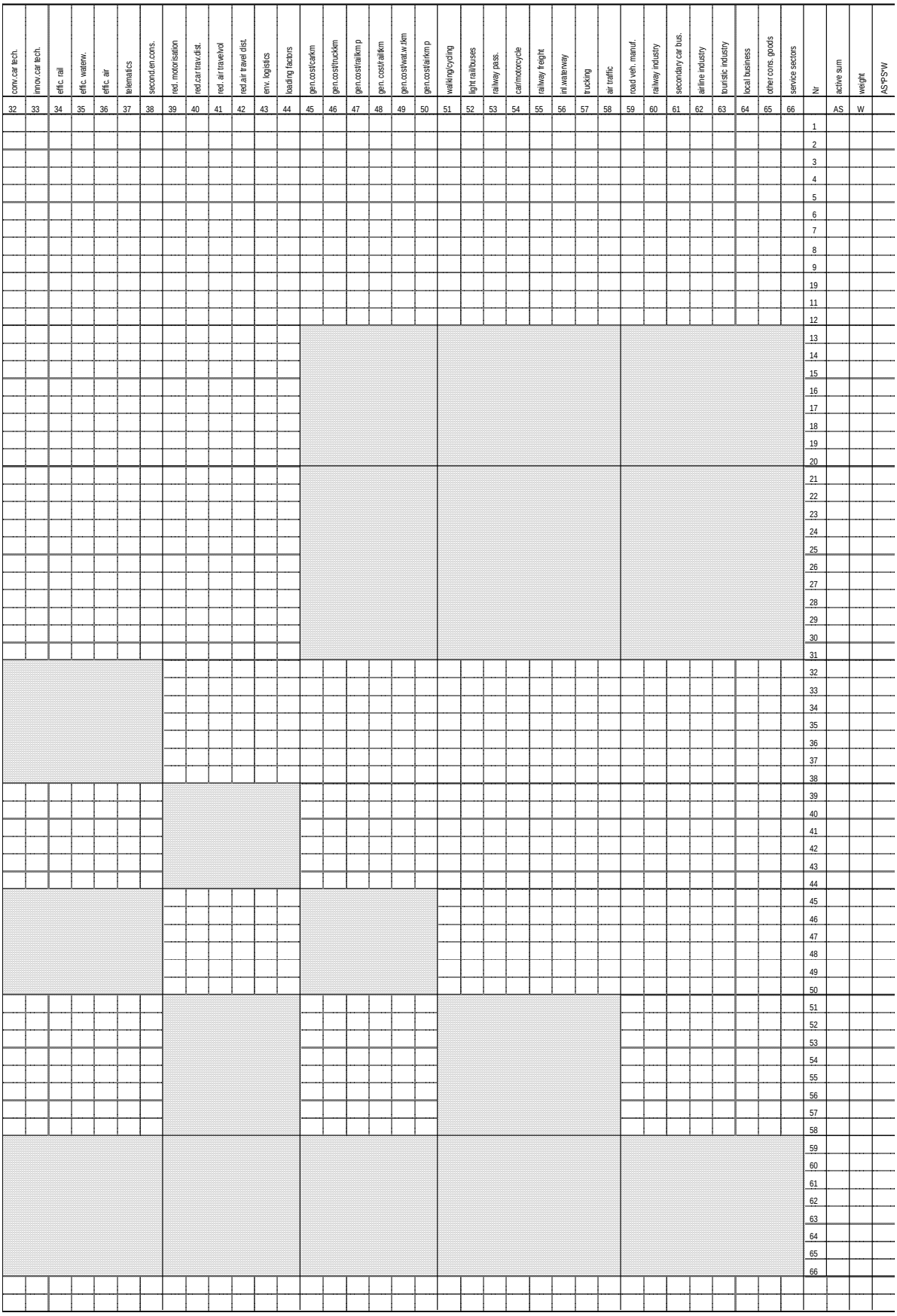
The rows show the **active influences** [e.g. variable user pricing (1) influences motorisation (39)]. The columns indicate the **passive influence** [e.g. motorisation (39) is influenced by variable user pricing (1)]. The intensity of the influences can be measured using a **scale from 0 to 10**. If a specific influence is negative (e.g. higher prices reduce motorisation), a "minus" is added (e.g. -5 for the influence of prices on motorisation).

In the present scheme, 66 variables are introduced which gives a total of 4290 (66*65) interrelationships. This shows that although the description of the different assessment parts is not very detailed and only a part of the system is analysed, there is already a considerable input necessary to study all interdependencies. From the evaluation, information is available to fill out the upper part (rows for policy actions) of the matrix. Furthermore, one can reduce the interrelations to be studied after inserting the direction of influences (some variables are only active, others only passive for defined areas of interdependencies). After these modifications the number of evaluation steps is still about 1000 and could be reduced through further considerations of the more relevant interactions.

The results from this matrix can be used to get information on the most relevant variables (sum of active/ passive influences). Also the feedback structure can be analysed using matrix algorithms. The results are the number of positive and negative feedback loops in the system and the strength of the feedback. This gives information on the probability with which particular variables (e.g. power of the industry lobby) can alter the trajectory of an EST scenario as well as providing information on best policy actions.

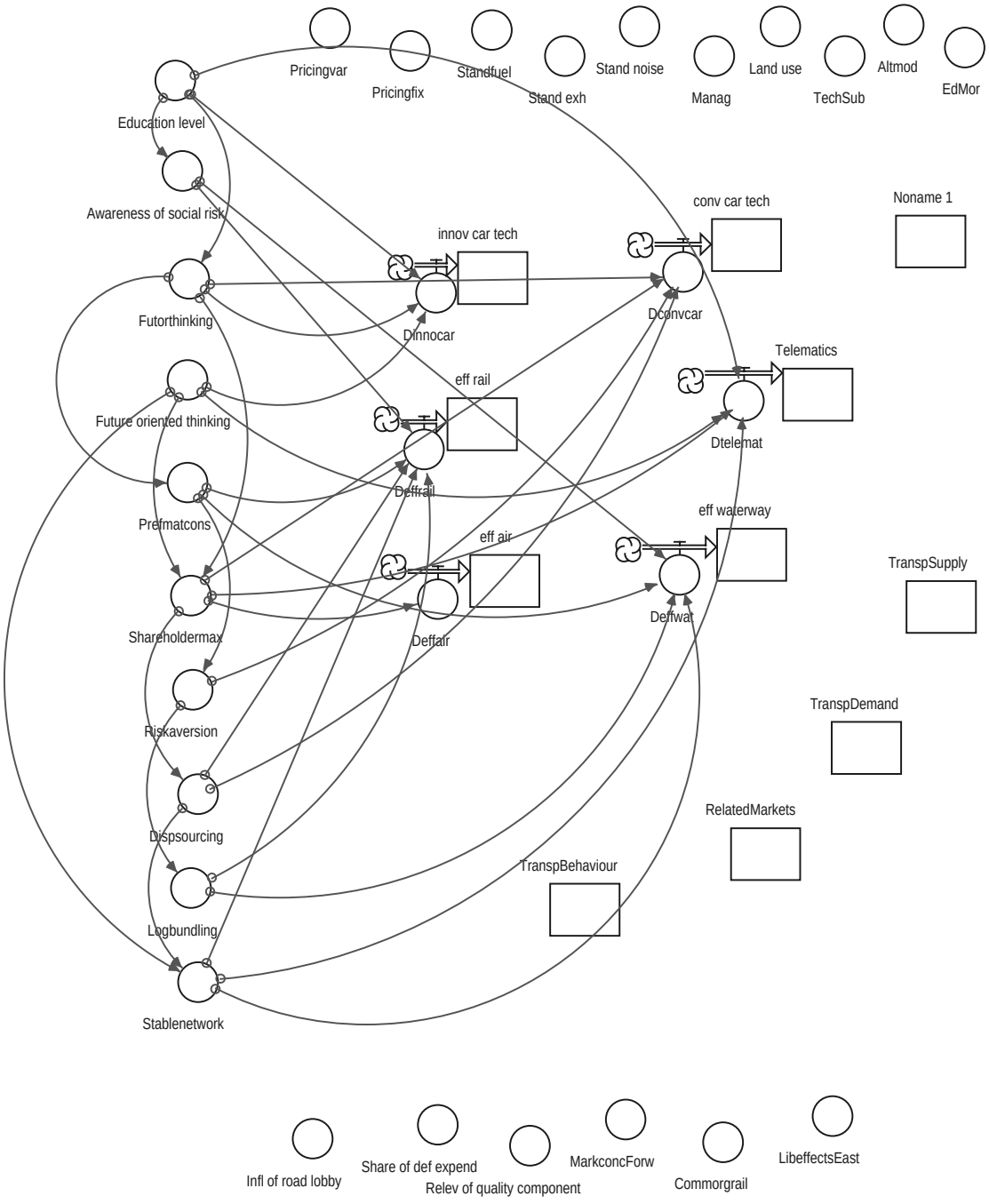
II.2 Example for a reduced impact matrix

			Pricing, variable	Pricing, fixed	Stand. fuel	Stand. exhausts	Stand. noise	Stand. behaviour	Man.eff.gain	Markte Reregul.	Land use	Tech. dev., subsid.	Invest.alt. modes	Educ., mor.suasion	Infl.road lobby	Share def. expend.	Share of qual.GDP	Sh. high en.cons.ind.	Sh.owner operator	Mark.Conc.Forw.	Comm.Org.Rail	Lib.eff.EastEur.	Education level	Awaren.of soc.risk	Future.or.thinking	Altruism	Pref. mat.consum.	Shareh.val.max	Long-term max.	Risk aversion	Disp. sourcing	Logist. bundling	Stable network
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Policy	Pricing, variable	1																															
actions	Pricing, fixed	2																															
	Stand. fuel	3																															
	Stand. exhausts	4																															
	Stand. noise	5																															
	Stand. behaviour	6																															
	Man.eff.gain	7																															
	Market Reregulat.	8																															
	Land use	9																															
	Tech. dev. subsid.	19																															
	Invest.alt. modes	11																															
	Educ., mor.suasion	12																															
Institut-	Infl.road lobby	13																															
ions&	Share def. expend.	14																															
structures	Share of qual.GDP	15																															
	Sh. high en.cons.ind.	16																															
	Sh.owner operator	17																															
	Mark.Conc.Forw.	18																															
	Comm.Org.Rail	19																															
	Lib.effects EastEur.	20																															
Basic	Education level	21																															
Preferenc	Awaren.of soc.risk	22																															
consumers	Future.or.thinking	23																															
	Altruism	24																															
	Pref. mat.consum.	25																															
producers	Shareh.val.max	26																															
	Long-term max.	27																															
	Risk aversion	28																															
	Disp. sourcing	29																															
	Logist. bundling	30																															
	Stable network	31																															
Transport	conv.car tech.	32																															
technology	innov.car tech.	33																															
	effic. rail	34																															
	effic. waterw.	35																															
	effic. air	36																															
	telematics	37																															
	second.en.cons.	38																															
Transport	red. motorisation	39																															
behaviour	red.car trav.dist.	40																															
	red. air travelvol	41																															
	red.air travel dist.	42																															
	env. logistics	43																															
	loading factors	44																															
Transport	gen.cost/carkm	45																															
supply	gen.cost/truckkm	46																															
indicators	gen.cost/railkm p	47																															
	gen. cost/railtkm	48																															
	gen.cost/wat.w.tkm	49																															
	gen.cost/airkm p	50																															
Transport	walking/cycling	51																															
demand	light rail/buses	52																															
indicators	railway pass.	53																															
	car/motorcycle	54																															
	railway freight	55																															
	inl.waterway	56																															
	trucking	57																															
	air traffic	58																															
Value added	road veh. manuf.	59																															
in related	railway industry	60																															
markets	secondary car bus.	61																															
	airline industry	62																															
	touristic industry	63																															
	local business	64																															
	other cons. goods	65																															
	service sectors	66																															
PS	passive sum																																


conv.car tech.
innov.car tech.
effic. rail
effic. waterw.
effic. air
telematics
second.en.cons.
red. motorisation
red.car trav.dist.
red. air travelvol
red.air travel dist.
env. logistics
loading factors
gen.cost/carkm
gen.cost/truckkm
gen.cost/railkm p
gen. cost/airkm
gen.cost/wat.w.tkm
gen.cost/airkm p
walking/cycling
light rail/buses
railway pass.
car/motorcycle
railway freight
int.waterway
trucking
air traffic
road veh. manuf.
railway industry
secondary car bus.
airline industry
touristic industry
local business
other cons. goods
service sectors
Nr
active sum
weight
AS*P.S*W
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66
AS
W

APPENDIX III

Figure A1. **Clip of an SDM graph of the impact matrix of example II.2**



The picture presents the relationships between the basic preference variables and the variables for the individual change of technology showing in the background other exogenous (circles) and endogenous variables (squares).

APPENDIX IV

Approximation of the BAU scenario of the German case study by a prototype SDM based on rough assumptions

On the following two pages an example of a SDM is shown projecting the future BAU development of transport and economic indicators in Germany. Figure A2 illustrates the functional diagram of the system consisting of the subsystems population, demand side (economy), supply side (economy), rail transport system and road transport system. The functions used stem from econometric studies for Germany and are adjusted by introducing model parameters and shift functions so that they reproduce the BAU data of the German case study.

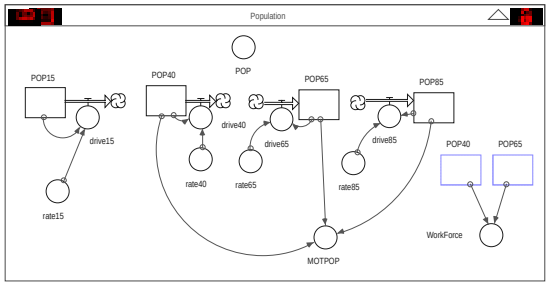
Figure A3 shows some results of the modelling in the form of time profiles from 1990 to 2030 (scale 1 to 40) for the selected variables:

- 1: GDP (real)
- 2: Motorisation (car stock in mill)
- 3: Generation freight rail (tonne km in bill)
- 4: Generation freight road (tonne km in bill).

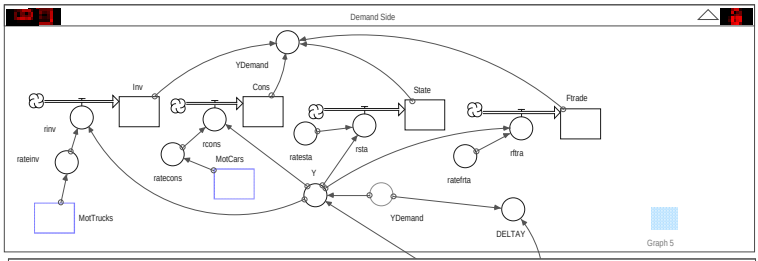
The values for the variables are given on the abscissa of the diagram: at the lower end, the starting values at the beginning of the simulation, in the middle the values after 20 years and at the top the values after 40 years. For instance, car stock starts with a value of ca 36 million cars. The 2030 value is ca 68 million cars (i.e. 825 cars/inhabitant). The graph of the car stock development is exponential, which can be interpreted as a comparatively high assumption. The time profile for road freight transport shows that road traffic might triple while railway freight transport will not increase by more than one third. These figures slightly exceed the estimations set out in the case study which pointed to a growth of road freight transport by the factor 2.5 and a stagnation of the railways. As this model has been developed for illustrative purposes only, it has not been readjusted to reproduce accurately the forecasted figures of the case study.

Figure A4 shows the future structure of the System Dynamics Model ESCOT that will be used for the assessment of BAU and EST policy implementation applied to the German case. The basic structure including the modules for macro-economics, regional economics, transport and environment is supplemented by the policy implementation module.

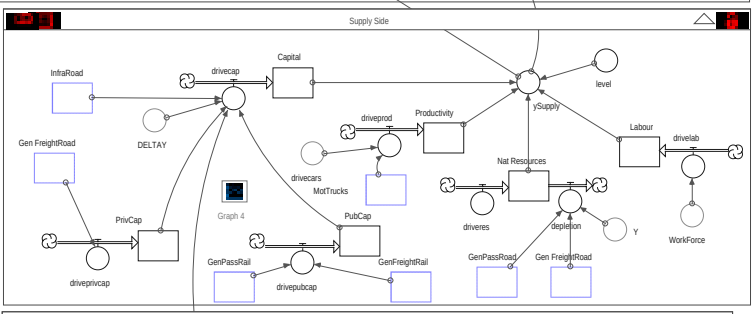
Figure A2. **Example of a structure used for the SDM of the German case study**



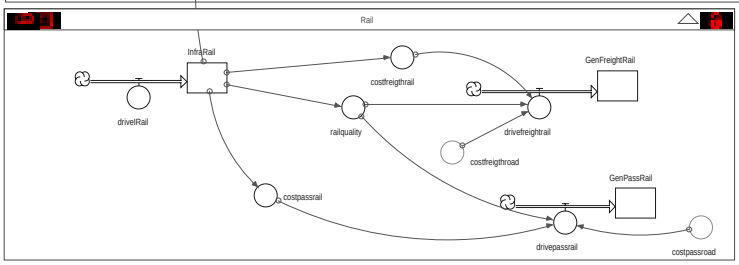
Population



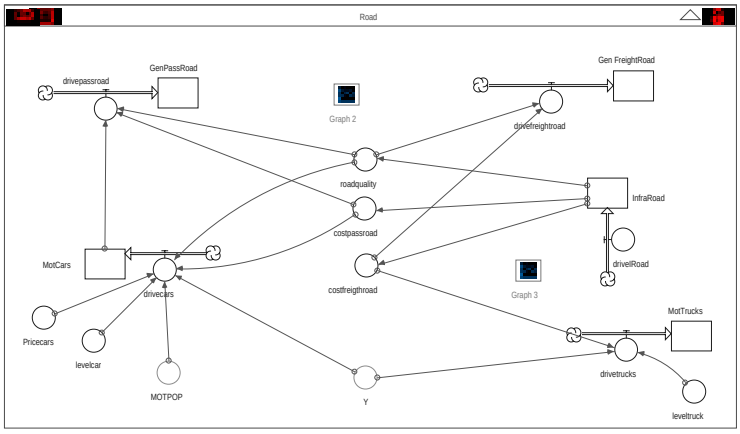
Demand side



Supply side

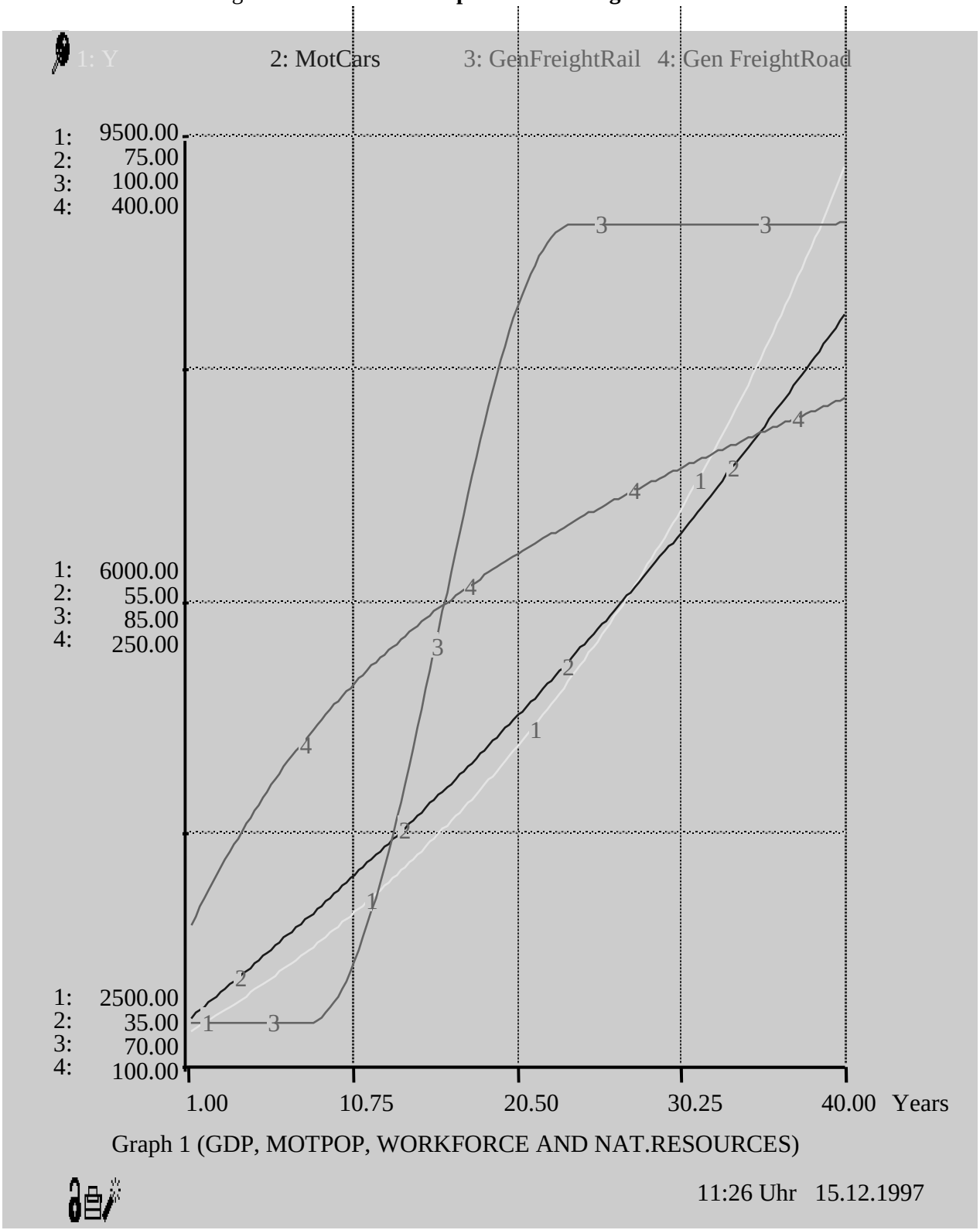


Rail



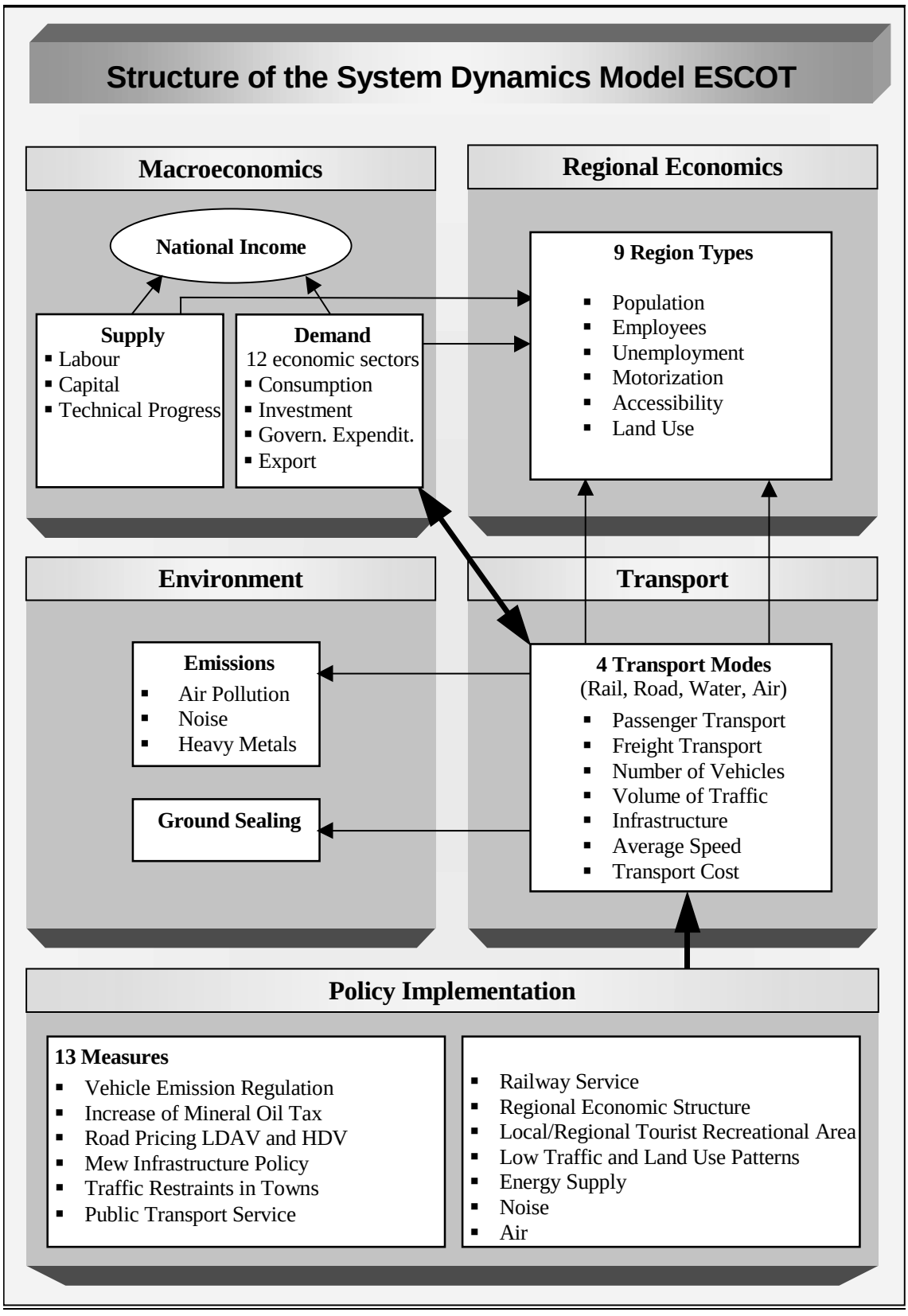
Road

Figure A3. **Selected time profiles resulting from the SDM**



Note: 1. GDP; 2. Motorisation; 3. Volume of rail freight; 4. Volume in road freight.

Figure A4. **Structure of System Dynamics Model ESCOT with BAU/EST Policy Implementation**



THE SOCIAL IMPLICATIONS OF HYPERMOBILITY

Speculations about the social consequences of the OECD Scenarios for Environmentally Sustainable Transport and Business-as-Usual Trend Projections

by

John Adams
University College London, United Kingdom

Terms of reference - Four questions

1. In what ways would the *social fabric* be different if the *EST* scenario were attained rather than the *BAU* scenario, both from an *individual* and from a *societal* perspective?

2. What would be the relative *social costs and benefits* of the two scenarios for individuals and households, for businesses of all sizes, and for local, regional, and national governments? Among factors that might be considered are family cohesion, democratic activity, social polarisation and segregation, alienation, criminal activity, and what is loosely known as "lifestyle."?

3. In general would people experience more *freedom/self-determination* (or have more freedom/self-determination) under the *BAU* scenario or the *EST* scenario?

4. What *packages of instruments* would assist the attainment of *EST*?

Executive Summary

The term *hypermobility* is used in this essay to suggest that it may be possible to have too much of a good thing. Historically, increases in mobility[3] have been viewed by most historians as indicators of progress; increased mobility, of both people and goods, has fostered economic growth, reduced our vulnerability to hostile forces of nature, expanded our intellectual horizons, and liberated much of humankind from claustrophobic social constraints and subservience to oppressive local rulers.

But the benefits of mobility have costs. The environmental costs, which are the main focus of this project, are now well known. The *social* costs have received much less attention. It is suggested in this essay that even if the harmful environmental consequences of current and projected levels of mobility could be eliminated by technological advances, significant social problems would remain.

[3] *Mobility* - measured by the distance traveled in a given period of time - is distinguished in this essay from *accessibility* - measured by the number of opportunities that can be reached in a given period of time. They often, *but not always*, are strongly correlated.

Fabric of Society

It is transport - and communications - that connect everything in society to everything else. The length, strength, quality and complexity of the connecting strands, and the patterns into which they are woven, are the physical manifestation of the social fabric - a metaphor for the myriad ways in which people and institutions relate to each other.

Mobility provides access to opportunities; from an individual perspective it will almost always be an advantage to be more mobile than average[4]. Current and projected transport trends present a classic *prisoner's dilemma*; everyone cannot be more mobile than average. It is unlikely that *anyone* would wish to live in the sort of society that would result if *everyone* were to achieve the level of mobility ultimately envisaged in the *BAU* scenario.

Social costs and Benefits

- Compared to countries pursuing EST policies, those countries in which the BAU scenario is achieved will be richer (measured by GDP), but poorer measured by most other social and environmental indicators. BAU countries will be:
  - more polarised (greater disparity between rich and poor);
  - more dispersed (more suburban sprawl);
  - more anonymous and less convivial (fewer people will know their neighbours);
  - less child-friendly (children's freedoms will be further curtailed by parental fears);
  - less culturally distinctive (the *McCulture* will be further advanced);
  - more dangerous for those not in cars (more metal in motion);
  - fatter and less fit (less exercise built into daily routines);
  - more crime ridden (less social cohesion and more fear of crime);
  - subject to a more Orwellian style of policing (more CCTV surveillance);
  - and less democratic (the majority will have less influence over the decisions that govern their lives).
- Under both scenarios reliance on information technology will increase. In EST societies - with less physical but more electronic mobility than BAU societies - there are likely to be tensions arising from incongruity of experience; people will live a shrinking part of their lives in real worlds which they will experience directly, and a growing part of their lives in virtual communities which they will experience electronically. The strong and positive historic correlation between trends in physical and electronic mobility suggests that increasing electronic mobility will create pressure for increased physical mobility. There are no large-scale precedents on which to base speculation about how these tensions will be resolved if electronic mobility is promoted while physical mobility is suppressed.
- The main winners under BAU will be the mobility providers and the principal users of their services:

[4] Or to command the mobility of others - and have them come to you.

  - those who build the infrastructure and equipment - road and airport builders, car manufacturers and airplane makers, energy companies, manufacturers of computer and telecommunications equipment, and all those who sell and service their products.

  - the tourist industry, airlines, freight hauliers, software developers and their customers, and all those who do business on the Internet.

  - participants in the process of globalisation - especially those with the freedom to cross international boundaries.

- The main winners under EST will be:

  - the many who get left behind by BAU; about one third of the population will always be too young, too old and infirm, too short-sighted or nervous, or drunk or otherwise legally disqualified from driving, to participate fully in the social and economic life of a country mainly dependent on the private car to meet its transport needs; their disadvantage increases as society's dependence on the car increases.

  - those who travel little - physically and/or electronically; under BAU their lives are increasingly buffeted by forces beyond their ability to influence.

  - all who value a cleaner, safer, healthier, more peaceful, more convivial, sustainable society in which people know their neighbours and it is safe for children to play in the street.

Freedom/self-determination

As mobility increases, the scale of all institutions of government must also increase or they will become impotent. As scale increases, relations between governors and the governed become more impersonal and abstract, and the significance of each individual voter diminishes. Increased mobility is liberating and socially progressive *up to a point*. Beyond this point it becomes socially destructive - especially when accompanied by increasing disparities in levels of mobility. The precise location of this point is a moot point, but *BAU* continued indefinitely will take us beyond it.

To the extent that *EST* is likely to produce an increase in the separation between lives lived in real communities in which people know their neighbours, and lives lived in *virtual communities of interest*, this scenario also is likely to foster social tension. The projections of both the *BAU* and *EST* scenarios provoke the question "How much more access/mobility do we want?"

A package of instruments

Policy instruments that seek to reduce dependence on the car are only likely to succeed to the extent that they are perceived as offering the majority of people an *improvement* on *BAU*. This is ***not,*** for everyone, the same as an improvement on their *present* circumstances. The BAU scenario has been produced by projecting past trends into the future; one of the principal conclusions of this project is that *BAU* is unsustainable. Thus if *BAU* continues, life for most people will get worse. Some life-styles are more unsustainable than others, and more in need of constraint. Nevertheless, for *EST* policies to succeed they must address convincingly the anxieties of those who fear that they would be stranded and isolated without their cars - *the ultimate objective of a sustainable transport policy should be the creation of a transport*

system which permits every citizen the possibility of leading a full and satisfying life without the need to own a car. Some suggestions are offered.

Method of working

The future does not exist except in our imaginations. The development of social scenarios to accompany the environmental scenarios being formulated in the Environmentally Sustainable Transport Project is a collective exercise in imaginative speculation. The method deployed here is essentially that of the science fiction novelist - projecting modified versions of past trends into the future, placing particular emphasis on plausible technological change and political interventions. Speculating about the future *social* implications of *BAU* and *EST* is much more difficult than attempting to estimate their effects on the physical environment; the clouds are indifferent to what the weather forecaster says about them, but people respond to plausible forecasts and scenarios - either to assist them or frustrate them.

In attempting to answer the questions set out in the terms of reference it has not been possible in the time available to give equitable coverage to the different circumstances of all the participating countries.[5] The first draft of this paper was produced mostly by consulting the experience of Britain - the country with which I am most familiar - in order to create a framework which indicated the nature of the data that would be needed for a comprehensive treatment of all the participating countries. This framework was subjected to the comments of the participants. The comments received, while not unanimous, have been broadly supportive of the conclusions presented here. This version of the paper incorporates supporting examples from other participating countries. Significant dissent by participants in this project from the speculations presented here is recorded in footnotes.[6]

Two caveats

1. Historians of transport come to very different conclusions about the desirability of past trends. While most equate increased mobility with progress, and see the car and the plane as instruments of liberation - and their adverse environmental impacts as side-effects remediable by technology - others see the car and the plane as instruments of social and environmental destruction, and consider technological "progress" as part of the problem not the solution. Where there is such profound disagreement about the desirability of past trends, obtaining agreement about the desirability of alternative projections of these trends into the future is unlikely to be easy.

2. The Business-as-Usual and Environmentally-Sustainable scenarios developed in this project represent extrapolations of past trends. The concept of unsustainability implies the possibility of discontinuity. The future could be very different from the scenarios considered here.

[5] Austria, Canada, France, Germany, Netherlands, Norway, Sweden, Switzerland.

[6] Comments on the speculations presented here were clearly influenced by the experience of the participants. The most consistent agreement came from Canada - where it was noted that many of the consequences of BAU discussed in this paper can already be observed. An objection from Germany - one of the more successful countries in curbing the depredations of the car - was that I have exaggerated some of the harmful consequences of hypermobility - the German participants proposed deleting the whole of sections 6 and 8, and the crime and law enforcement sections of section 7. The reader must decide.

THE SOCIAL IMPLICATIONS OF HYPERMOBILITY

1. The Social Fabric

It is transport - *and communications* - that connect everything in society to everything else. The length, strength, quality and complexity of the connecting strands, and the patterns into which they are woven, are the physical manifestation of the social fabric - a metaphor for the myriad ways in which people and institutions relate to each other.

In seeking to establish the ways in which this fabric might be altered by the changes embodied in the *BAU* and *EST* scenarios, the challenge will be to identify those social factors that are most important and most sensitive to changes in patterns of mobility. The factors that I have provisionally identified are:

- material wealth;
- social polarisation;
- land use;
- community relationships;
- cultural diversity;
- health and safety;
- crime and law enforcement;
- the functioning of government.

Figure 1 presents historic trends and *BAU* projections for Britain to the year 2025. It contains, with one significant exception, the main modes by which people travel to interact with each other. In Britain statistics on walking have not been collected in a form that permits comparison with the other modes presented in the figure, but evidence from a variety of sources suggests that its long-term rate of decline is comparable to that of cycling; according to Britain's National Travel Survey, between 1985/6 and 1993/95 the distance walked by the average person decreased by 18%, while the distance cycled decreased by 16%. Also absent from Figure 1 are the other ways in which we interact - post and telecommunications, and the one-way modes - radio, television and print media. Trends in these forms of interaction are all fairly flat with the exception of telecommunications which is experiencing explosive growth.

Figure 1 shows that in 1950 the average Briton travelled about 8 kms a day. Now, in the late 1990s it is about 40 kms a day, *and forecast to rise to about 100 by 2025*. (In the USA, the mobility leader of the OECD, by 1994 it was already 74 km per day.[7]) Travel by bicycle has declined by 80% and by bus by 50%. Rail has held fairly constant in terms of passenger kilometres, but far less of the country is now accessible by rail; there has been a shift of traffic from the abandoned branch lines to the main inter-city lines. Car travel has increased more than10-fold and air travel more than 30-fold.[8]

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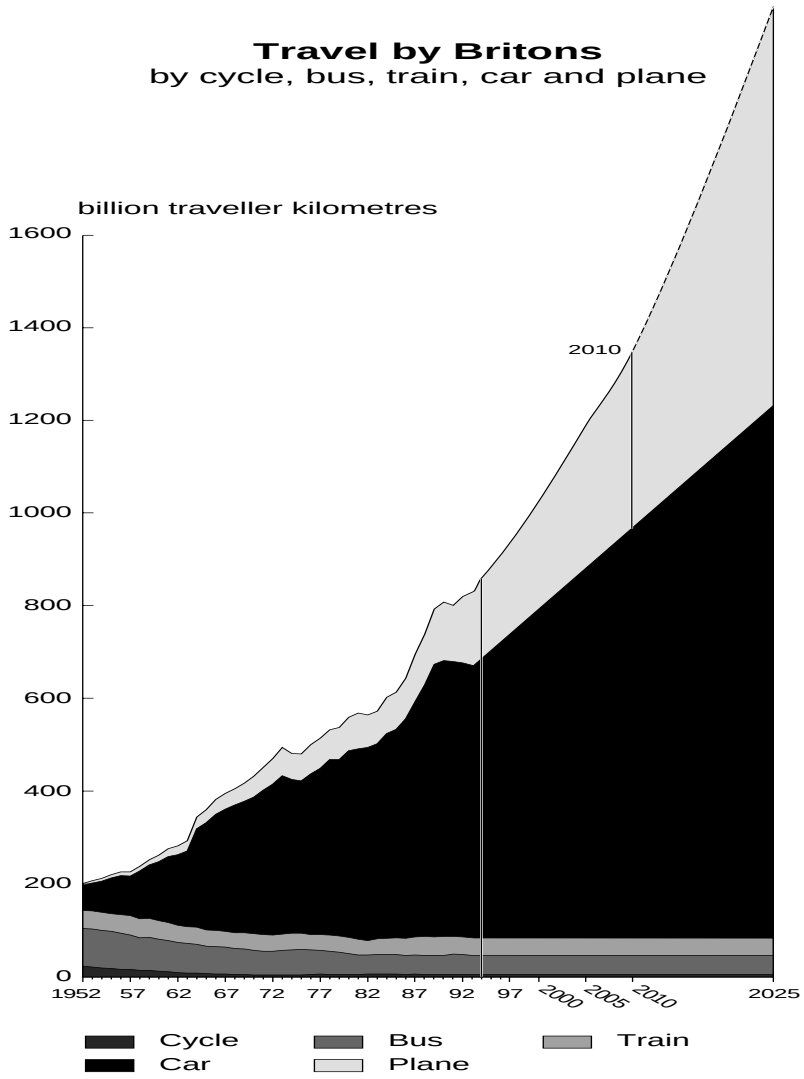
[7] *Sustainable Transportation Monitor*, No.1, March 1998.

[8] On the graph future levels of cycling and train travel are shown, for graphic completeness, as continuing at present levels. This is because no official forecasts have been made for these modes. Their decline will almost certainly continue if car travel increases as forecast, but even if they were to increase substantially their *share* of total traffic would decline if the growth rates for travel by car and plane continue as forecast.

Figure 1. **Historic travel trends and *BAU* projections for Britain to the year 2025**

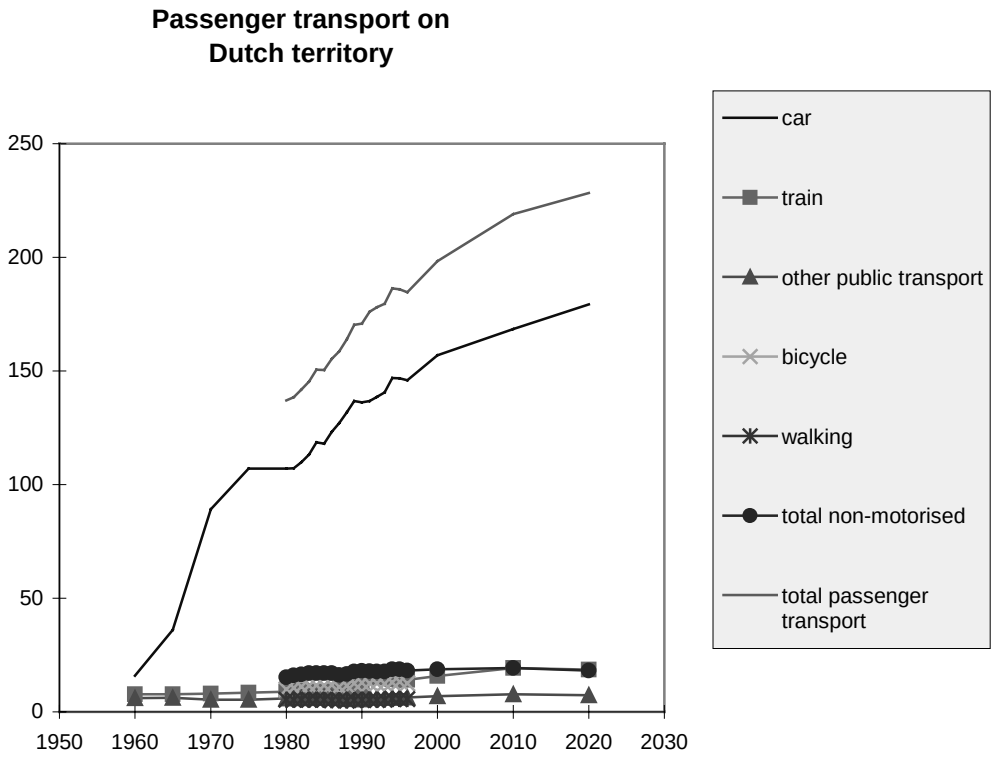


Source of air traffic forecasts: *Air traffic forecasts for The United Kingdom 1994*, HMSO. Official UK forecasts extend only to 2010; they have been extrapolated in Figure 1at the same rate to 2025.
Source of car traffic forecasts: *Transport Statistics Great Britain 1997*, Government Statistical Office, London. Forecasts published in October 1997 (*National Road Traffic Forecasts (Great Britain) 1997)* reduced the 2025 car travel estimates by 10%. However, the earlier forecasts have been retained in Figure 1 because the new forecasts are accompanied by a number of caveats which indicate that the forecasters do not really believe them. Historically, most traffic forecasts have been based on the projection of BAU into a boundless environment. The caveats that the British Government's forecasters have attached to their most recent projections are symptomatic of the cultural dissonance engendered when BAU encounters environmental and social constraints. Actual growth, they say, is likely to exceed their estimates because:

- the new forecasts disregard the likelihood that "adaptation of location … can be expected to lead to traffic growing elsewhere to make up for some of the growth suppressed … in these forecasts;"
- "some growth in longer distance travel has … been cut off when it might be expected to continue;"
- "the change [in road freight] modeled in these forecasts is well below the historic trend;" and "no increase in travel has been included specifically to allow for the dispersion effects of providing for additional housing."

Box 1 compares past trends and forecasts for the Netherlands with those for Britain.

Box 1. **Growth and forecast growth of passenger transport in the Netherlands under BAU - billions of passenger kms**



Source: Middle forecasts from the European Co-ordination of Netherlands National Environmental Outlook 4, July 1996.

Note:

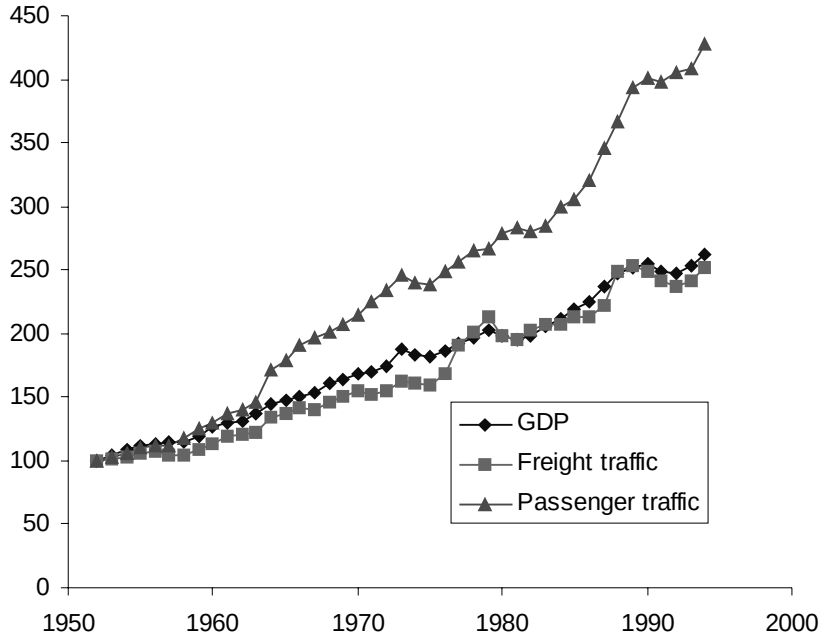
- the average Briton travels further every year by car (10088 kms) than the average Dutch person (9538 kms) - 1994 data from TSGB 1997.
- forecast growth is slower for the Netherlands than for Great Britain: 24% increase between 1996 and 2020 for total passenger travel, 23% by car (air travel forecasts not available). In Britain traffic by cars and taxis is forecast (high) to increase by 64% by 2020.
- train travel is forecast to increase by 32% and other public transport by 7% (official forecasts for Britain by these modes do not exist)
- zero growth is forecast for non-motorised modes (forecasts for Britain by these modes do not exist, but their long-term decline can be expected to continue if the forecast increases in motorised modes materialise.)
- data for the growth of travel by air and forecasts for travel by air - the mode of travel with the fastest growth rate in Britain - are not available for the Netherlands.

2. Material wealth

Figure 2 describes the historic relationship in Britain between Gross Domestic Product and indices of movement of people and freight. A recent EU communiqué of transport and the environment speaks of the need to decouple these trends: "It will be necessary to ensure that economic growth can continue without necessarily entailing continued traffic growth." This task is also referred to in *Scenarios for Environmentally Sustainable Transport* (OECD, 1998), where it is observed that there is a need "for exploration of the concept of 'uncoupling' of transport activity and economic activity and its relevance to sustainability" (p.32). This is likely to be difficult.

Major components of Gross Domestic Product are:

Figure 2. **GDP, Freight and Passenger Traffic in Britain**



1. The collection of spatially dispersed raw materials, processing, and distribution to spatially dispersed consumers; exploitation of further economies of scale in production - an essential aspect of further growth - is likely to increase the distances over which raw materials and consumer goods are moved.[9]
2. Service activities; all such activities that cannot be performed electronically will involve the mobility of the server or the customer or both.
3. Travel as a consumer good; tourism and other social travel.

[9] Andreas Pastowski, in *Decoupling Economic Development and Freight for Reducing its Negative Impacts*, notes that "decoupling economic development and freight transport activity is something that has not been observed so far." He offers reasons for believing that the ratio of% increase in Tonne-kms to% increase in GDP, which has been close to unity in Britain for the past 25 years, might be reduceable, but it is difficult to see how the two trends might be completely decoupled.

Figure 3 presents evidence that suggests that the relationship between GDP and traffic described in Figure 2 is typical of many other countries. *Over the period 1985-94 the average GDP increase was 24%, the average freight traffic increase was 31%, the average road traffic increase was 36%, and the average air traffic increase was 85%.*[10]

Figures 2 and 3 almost certainly understate the growth rate of freight and surface passenger traffic because they do not include international movements. Most national traffic statistics exclude international traffic - although the statistics of most European countries do include movement by foreign people and goods within their borders and foreign transit traffic. Figure 4, showing that the component of global GDP consisting of international trade has increased, since 1950 almost three times more than GDP strongly suggests that growth in the movement of people and goods internationally has been faster than the national growth of most countries.

BAU is likely to see a continuation of this close correlation between GDP and the movement of people and goods. *This correlation remains the basis of most traffic forecasting*. Despite many years of spectacular growth in services, telecommunications and the computer industry, there is, as yet, no convincing historical evidence to suggest that the slower transport growth rates envisaged in *EST* could be achieved without a slowdown in GDP growth - and indeed the consensus amongst the countries participating in the EST project is that EST is likely to be accompanied by slower growth of GDP.

Exponential growth extrapolated indefinitely produces mind boggling numbers. 3% per year is a growth rate commonly used in *BAU* scenarios; it is a rate thought by many economists to be the minimum necessary to prevent unemployment from increasing. A recent article in *Nature*[11] presents *BAU* projections for CO_2 emissions and global temperature to the year 3000. Given the residence times of CO_2 in the atmosphere and the long time lags in the response of both oceans and atmosphere to anthropogenic changes in the radiative balance, 1000 years is perhaps a reasonable period over which to contemplate potential climate change. It is transport's potential contribution to such change that constitutes one of the *raisons d'être* of the OECD sustainable transport project. 3% per year growth, compounded over 1003 years would make the world 7.5 trillion times wealthier - an economist might add "in real terms"[12]. At what point along this trajectory the world will agree that "enough is enough" is not obvious. Many environmentalists argue that OECD countries have already passed this point[13], while most politicians see this as a question for a very remote future. *Scenarios for Environmentally Sustainable Transport* (OECD, 1998, p.31) concludes that "the overall conclusion must be that continuation of present trends in transportation and transport policies would be environmentally unsustainable."

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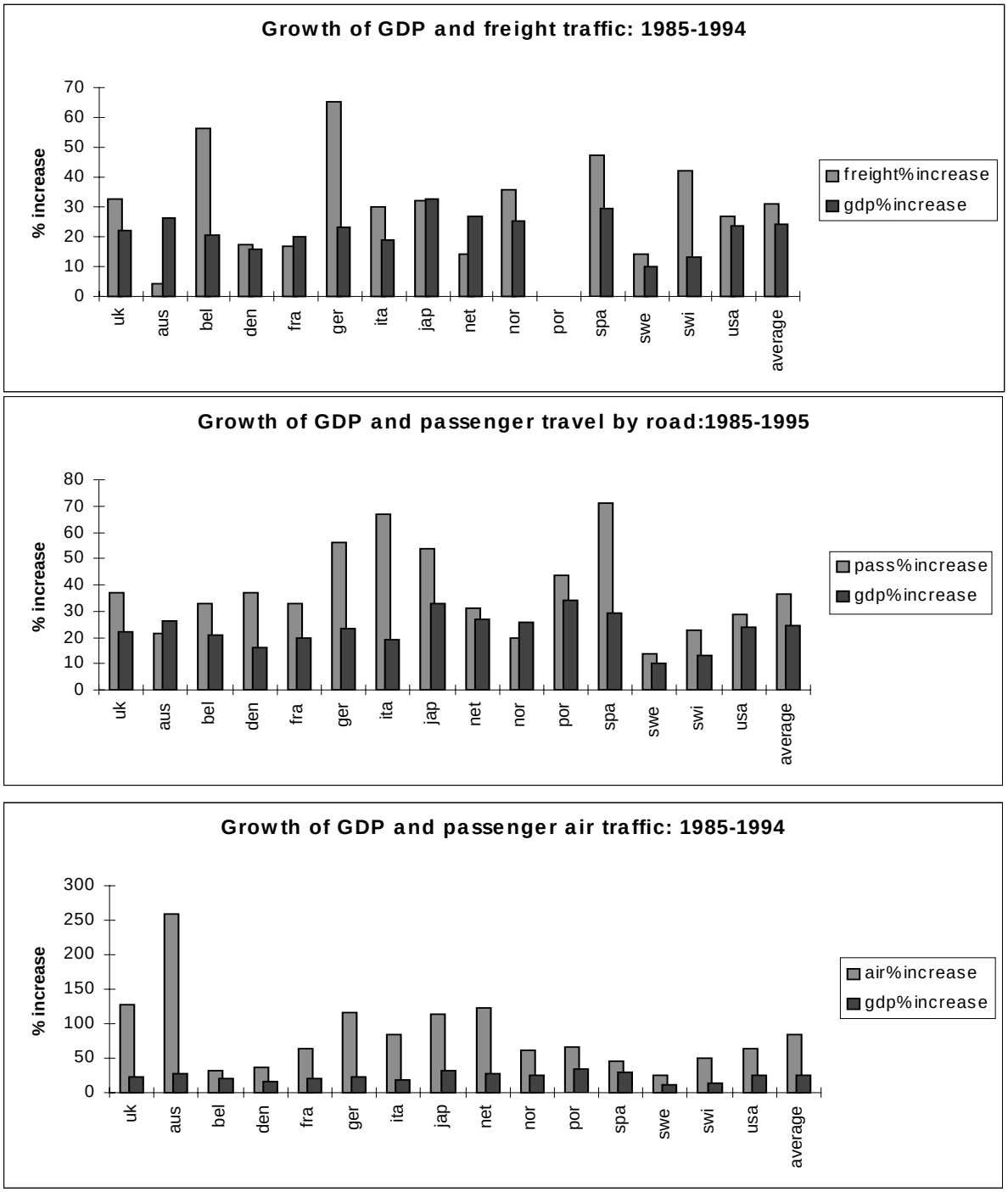
[10] It was suggested by some participants that the movement of heavy manufacturing to the developing world and the "dematerialisation" of economic activity associated with the information economy might decouple economic growth and physical mobility. Perhaps, but this much vaunted and long-anticipated dematerialisation effect has yet to "materialize"; Figure 3 shows that the United States, the world leader in the use of information technology is still experiencing strong economic *and* mobility growth, and that the rate of mobility growth - of both people and goods - still exceeds the rate of economic growth.

[11] Climate-change research after Kyoto, *Nature*, 20 November 1997, Klaus Hasselman.

[12] 2.11% - the average of the growth assumptions in Table 4 of *Scenarios for Environmentally Sustainable Transport* (OECD, 1998), - compounded over 1003 years yields a mere 1.25 billion-fold increase in global wealth.

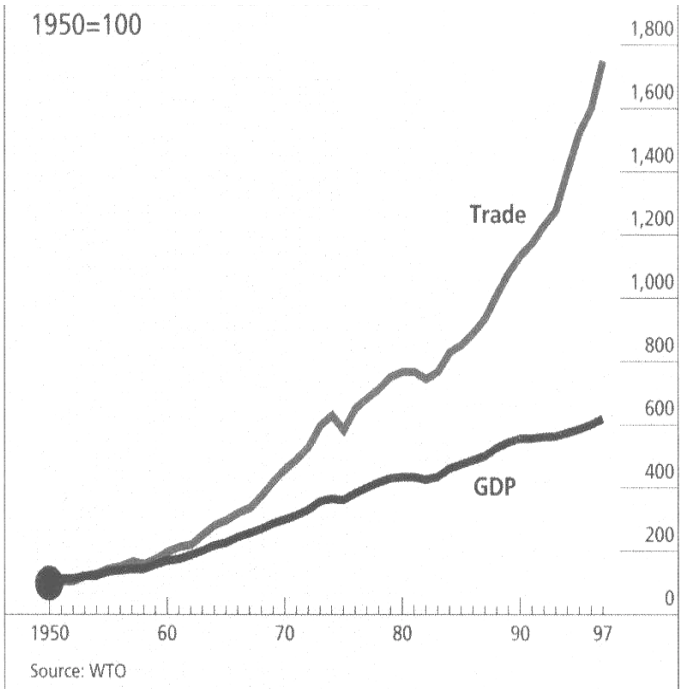
[13] D.H. Meadows, D.L. Meadows & J. Randers, 1992. *Beyond the Limits*. Earthscan, London.

Figure 3. **GDP growth and Freight, Passenger and Passenger Air Travel for selected countries (1985-1995)**



Sources: GDP growth - OECD Statistics, www.oecd.org/std/gdp.htm. Traffic growth - International Comparisons of Transport Statistics 1970-94, Transport Statistics Report, UK Department of Transport, The Stationery Office, London 1997. Air travel growth based on increase 1985-1995 interpolated to 1994. Air travel growth is based on passenger kilometres flown by scheduled airlines of different nationalities - a crude proxy for the amount of air travel by the citizens of those nations. German freight traffic growth: DIW, Verkehr in Zahlen (1997).

Figure 4. **Runaway success: world trade and GDP volume**



Source: The Economist, 3 October 1998, p.4.

The same conclusion, I would suggest, should be drawn with respect to the economic growth trends assumed to underpin the transport trends. If people become vastly wealthier and do not spend more money on goods and travel, what are they likely to spend their money on? *Factor Four: doubling wealth, halving resources*, (Ernst von Weizsäcker, Amory Lovins, Hunter Lovins, Earthscan 1997) contains many convincing demonstrations that greater efficiency is possible in the use of resources, but no evidence that the world will be content with a mere doubling of wealth. [14] The basic demand curve of economics describing the relationship between price and demand provides a simple and convincing explanation for historic mobility trends - so convincing that it remains the basis of most traffic forecasts. If the Hyper Car, whose vastly increased efficiency is described in *Factor Four*, makes motoring much less expensive, we can predict, in the absence of effective restraint (i.e. under BAU), that it will encourage more motoring.

Material Wealth

The close correlation between GDP and passenger kilometres and tonne-kilometres of freight is likely to be maintained. GDP growth is likely to be slower under EST.[15]

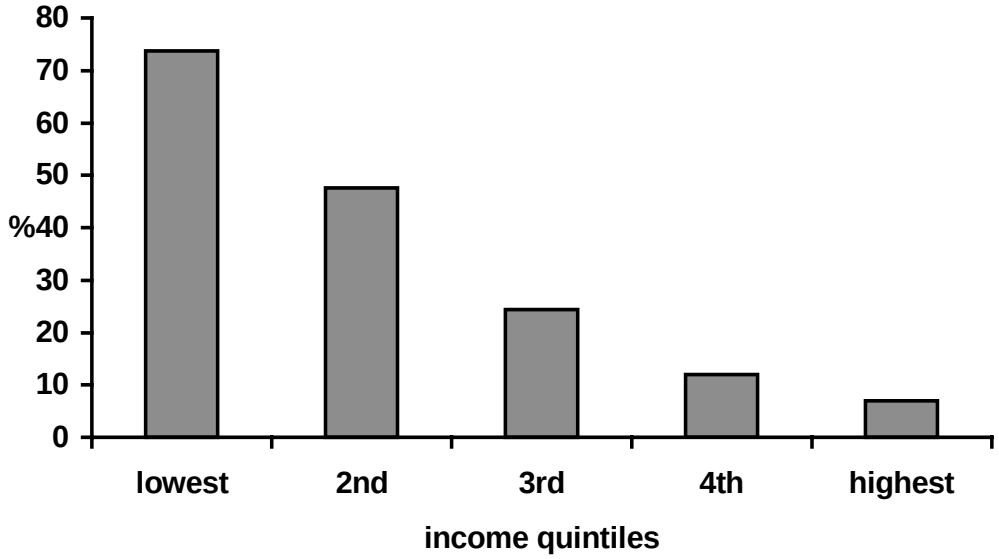
[14] *Factor Four: doubling wealth, halving resources*, (Ernst von Weizsäcker, Amory Lovins, Hunter Lovins, Earthscan 1997).

[15] The primacy of sustainable economic growth for the governments of OECD countries is likely to remain an impediment to the development of policies for environmentally sustainable transport.

3. Social Polarisation

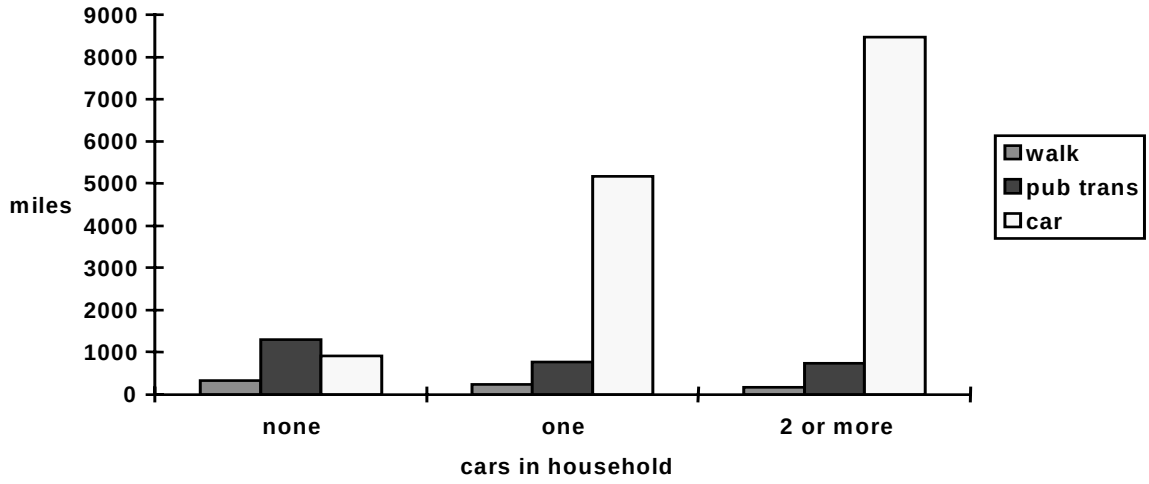
The large increase in the distance that the *average* person travels in a day (noted in Section 1) conceals a large and growing disparity. Those with cars and sufficient money to fly freely travel much more than average, and those dependent on declining public transport travel much less. Car ownership is strongly correlated with household income (Figure 5), and mobility is strongly correlated with household car ownership (Figure 6).

Figure 5. **Percentage of UK Households not owning a car by income**



Source: National Travel Survey 1989/1991 , department of Transport 1993, HMSO, Table 3B.

Figure 6. **Distanced travelled per person by mode and household car ownership**



Source: National Travel Survey 1989/91, Table 2.4.

Those dependent for their mobility on walking, cycling and declining public transport are suffering from decreasing *access* to social and economic opportunities because of changes in land use patterns. As local shops and services disappear, to be replaced by fewer, larger facilities - often out of town - reaching them becomes more difficult for those without cars.

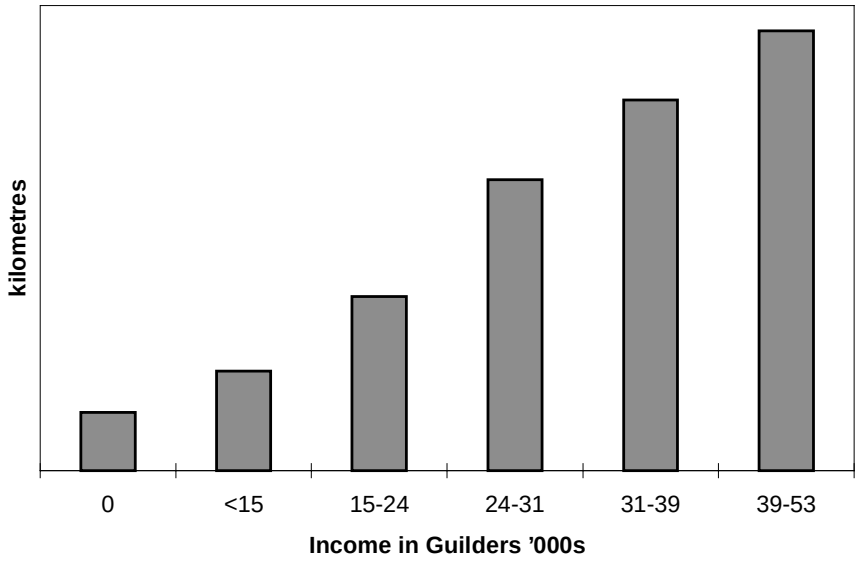
All those without a driving license, but otherwise capable of independent mobility, face a growing threat to their independence. Children in particular have lost considerable independence as society's dependence on the car has increased. In Britain in 1971 80% of 7 and 8 year old children got to school unaccompanied by an adult. By 1990 this percentage had fallen to 9%. Parents, when asked why they were denying their children the freedom and independence that they had enjoyed as children, gave as their main reason the fear of traffic.[16]

British Government traffic forecasters assume a "saturation level" of car ownership of 66%-70%. This is reached when everyone who is old enough and fit enough to drive owns a car. The closer a society gets to this level the greater will be the disadvantage of those without cars, and the greater will be the motivation of those without cars to acquire them. Those who are too young, or old, or poor to drive become second class citizens, dependent for their mobility on the good will of car owners or the withered remains of public transport. Thus the process of increasing car dependence is one of increasing polarisation.

Box 2, containing data from the Netherlands, depicts a relationship between income and car ownership similar to that found in Britain. Measures of national income in the form of GDP are good predictors of national car ownership trends over time, and measures of income variation within countries are good indicators of variation in car ownership at particular points in time.

[16] M Hillman, J Adams and J Whitelegg (1990) *One false move…: a study of children's independent mobility.* Policy Studies Institute, London.

Box 2. **Average number of car kilometres per person per day by income, Netherlands 1995**



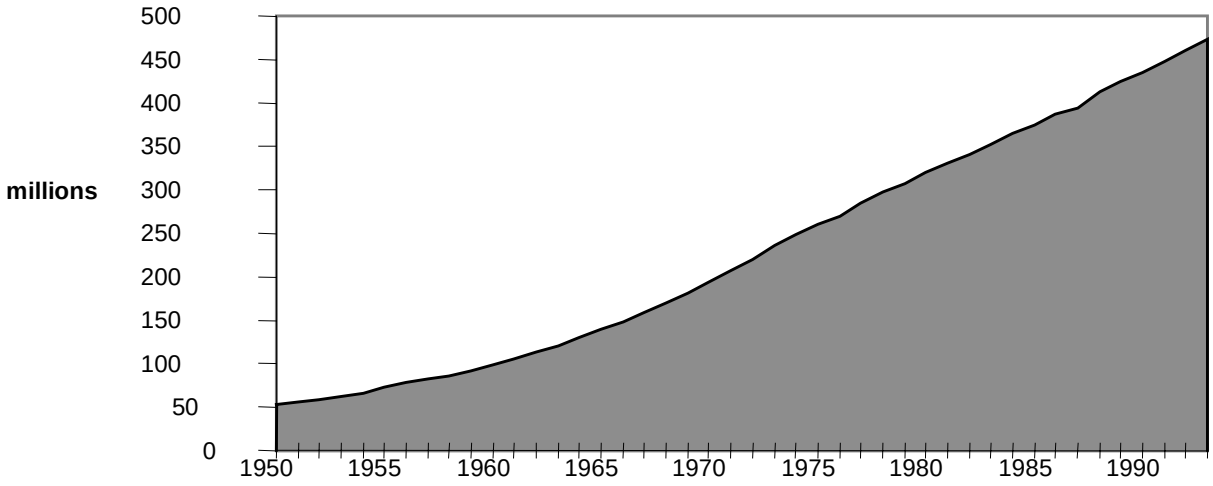
Source: Middle forecasts from the European Co-ordination of Netherlands National Environmental Outlook 4, July 1996.

Polarisation - the international dimension

The aspiration to own a car is not confined to the OECD countries who own most of the cars in the world. It is now the poor countries of the world who are experiencing the most rapid car-ownership growth rates - albeit from a very low base[17]. Figure 7 shows the progress that the world has made since 1950 in satisfying the universal aspiration to own a car.

[17] Statistics for the poorest countries are of uncertain quality - but almost all indicate very rapid growth from a very low base - e.g. China 1973 - 680 000 motor vehicles, 1993 - 7million; Nigeria 1974 - 232 000 motor vehicles, 1993 - 1 425 000 (Source: *World Almanacs 1978 and 1996*). BAU would see a continuation of trends to "saturation" in rich countries and further rapid catching-up growth in poor countries.

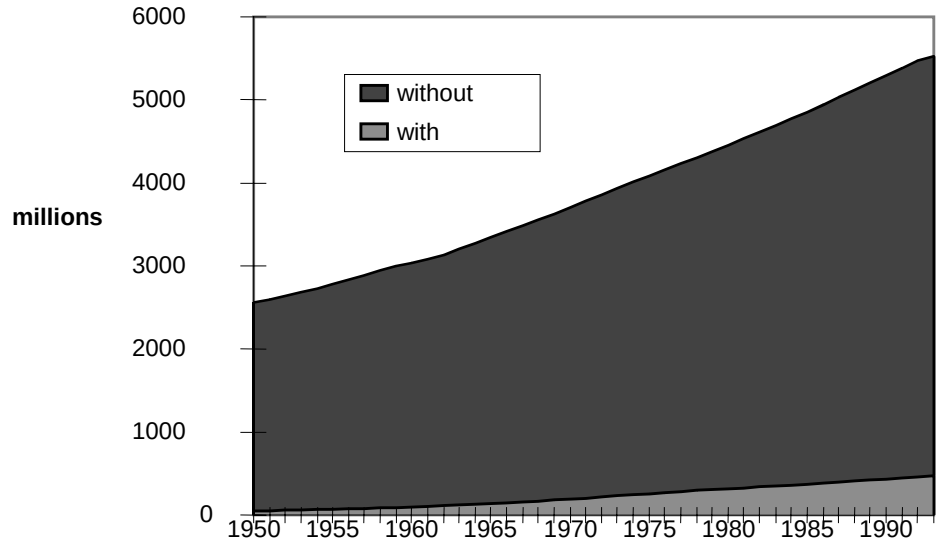
Figure 7. **World car population**



Source: Worldwatch Inst. 1995.

Figure 8 places the growth in the world's car population illustrated by Figure 6 in the context of global population growth. While the car population has increased 10 fold, the human population has doubled. *The number of people who do not own cars has increased from 2.5 billion to 5 billion.*

Figure 8. **People with and without cars**



What would be the result should China, and the rest of the Third World, sustain their growth rates in motorization, and succeed in their aspirations to catch up with the developed world? A few simple calculations help us visualise the size of car park that would be needed.

The UN medium projection for the world population in 2025 is 8.5 billion. The United States now (1993) has 194.6 million motor vehicles of all descriptions (755 per 1000 population). Should the whole world succeed in catching up with the United States, by 2025 there would be 6.4 billion motor vehicles. London parking meters are 6 metres apart, allowing 167 vehicles per kilometre parked end-to-end. Thus 6.4 billion vehicles parked end-to-end would stretch 40 million kilometres. If stationary they could be accommodated on a motorway around the equator 1000 lanes wide. This scenario might be considered the global ***BAU*** car-ownership forecast. It does not of course represent the global upper limit to the growth of car dependence; the motor vehicle population of the United States is still growing.

It is no longer possible to consider the sustainability of OECD transport systems in isolation from the rest of the world; the potential global consequences of the poor nations of the world following the OECD's example are likely to be catastrophic for rich and poor alike. But, as the current controversy over CO2 emissions illustrates, the rich are in no moral position - or effective political position - to lecture the poor about the environmental damage they would cause if they were to emulate the rich.

Social Polarisation
• *disparities between the rich and poor in terms of access to social and economic opportunities will diminish under EST.*
• *the rate of increase of car dependence under BAU will be greatest in the poorest countries as they strive to catch up with the "developed" world.*
• *unless the OECD leads by example with a convincing EST programme there is little prospect of dissuading poor countries from following the OECD's current unsustainable example.*

4. Land use

The large increase in travel by car in all OECD countries, such as that illustrated by Figure 1 for Britain, was accompanied first by changes in *activity patterns* and, with a time lag, by changes in *land use patterns*. When people acquired cars their activity patterns were transformed. They began going places previously unreachable by public transport, and travelling at times when public transport did not run. With a time lag, as more people acquired cars, land use patterns responded. Retailers began locating out of town for the convenience of motorists. Residential developments moved to the suburbs where there was room for garages and off-street parking. Offices moved to out-of-town business parks surrounded by car parks. And hospitals, cinemas, post offices, warehouses all became bigger and fewer in number, and more difficult to reach by foot, bicycle or bus.

Figure 9 shows how the population of Britain has moved, since the 1971 census, out of the most densely populated urban areas - where parking is most difficult and congestion is worst - to the less densely populated parts of the country where there is still room to accommodate a few more cars.

Figure 9. **Percentage population change in Britain 1971-1991, by 1991 population density of districts**

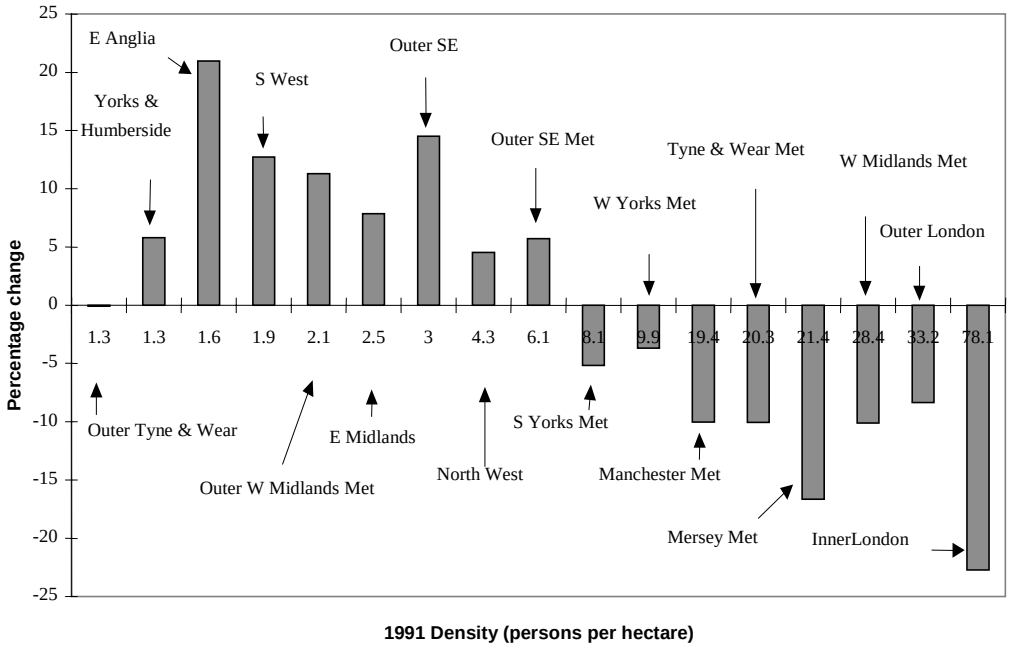
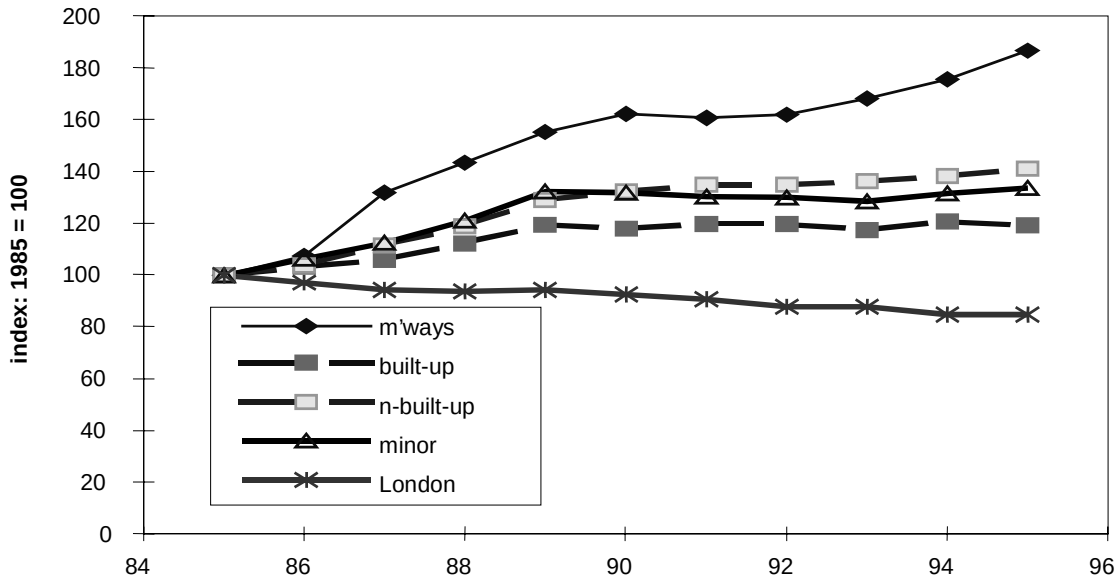


Figure 10a shows how traffic has increased fastest in the non-built up parts of the country - on the motorways and the high capacity non-urban roads. The slowest increase has been on roads in built-up areas. The decrease in car-borne traffic entering central London in the morning peak suggests that the most densely populated and congested parts of the country are losing traffic.

Figure 10a. **Great Britain: change in traffic 1985-1995**



Note:
Traffic by road type from Transport Statistics Great Britain 1996 (Table 4.10). London graph represents people entering central London by car in morning peak hours (Table 1.3).

Figures 10b and 10c show similar trends for Denmark and the Netherlands. Although the sprawl phenomenon is widely acknowledged, most measures currently being proposed to reduce car dependence - such as road pricing - tend to focus on cities. The result is often an encouragement of sprawl. Denmark has the lowest level of car ownership in Europe relative to income, and has been notably successful in curbing the car in Copenhagen, but traffic has still grown strongly in the suburban fringes of Copenhagen and the rest of the country. This suggests that restraint is needed most where the growth is fastest, and that suppressing growth only in cities produces a centrifugal force which, if not resisted outside cities will result in further sprawl.

Figure 10b. **Vehicle use inside and outside urban areas in the Netherlands**

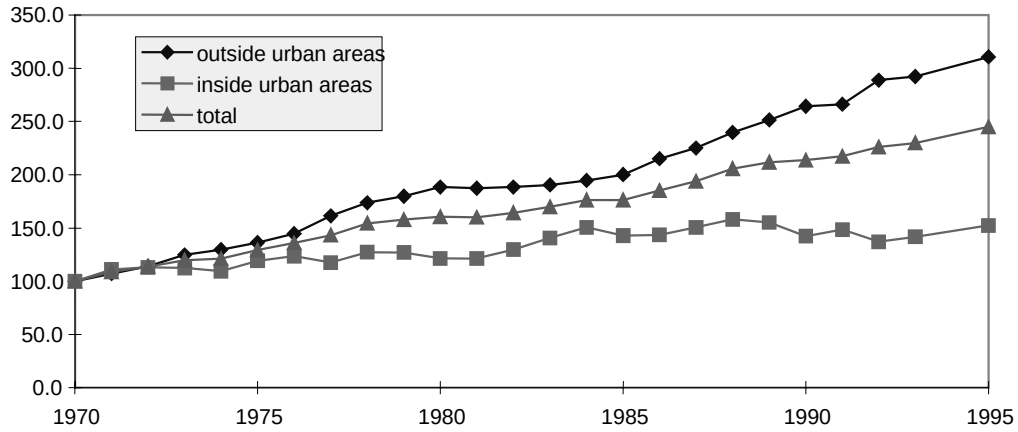


Figure 10c. **Traffic trends in Denmark**

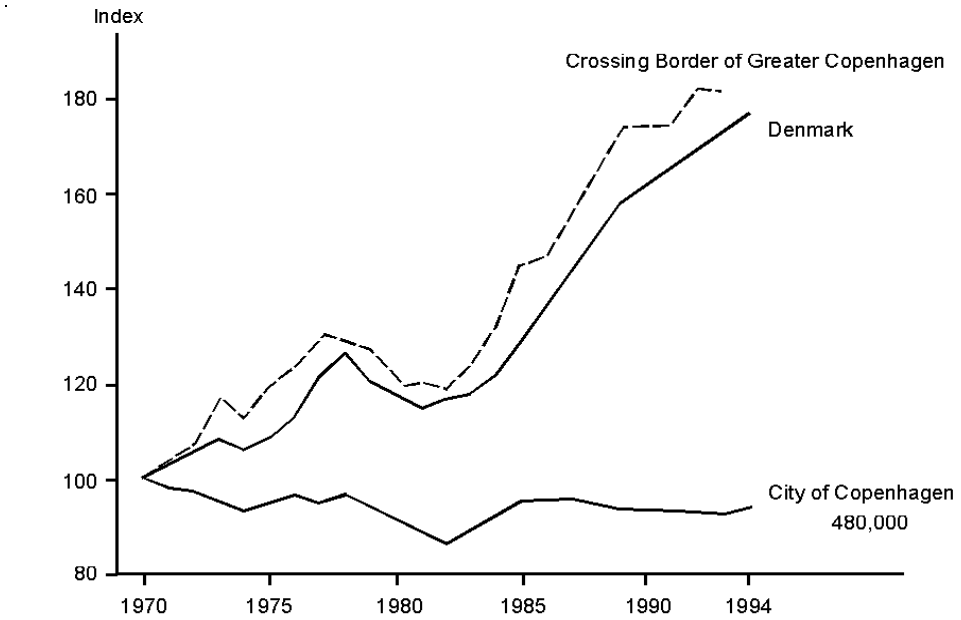
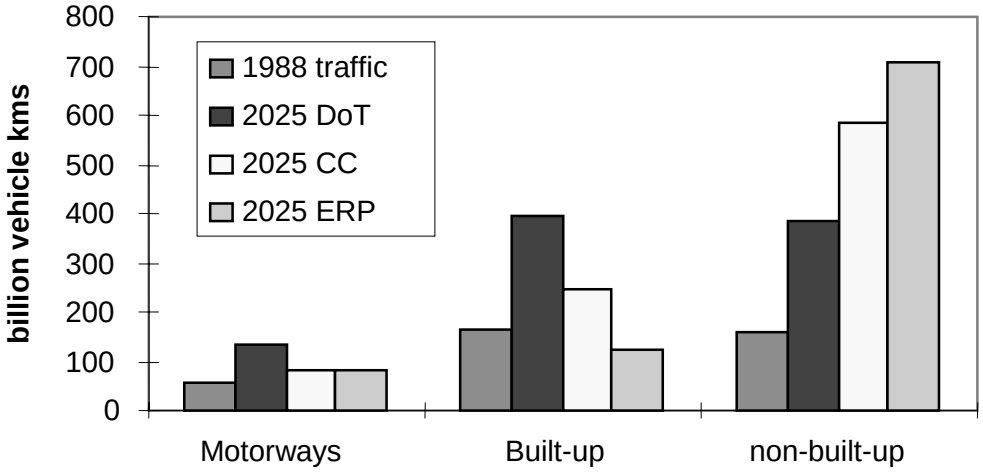


Figure 11 shows what might happen to these flows in the future in Britain. The left-hand bar represents the traffic flows in 1988 - the base year for the current official government forecasts. The next bar shows the forecast growth in traffic spread evenly over all classes of road. The third bar is taken from a study done for the British Countryside Commission to show how the forecast growth is likely to be displaced into rural areas because the urban areas are already full. And the final bar is my modification of the Countryside Commission forecasts to show the further displacement that would result should the national forecasts come true while urban areas succeeded in reducing their traffic levels by 25 per cent through the introduction of Electronic Road Pricing (ERP) or some other method of urban traffic restraint.

Figure 11. **Forecast traffic by road type**



Note:
DoT = gov't forecasts, CC = Goodwin's modification for Countryside Commission, ERP = Adams' modification assuming ERP reduces urban traffic 25%.

It is sometimes argued that if only public transport were improved people would use it instead of their cars. This would appear to be a very optimistic assumption. Travel by public transport in OECD countries is a small and decreasing proportion of all motorised travel. Figure 1 shows that in Britain, even when public transport used to be better, and cheaper, and more reliable and more pervasive than it is now, when people could afford cars they bought them, and were rarely seen on public transport again. Public transport in many other OECD countries is more highly subsidised than in Britain, and has not declined as steeply as it has in Britain, but even in these countries dependence on the car is still increasing.

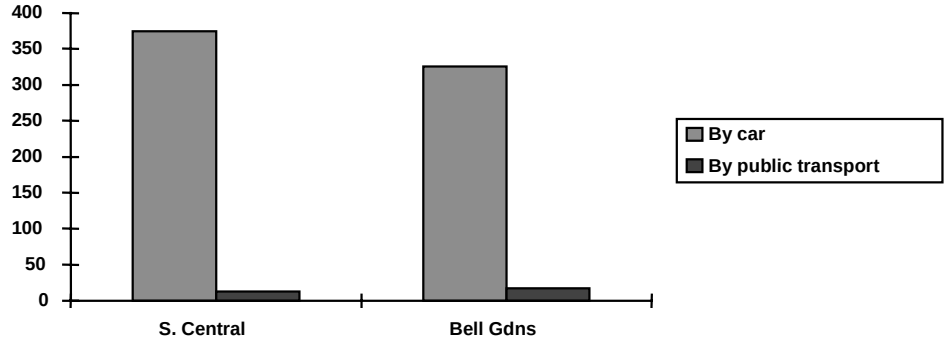
The *total* amount of travel in Britain by bus and rail in 1994 is equal to about five years *growth* in travel by car. If it were possible, by some political miracle, to divert sufficient car travel to buses and trains to restore public transport usage to its 1952 level, car travel would, according to the forecasts, be back at its present level in less than three years. The longer the trends in Figure 1 continue, the stronger become the pressures that drive them; the more expensive it becomes to maintain existing public transport services, as fixed overheads must be shared among a dwindling number of passengers; and the greater becomes the need to have a car to reach the shops, services and friends that used to be reachable without one.

For every passenger kilometre lost to the bus services in Britain since 1952 twelve have been gained by the car. Thus the solution to present transport problems cannot be, as many environmentalists have argued, "to get motorists out of their cars and back on to public transport." Most journeys now made by car were never

on public transport; they are journeys between highly dispersed origins and destinations, mostly infeasible by public transport. The countries participating in the ***EST*** Project vary in the level of their dependence on the car. The average Austrian, for example, travels 8500kms per year by car, compared to the average in Britain of 10000kms and in France of more than 11000kms. But all face problems of increasingly dispersed land use patterns. The *Environmental Balance of Transport: Austria 1950-1996* speaks of "the increasing urban sprawl and the disintegration of life activities"[18].

Figure 12, from a study in Los Angeles, indicates that there is a land-use dimension to the problem of social polarisation discussed in Section 3. It shows the difference in access to health facilities between those with and without cars in a spread-out car-dependent society. The longer the trends continue the more the assumption of car dependence becomes built into the planning framework. The more dependent a country becomes on the car, the more difficult it becomes for politicians the world over to contemplate measures that would constrain the freedom to own a car.

Figure 12. **Accessibility to health care in Los Angeles: GPs, clinics and hospitals within 15 minutes travel time**

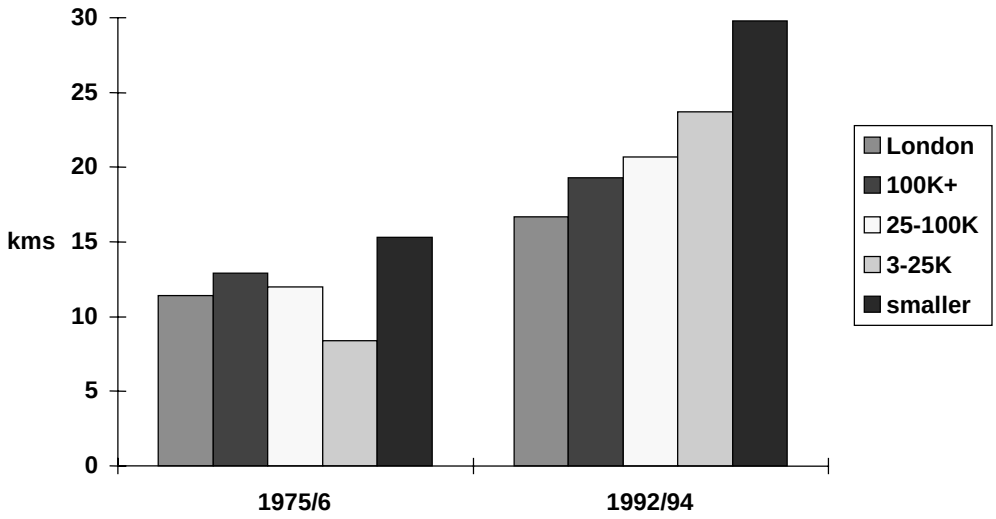


Source: Wachs and Kumagi 1972 (cited in Tolley and Turton 1995).

Figure 13 shows the change that has taken place in Britain between 1975/76 and 1992/94 in the distance that the average person travels to shop every week. The increases have two main causes: the increase in the proportion of shopping trips made by car, and the shift in shopping destinations from small local shops to larger more distant shops. The increases have been greatest in the smallest settlements, those areas into which population is dispersing.

[18] Austrian Federal Ministry for the Environment, Youth and Family Affairs, Vienna, November 1997 (p10).

Figure 13. **Increases in average annual distance travelled to shop by settlement size**



Source: Vital Travel Statistics 1997, Table 3.10.

Land Use
• *Land-use sprawl will continue under BAU - increasing society's dependence on the car, and increasing the disadvantage of those without cars.*[19]
• *Land-use patterns under EST will be more "disciplined", and transport policies will promote greater equity of access for those without cars.*

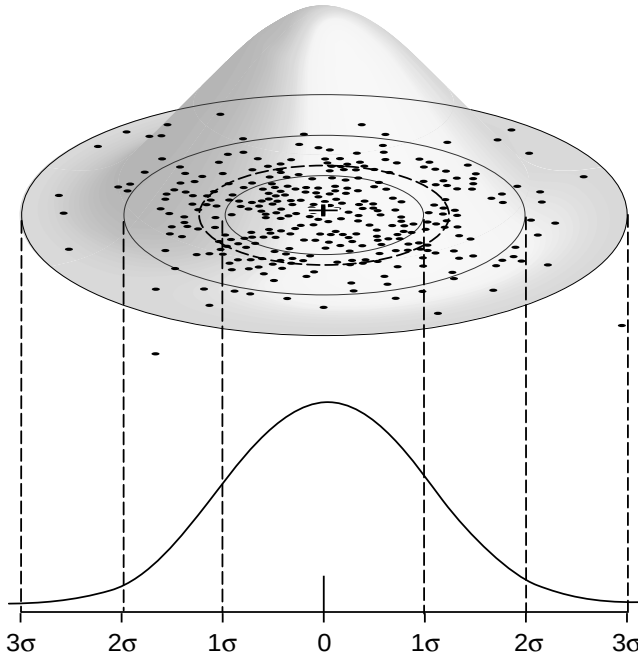
5. Community relationships

Various mathematical models have been developed over the years to describe human travel behaviour. The most popular is the 'gravity model'. It describes the way in which the force of attraction between any two places - and hence the frequency of travel between them - varies directly with their populations and inversely with the distance separating them. This tendency for journey frequency to decrease with distance is also captured by Figure 14. It illustrates the way in which the opportunities of which people avail themselves by travelling are typically distributed over space. It also illustrates the fact - incorporated in all models of travel behaviour - that the frequency with which people make journeys has an extremely strong tendency to decrease as journey length increases.

When the journeys made by a number of people are plotted on a graph as though they had a common origin, and with the position of each dot indicating the length and compass direction of each journey, a clear distance decay effect emerges. The density of the dots decreases with distance from the centre, permitting the generalisation of the pattern as a domed 'mobility surface'.

[19] The Canadian critique commented that "we don't have to speculate what that scenario means; we can observe it and its consequences at first hand." It went on to note that in Canada "there are strong economic as well as political pressures on governments to maintain or strengthen policies that directly or indirectly promote sprawl."

Figure 14. **A centred interaction field**
(the broken ring shows the mean radius of interaction)



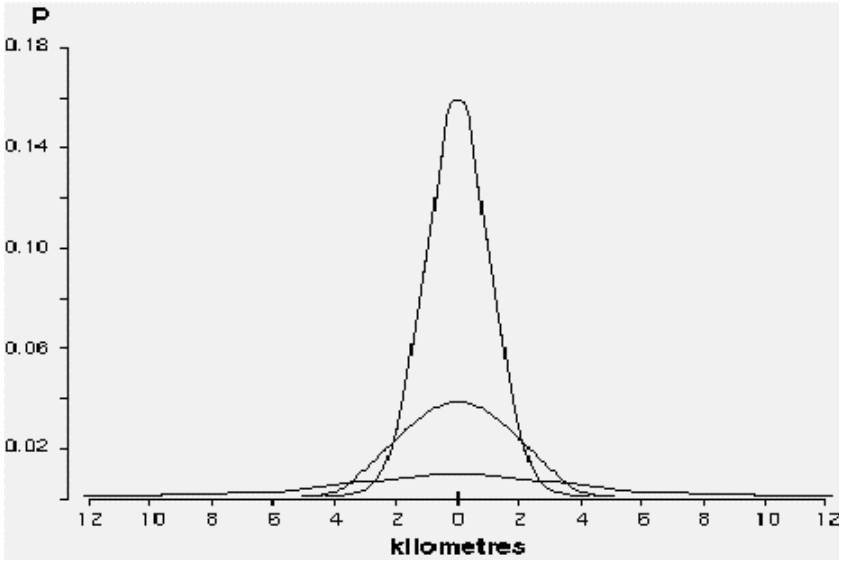
Broken ring shows mean radius of interaction

Source: Admans 1981.

For the purpose of appreciating some of the consequences of the mobility trends discussed above we can think of the mobility surface as a 'time-space dome' within which people spend their lives. The height of the dome at any particular point is proportional to the amount of time that is spent at that point. The volume of the dome corresponds to the total amount of 'interaction time' that people have to spend - the number of waking hours in a day that are available for interacting with others. People can alter the shape of the dome, but not its volume; the number of hours in a day does not increase as people become more mobile. People and societies that do not travel much inhabit high, rigid, confining domes; those who travel a lot live in low, flexible, spread-out domes. But they all live in domes that have the same volume because they all have the same number of hours a day at their disposal.

Figure 15 gives an indication of the dramatic transformation that takes place in the time-space dome of a society as its level of mobility doubles and redoubles. The high peaked dome represents the spatial activity pattern of an individual, or a group, with an average trip length of 1.25 kilometres. The other domes represent the effect of doubling and then doubling again the average trip length. The new, more remote, opportunities of which people avail themselves as they become more mobile are generally not additional to those previously enjoyed, but substitutes for opportunities previously taken closer to home, and now foregone. Figure 15 illustrates the obvious fact that if people, in spending the time at their disposal, distribute themselves more widely over space, the amount of time they spend closer to home, and perhaps at home, must be substantially reduced.

Figure 15. **Average trip length doubles and then doubles again**

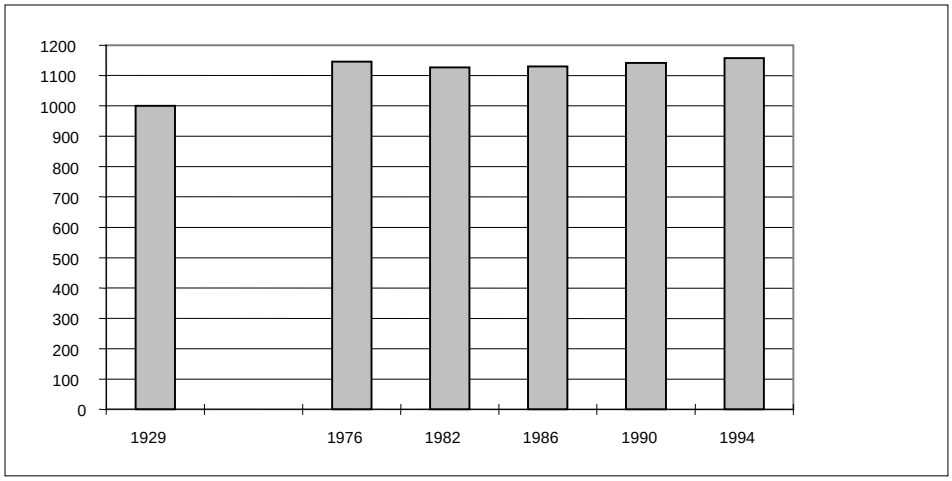


Although the travel behaviour of people will rarely display a pattern as simple and symmetrical as that in Figures 14 and 15, the essential principle illustrated by the time-space dome is inescapable: if people in their travelling choose to spread themselves more widely, they *must* spread themselves more thinly. If the average trip length doubles, the area covered by the dome quadruples, and the average height of the dome decreases to a quarter its previous height

In Britain while the distance the average person travels in a day has increased five-fold the *number* of trips taken every day has not increased, and has possibly decreased slightly as the short daily shopping trips to the local high street have been replaced by the once-a-week trip by car to the out-of-town superstore, and as trips to the cinema or theatre have been replaced by television. Thus the *length* of the average trip made in Britain now is about five times greater than in 1950.[20] This finding is supported by data for Germany on the number of trips per person that is almost constant over the last 25 years (Figure 16).

[20] Figure 16 shows that the average number of trips made yearly in Germany has also been remarkably stable over many years.

Figure 16. **Trips per person and year in Germany**



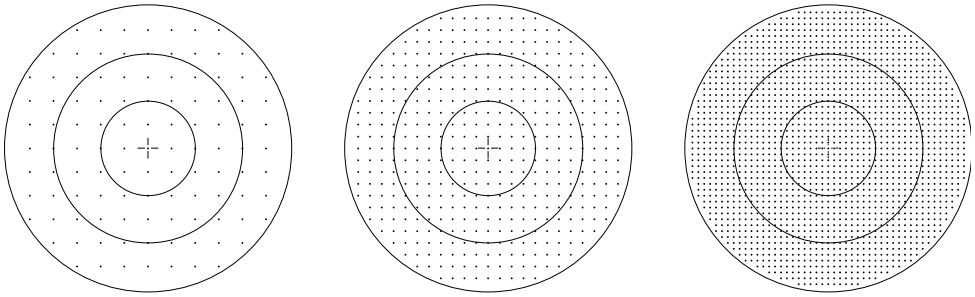
Sources:
1929: Apel, Henckel *et al*., Flaechensparen, Verkehr reduzieren.
1976-1994: Results of national statistics and assessment by the German Institute of economics DIW, DIW Wochenbericht 37/96.

The amount of *time* that the average person spends in motion has also changed very little since 1950. People make their travel decisions within the constraints of time and money budgets. Improvements in transport technology have reduced the cost of travel, and rising real incomes have relaxed the constraint imposed by the money budget, but the number of hours in the day has not changed. The increase in average trip length is accounted for by increased *speed* of travel. Despite congested conditions for motorists, the huge shift from feet and bicycles to cars and planes has approximately quintupled the speed of the average journey.

Figure 17 shows what would happen on a plain with a uniform population density if the average journey speed were to double and then redouble while the time spent travelling remained constant. The number of people within the circle described by the average radius of interaction would quadruple and quadruple again. Thus, in Britain since 1950, as average journey speeds have increased five-fold, the psychological population density has increased about 25-fold; we now live in a world crowded with strangers - a world in which we have fleeting contact with far more people than we have the possibility of knowing as individuals[21].

[21] It was noted by the one of the Canadian participants that in rural areas with very low population densities in some OECD countries the problem is not encountering too many people but too few, and that the extended range provided by the car has enriched social life. But with access, as with many other things in life, the maximum amount is not the optimum amount. In most urban and suburban parts of most OECD countries (which includes most of their populations) it is likely that average levels of access to people, goods and services already exceed the optimum, and that the undesired side-effects discussed in this paper exceed the benefits. Where, as yet, they do not, the indefinite extrapolation of trends assumed in BAU will ensure that ultimately they will.

Figure 17. **As average journey length and speed double and double again, the psychological population density quadruples and quadruples again**



Change at the centre. Most models of travel behaviour do not seek to account for the amount of time spent at home. But Figures 14, 16 and 17 seek to describe changes in the way people's interaction time is distributed over space as their average trip lengths increase. The figures suggest a very large reduction in the amount of time spent not only close to home but *at* home. If the model is taken to embrace electronic mobility as well as physical mobility the impression conveyed by the figures may not be too inaccurate.

The increases noted above in telecommunications traffic suggest that whatever is happening to the amount of time people are spending physically at home, social life there is being sapped electronically. The now wide-spread use of the guilt-laden term 'quality time', to distinguish the time during which parents are actually paying attention to their children from the time during which they are merely physically present is symptomatic of the distracting power of television, computers and telecommunications. Although interaction by telephone or Internet is a weaker form of communication than that afforded by face-to-face contact, the growth rates in these forms of interaction are much greater. The influence of television is much debated. Surveys over many years suggest that in Britain and the United States the average person spends over three hours a day watching television. Television coverage of current events now extends, depending on their 'newsworthiness' to all parts of the world.

If graphs were to be drawn to describe changes in the average individual's centred *information* field, the spreading and flattening effects caused by the telecommunications revolution would be even more pronounced than the changes depicted by the graphs of physical interaction. If the growing amount of time spent interacting electronically is charged against time spent at the centre - that is those so interacting are counted as present in the flesh but absent in spirit - then figure 15 can probably serve as a valid representation of the nature of change at the centre as well as at a distance.

The *death of distance*[22] is now creating problems of hyper*accessibility*. In *The Road Ahead* Bill Gates asks, enthused by the prospect, "What if communications became almost free?" The correlation between physical distance and the cost of communications is fast disappearing, and for growing numbers of affluent people communications are already sufficiently cheap that cost is no longer a determinant of use. For such people electronic accessibility - to people and information - completely overwhelms the ability to use it.

[22] This is the short title of a book by Frances Cairncross: *The Death of Distance: how the communications revolution will change our lives*, Orion Books, London, 1997.

Many (most?) users of email, after a brief period of enthusiasm, feel harassed by it, and growing numbers of telephone users are defending themselves by going ex-directory.[23]

Decoupling trends in physical and electronic mobility? Electronic mobility and physical mobility are highly correlated over space and time. Those societies that make the greatest use of telephones and the Internet are also the most mobile physically. The growth trends of both forms of mobility are also highly correlated; the travel industry is one of the most important users of telecommunications. Historically telecommunications have primarily served as stimulus for travel, rather than as a substitute for it.

A recent IBM advertisement (*Sunday Telegraph 29 March 1998)* highlights one straightforward way in which electronic mobility encourages physical mobility; the advertisement boasts that its new system for selling plane tickets over the Internet reduces the transaction cost per ticket from £5 to 62p. And the main point of mobile phones and notebook computers with modems, the market for which is expanding at a prodigious rate, is that they facilitate mobility by making people contactable wherever they happen to be.

The hope that extensive use of telecommunications will obviate the need for travel and the movement of goods, rests upon a decoupling of the trends of electronic and physical mobility for which there is no precedent. Advocates of telecommunications as a part of the solution to present transport problems argue that they will revive and promote human-scale community life by permitting more people to work from home, thereby encouraging them to spend more time close to home, and helping them to get to know their neighbours better. Perhaps. But it presumes that people will be content to lead a shrinking part of their lives in the *real* world which they will experience directly, and a growing part of their lives in *virtual communities* which they will experience electronically. It presumes that people will be content with lives of increasing incongruity of experience - that they will not want to meet and shake hands with the new friends that they meet on the Internet, that they will not seek first-hand experience of the different cultures that they can experience vicariously electronically, and that they will not wish to have *real* coffee breaks with their fellow workers. It presumes much for which there is, as yet, little encouraging evidence.

In "Who killed civic America?" Putnam[24] documents the decline of civic engagement in American life, and concludes, after considering a number of candidates for the blame, that the principal culprit is television. He observes that "the electronic revolution in communications technology was the first big technological advance in centuries which would have a profoundly decentralising and fragmenting effect on society and culture."[25] His list of potential culprits curiously does not include the car and the airplane, and the decentralising and fragmenting influence for which they have been responsible. A more convincing diagnosis would, I suggest, share the blame more equitably between the revolutions in transport and communications.

Evidence for the much heralded "dematerialization" of GDP following the growth of information technology is not yet apparent in the traffic growth statistics presented in Section 2. Whether policies can be implemented to cause the IT and physical mobility trends to diverge is still a moot point, but if business continues "as usual" they will not.

Traffic. Figure 18 is reproduced from a study of three residential streets in San Francisco. It shows the power of motorised mobility - traffic - to undermine community life. As traffic along residential streets

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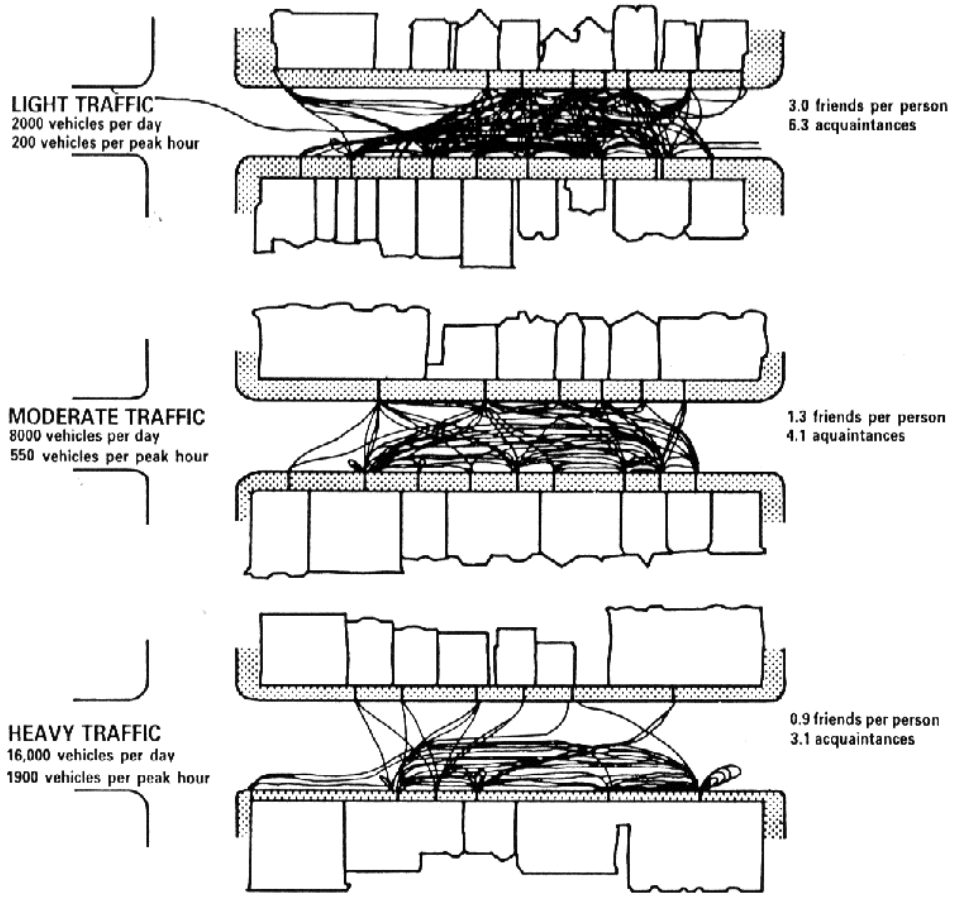
[23] BT, Britain's largest telephone company, reports that by 1998 40% of its customers were ex-directory – up from 33% in 1996.

[24] Robert Putnam (1996) "Who killed civic America" , *Prospect*, March. pp.66-72.

[25] An insight that he attributes to Ithiel de Sola Pool's *Technologies without Borders*.

increases, the number of people attempting to cross the street decreases, and the number of people who know their neighbours on the other side of the street also decreases.

Figure 18. **Social interactions correlated to street traffic**



Source: Applyard and Lintell (1969).

Community Relationships
• *under BAU, more traffic will further undermine street life, and greater mobility will undermine local communities; society will become more anonymous, and fewer people will know their neighbours* • *under EST, less traffic and more time spent in the local neighbourhood will promote conviviality* • *children are the principal winners under EST - whose safer neighbourhood environments will permit greater independence* [26] • *increasing electronic mobility, under BAU, will continue to serve as a stimulus to more travel* • *the increased electronic mobility and decreased physical mobility envisaged in EST will lead to a greater incongruity of experience as people spend less of their time in geographically delimited communities and more in virtual communities of interest.*

6. Geographical uniformity and cultural diversity

Travel opportunities will be destroyed. The cultural diversity in the world - the potential experience of which provides the motivation for much travel - will increasingly be obliterated by the rising tide of tourism, and the hegemony of English on satellites and the Internet. Our sense of place will disappear in a world obsessed with making it easier and cheaper 'to get there'; when we get there we increasingly will discover there is no 'there' - it will have been flooded with traffic, or bulldozed to make way for a new road or a fast-food restaurant. The most widely discussed, and least disputed, example is that of "tourist spoil" - travel writers routinely urge their readers to visit this or that unspoilt part of the world before it is too late - i.e. before MacDonald's, Hilton and the tourist hordes transform it into something indistinguishable from any other popular tourist resort. Under ***BAU*** distinctive traditional indigenous cultures, expressed in the form of music, dance and artefacts, become commodities marketed by the tourist "industry" - the Tower of London has now installed a moving pavement to speed tourists past the Crown Jewels more efficiently.

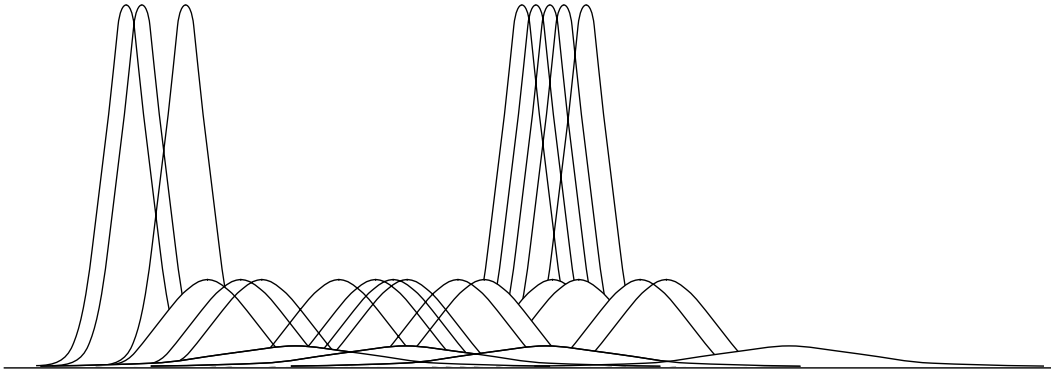
The process of cultural homogenisation has been much remarked upon by writers in America, where the process is furthest advanced. Lewis Mumford decried the bland geographical and cultural uniformity of American suburbia: "a multitude of uniform, unidentifiable house lined up inflexibly, at uniform distances, on uniform roads … inhabited by people of the same class, the same income, the same age group, witnessing the same television performances … conforming in every outward and inward respect to a common mould…" Jane Holtz Kay, in *Asphalt Nation*, speaks of the "cookie-cutter clutter … oblivious to place" in "sprawl city". And Tom Wolfe, in his most recent book, *A Man in Full*, complained that "the only way you could tell you were leaving one community and entering another was when the franchises started repeating and you spotted another 7-Eleven, another Wendy's, another Costco, another Home Depot." But perhaps Gertrude Stein put it best and most succinctly in her famous lament about Oakland California: "There is no there there." Under *BAU* the world will be more the same everywhere. But the world is unlikely to be as it is now.

[26] One participant insists that "it must be stressed that absolutely everyone is a winner in a healthier and safer environment." Would that everyone thought that EST would make them a winner!

The mobility landscape. Figures 14, 15 and 17 depicting centred interaction fields indicate the nature of the change that takes place in the spatial and temporal dimensions of a society's activities as it becomes more mobile. These illustrations have assumed that all members of society share equally in the increase. Figure 19 represents an attempt to describe what happens when some become less mobile while others become more mobile - the current trend under BAU. It is a highly impressionistic cross section through a 'mobility landscape'. No scale is provided because the interaction field shown can represent a number of different levels of aggregation from the small group to the international scale. The interaction fields of the highly mobile spread and overlap, while those of the decreasingly mobile contract.

Even when they live in close physical proximity to each other the mobile wealthy and the immobile poor live in different worlds. The high confined time-space domes inhabited by the poor may be statistical abstractions, but they have an unyielding strength. Their occupants are confined by their lack of mobility in prisons with invisible walls. They are continually tempted and taunted - in a way that prisoners confined to cells with opaque walls are not - by the freedom and conspicuous consumption of the affluent. The wealthy can be seen and heard flying overhead, or driving along motorways through the ghetto, or on television, enjoying privileges that remain tantalisingly out of reach. To the wealthy, the poor are often invisible; because of the height and speed at which they travel, the wealthy tend to see the world at a lower level of resolution. Cultural diversity will become aspatial in the sense that similar conflicts between the cultures of the rich and the cultures of the poor will be found everywhere.

Figure 19. **A cross section through a mobility landscape**



There has been substantial agreement amongst this project's participants about the continuation of the process of cultural homogenisation likely to occur under BAU, but much less certainty about whether the reduced physical mobility assumed under *EST* might arrest this trend. The accelerated increase in electronic mobility assumed under *EST* was thought likely to continue to assist the homogenisation process.

Geographical uniformity and cultural diversity
Under BAU the world becomes everywhere more the same culturally - the Hilton-McCulture effect. EST is likely to be a weak restraint on this process if the growth in electronic mobility continues unchecked.

7. Safety and Health, Crime and Law Enforcement

Safety and Health. As traffic increases, traffic danger increases, especially for pedestrians and cyclists. This cannot be demonstrated by road accident fatality statistics which have been falling in most OECD countries for many years despite increasing traffic. The table below shows that road accident fatalities are not simply and positively correlated with speed and traffic volume, as is commonly assumed in many economic studies; despite a more than ten-fold increase in traffic and large increases in the speed of traffic since 1929, road accident fatalities in Britain have decreased by almost 50%.

Figure 18 above helps to explain why. As traffic increases, vulnerable users defer to it. Fewer people attempt to cross the road, fewer cyclists venture forth upon the road and, as noted above, fewer children are permitted to get about independently. The biggest costs are borne by children who are increasingly confined in back gardens or in front of television sets and chauffeured everywhere by parents.. Some of these costs have been documented for Britain in *Children, transport and the quality of life*[27]. They include, in addition to the loss of traditional freedoms, the impairment of social development - as children are denied the experience of mixing independently with their peers and learning to cope without adult supervision - and the impairment of fitness as they get less physical exercise. The habit of taking little exercise which is becoming established in childhood is continued into adulthood.

Box 3. Road safety and the role of speed & traffic volume

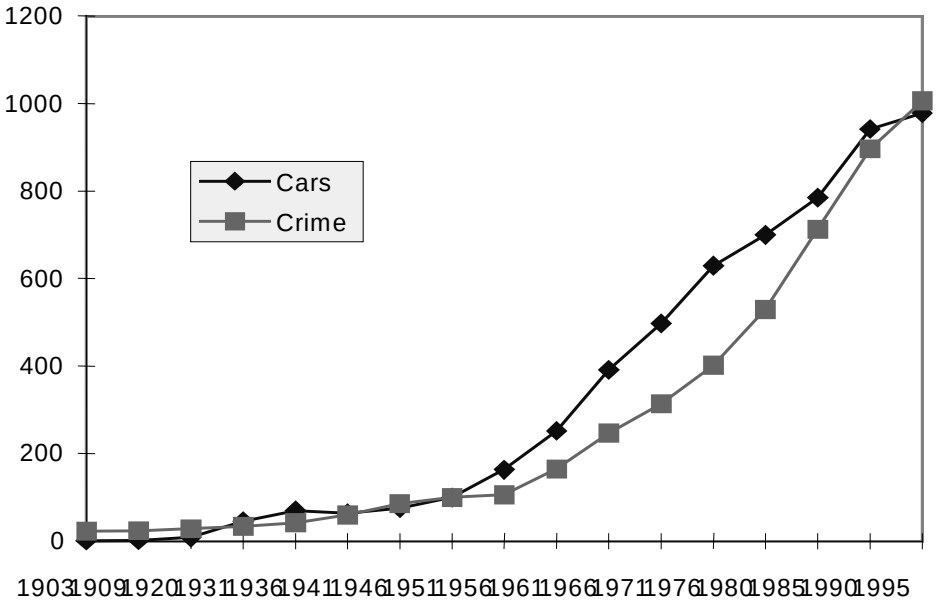
In Britain the Motor Car Act of 1903 imposed a 20 mph nation-wide speed limit which was not abolished until the Road Traffic Act of 1930. Pre-1930 only 4.5% of all accidents involved cars travelling at speeds in excess of 20 mph. [1]

Road Accident Fatalities

	Pedestrian	Cyclist	M/cyclist	M/vehicle	Total	Motor vehicles
1929	3523	795	1582	796	6696	2.2 million
Now (1995)	1038	213	445	1925	3621	25.4 million
Change	- 70%	- 73%	- 72%	+ 142%	- 46%	

[27] Mayer Hillman (ed) 1993, *Children, transport and the quality of life.* Policy Studies Institute, London.

Figure 20. **Cars and crime in Britain 1903-1995 indices 1951 = 100**



One result is an increase in obesity throughout the OECD. In 1998 US National Heart, Lung and Blood Institute classified 55% of adult Americans as overweight or obese, up from 43% in 1960. In addition to over-eating the Institute identified the main causes as "too much time sitting at our computers, driving the car, watching television and taking the elevator instead of the stairs."[28] In Britain a Gallup Poll revealed that in a typical week 37% of the population get no exercise which makes them slightly out of breath. The UK Health Education Authority guideline for healthy living is "30 minutes of moderate exercise, *such as brisk walking*, every day."[29]

Increasing dependence on the car has been associated with ill-health for another reason. The British Medical Association has documented in a recent report[30] an increasing polarisation in access to healthy food. They note a marked decrease in the consumption of leafy green-yellow vegetables - which are inversely correlated with cardiovascular diseases and cancers - by low-income families, and attribute the cause to the declining numbers of local shops and the lack of access by the poor to supermarkets which are increasingly located for the convenience of car-borne shoppers.[31]

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28 BBC, June 18, 1998, www.news.bbc.co.uk.

29 BBC News Release, 5 January 1999.

30 British Medical Association 1997. *Road Transport and Health.* BMA. London.

31 The Austrian participants report that in Austria 240 communities lack a food shop, and that 2.3% of the population have no access to basic goods without using motorized transport.

Crime[32]

People who live in different cultures will develop different group loyalties. Those who live in the least desirable worlds will become alienated and prone to rationalise their resentments, and develop ethical codes that favour a redistribution of the world's goods and privileges - by whatever means. And the wealthy, in turn, rationalise their good fortune, and devise means for holding on to it. As science and technology continually improve the physical means of communication, they are at the same time undermining the conditions of shared experience essential for meaningful dialogue.

Figure 20 describes the trends in Britain since the beginning of this century in car ownership (the best available indicator of car dependence) and notifiable offences recorded by the police (the best available indicator of serious crime).

There are basically four distinct possible explanations for a correlation as close and durable as that illustrated by figure 20:

- the rise in car ownership has been caused by the rise in crime,
- the rise in crime has been caused by the rise in car ownership,
- the association is purely fortuitous,
- the crime statistics are artefacts of a recording system that, over time, is recording an increasing proportion of all crime.

The first explanation is unlikely[33]. The other three are all possible. The strength and duration of the correlation displayed in Figure 20 compare favourably with the relationship between car ownership and GDP commonly used by forecasters for predicting future car-ownership levels.

While it would be foolish to claim that the trend in car ownership is the exclusive cause of the rise in crime, there are reasons for believing that the association is not purely fortuitous[34]. More mobility increases both productivity and opportunity; if it does this for the travelling salesman, there is no reason why it should not do it for villains also. Secondly, it fosters anonymity and thereby encourages the commission of crime by increasing the difficulty of apprehending offenders; communities in which people know each other tend to be largely self-policing because of the much greater risk of miscreants being found out.

It is also likely that a growing proportion of crime is being officially recorded. Where neighbours know each other, misbehaviour by children, for example, is more likely to be sorted out by parents without recourse to the police. In anonymous societies, the victims of crimes committed by children and teenagers whom they do not know, are much more likely to be reported to the police and become official statistics.

Figure 17 above shows the way increasing mobility increases anonymity. In highly mobile societies we come into contact with far more people than we can possibly know. Figure 18 illustrates another way in which increasing car dependence fosters anonymity; as traffic on residential streets increases, fewer

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[32] The German participants proposed deleting the whole of this section - arguing that increased mobility was not a significant caused of increased crime. Discussions with the British police however elicited strong support for the view that mobility fosters anonymity and anonymity fosters crime.

[33] Although increasingly one hears people claim that fear of using public transport leads them to use cars.

[34] Recorded crime also correlates highly and positively with expenditure on education, expenditure on the police, and GDP.

people know their neighbours on the other side of the street. Also, as noted above, fewer children are permitted independent mobility, with the result that they less often serve as catalysts for neighbourhood sociability. Anonymous societies tend to be suspicious societies. The natural mistrust of people we do not know is reinforced in British primary schools by regular "Stranger Danger" campaigns, which inculcate paranoia at a tender age.[35]

The connections between mobility and anonymity, and anonymity and crime were impressively documented by Vance Packard in *A Nation of Strangers*. Although first published in the USA in 1972 it has current relevance for most European countries whose levels of mobility have only recently reached those of America in the early 1970s. Packard observed

> "There are many causes for the soaring U.S. crime rates involving dishonesty and stealing; but certainly a major cause is the depersonalization of metropolitan life. … People are far more willing to steal from strangers and institutions than from personal acquaintances; witness the contrast between life in small towns where doors frequently are left unlocked and life in big cities where residents often have three or four locks on a door."

In the last six years the FBI's crime index for the USA has fallen away from the long-term upward trend, fostering hope of a new, more hopeful trend. There are a number of reasons to defer optimism. Firstly, the FBI index excludes offences relating to the most rapidly rising category of crime - possession and sale of drugs; these offences accounted for over a third of the recent increase in numbers jailed. Secondly, the fall in recorded crime coincided with a fall in the number of men aged 15-25, the peak age of criminality in most societies. Thirdly, measuring crime and fear of crime is notoriously difficult. By one indicator that captures aspects of both - the "correctional population" (people in jail or on parole or probation) it has continued to soar in the U.S. to the point where it now includes one American in 50. It has increased almost three-fold, from 1.84 million in 1980 to 5.37 million in 1995.

Fourthly, crime rates tend to be highest in the poorest neighbourhoods, where fraught relations with the police are likely to augment the problem of under-reporting. The immobile poor in a mobile society were described in section 6 above as living in prisons with transparent walls; as in real prisons their anger, frustration and resentment are most likely to be vented on those closest to hand. Fifthly, there has been a large increase in resources devoted to security - another index of fear of crime. The number of American homes with burglar alarms has increased from 1% in 1970 to 5% now, and since 1975 spending on private guards has increased 10-fold, and sales of car alarms have increased 40-fold.[36]

A caveat. Just as road accident statistics are not a satisfactory measure of danger on the road (see above), crime statistics are a less than satisfactory measure of the threat of crime. Precautionary or defensive measures, such as restricting children's freedom or fitting doors with multiple locks, may limit the number of accidents or burglaries, but the fears that motivates such measures are themselves indicators of social pathology.

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[35] Some participants argued that people, especially women, are safer in cars than using public transport at night. But it can be argued that the increase in numbers travelling safely in their metal cocoons increases the vulnerability of those outside cars by undermining the protective effect of a healthy street life – see figure 18.

[36] The statistics for the correctional population were taken from the *Sourcebook of Criminal Justice Statistics 1996*, p 502; all other statistics in this section are taken from *The Economist* 3 October 1998, pp. 35-38.

Law enforcement[37]

A world full of highly mobile strangers will require ever more ingenious technology to detect and apprehend wrong doers. Traditional methods of policing no longer work. The local policeman can only stand on the corner and watch the criminals flash past, talking on their mobile phones. Policing must become more dependent on the use of CCTV surveillance, DNA finger printing, and large computerised police data bases.

The Times (London, 2 May 1997) described a recent advance in surveillance technology that fairly merits the adjective Orwellian;

> "A surveillance camera capable of instantly checking a car numberplate with a central computer is being heralded as the latest weapon for the police in the war against crime and terrorism. The system, which can scan up to 300,000 index numbers and hour an check them against national police records in four seconds is operating at the City of London's 'ring of steel' anti-terrorism cordon."

The proliferation of CCTV surveillance and the development of face-recognition software is extending the capacity of the technology to enable the identification of individuals in anonymous crowds as though they were wearing numberplates. Although this style of policing is opposed by civil libertarians, in England even small villages are now clamouring for surveillance cameras - they appear to trust those who control the cameras more than the anonymous strangers increasingly in their midst. Control of this technology is likely to become an increasingly contentious issue; opinion polls in the U.S. over the last 25 years reveal a diminishing level of confidence in the institutions of government[38].

The increasing numbers of Neighbourhood Watch schemes would appear to represent an attempt to replicate a phenomenon that used to occur naturally in less mobile times. The proliferation of wealthy high-security ghettos is the neighbourhood equivalent of the multiple door locks noted by Packard. The ultimate high-security ghetto has now moved off-shore (*The Times* 30.12.97). A luxury liner is now on the market providing 250 private apartments. 39 have already been sold at an average price of $2 million. Annual maintenance charges will range from $61,000 to $241,000. It will spend 100 days a year at sea and the rest of the time in various ports around the world. In addition to luxury and security it will provide high-tech communications facilities and the financial advantages of off-shore living.

Sociologists such as Giddens and Beck, identify a feeling of impotence in the face of technology racing out of control as one of the defining features of modern "Risk Society". Giddens argues that "authentic, or 'active' trust … comes from democratic engagement and open dialogued through which all concerned have a stake in the decision-making process."[39] Such conditions, as the next section argues, are increasingly difficult to sustain in high-mobility societies.

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[37] The German participants proposed deleting the whole of this section. It has been retained for the reason discussed in footnote 24.

[38] Sourcebook of criminal justice statistics online, Table 2.7, Reported Confidence in Selected Institutions 1973-98. A recent poll in Britain revealed that only 6% of the population would trust the Government to tell them the truth about risks to health and the environment - C. Marris, I. Langford and T. O'Riordan, *Intergrating soiological and psychological approaches to public perceptions of environmental risks: detailed results from questionnaire survey*, CSERGE Working Paper GEC 96-07, University of East Anglia, 1996.

[39] In *The Politics of Risk Society* (1998), Jane Franklin (ed), Polity Press, Cambridge.

Safety, Health, Crime and Law Enforcement
Under EST • *life is safer for pedestrians and cyclists - especially children and the elderly* • *increases in walking and cycling promote greater fitness* • *more local provision of fresh fruit and vegetables promotes the health of those without cars* • *The threat of crime decreases - societies in which people know their neighbours are mostly self-policing - and the need for "Orwellian" forms of policing, such as CCTV surveillance, diminishes.*[40]

8. The functioning of government

Bureaucratic deterrents to travel

As travel becomes faster, cheaper and easier under *BAU* it becomes more difficult bureaucratically, especially for the poor. Wealthy countries previously protected by distance from mass invasion by the indigent will increasingly resort to restrictive prohibition and force. New barriers - in the form of stringent visa requirements, difficult-to-obtain work permits, and insistence on obstructive immigration qualifications - will be erected to contain the numbers who will take advantage of the mobility afforded by technology; - the poor who used to be welcomed to America by the Statue of Liberty are now dubbed 'economic migrants' and denied entry to protect the living standards of those who got there earlier. Under *EST* this form of protection is increasingly likely to be circumvented electronically. The current trend for low-level data processing and computer programming jobs to migrate to low-wage countries will continue and possibly increase; such workers no longer need to be physically present in the wealthy countries who buy their services.

Under both *BAU* and *EST* new price barriers will be erected to replace the diminished deterrent effect of distance. Entrance fees will be charged for previously-free tourist attractions, and charging schemes such as electronic road pricing will be devised to price off the road those who are on the threshold of being able to afford to travel by car.

Political authority will become more remote

Under *BAU* as the numbers of people crossing traditional political boundaries continues to increase, the scale of political authority must increase or it will become impotent; political power will continue to migrate upward, diminishing the significance of the local. Diminishing participation in local elections is a widely observed aspect of the decline in civic participation discussed in Section 5. The cartoon below (Figure 21) accompanied an article in *The Times* observing that the principal winner in the recent local elections was apathy.

It is not obvious that *EST* will be more democratic. Bill Gates enthuses "The day a senator receives a million pieces of e-mail on a topic or is able to have his bleeper announce the results of a real-time opinion poll from his constituents is not far away." But how a senator will read all this e-mail and resolve the conflicts of opinion contained within it he does not explain. As technology deluges us in information, it leaves us less time for contemplation and reflection, and forces us to employ ever cruder perceptual filters

[40] The Swiss participants cite Switzerland as a counter example: "In Switzerland we have had several people's referendums about issues that concern foreigners. The more foreigners living in a canton, the more tolerant/less paranoid usually was the outcome of the ballot."

in order to make sense of it all. It can only increase the numbers of people with whom we have relationships at the cost of diminishing the intimacy and intensity of our relationships.

Democracy will disappear

Democracy is government by the people. Its purest form (ignoring the plight of women and slaves) is widely held to be Athenian democracy. Beyond a certain scale this becomes impractical, and the preferred model becomes representative democracy. But as the scale of the issues requiring collective management increases still further representative democracy also breaks down. Either the number of representatives becomes unmanageable and the limits of the Athenian model are reached again - i.e. the forum for debate becomes overcrowded - or the number of voters per representative reaches a level that renders the individual voter insignificant. [41]

As a society's dependence on the car increases, those without cars have diminishing control over their lives, and diminished faith in either markets or the institutions of government to safeguard their interests. The more dependent a society becomes on the car, the stronger becomes the motivation of those without cars to acquire them. A recent survey of young adults in England contained the following question: "imagine you are only able to have one of the following two rights - the right to vote in an election, or the right to obtain a driving licence - which would you choose?" 72% chose a driving licence[42].

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[41] The 1998 film *Antz* explores this theme entertainingly. The Woody Allen character complains to his psychiatrist that being the middle child in a family of 5 million makes him feel insignificant. He is complimented by his psychiatrist on his progress; "you *are* insignificant" his psychiatrist reassures him. In Britain the new Euro-constituencies contain over 4 million people eligible to vote. They too might have difficulty appreciating their significance; the percentage bothering to vote is likely to be small.

[42] J. Solomon (1998) *To Drive or Vote?: young adults' culture and priorities.* Chartered Inst. of Transport, London.

In the whole of the literature of science fiction devoted to fantasising about futures in which distance has been defeated by science and technology, there are to be found no plausible examples of democratic government[43]. Democracies, to function effectively, require common values, and a measure of agreement about societal goals forged out of common experience. If distance is vanquished the requisite minimum level of consensus and trust will be unattainable; the world will be filled with billions strangers sharing the same physical space, but living in very different virtual communities of interest. These problems are likely to become more severe under ***BAU*** than under ***EST***, but the conquest of distance electronically envisaged in ***EST*** is also likely to have democracy-sapping effects.

The functioning of government
• *under BAU access will be rationed by fiat and price, increasingly discriminating against the poor* • *equitable demand management is assumed under EST, details of how it will be achieved remain unclear* • *under EST "the local" should assume greater importance and community politics should stand a chance of being reinvigorated - if the undermining effects of electronic mobility can be contained.*

9. Instruments for attaining ESST (Environmentally and *Socially* Sustainable Transport)

There is now a large literature describing more environmentally benign transport and land use systems. An environmentally and socially sustainable transport system would, in essence, involve much less use of cars, planes and lorries, and much improved provision for walking, cycling and buses. The main problem is not a shortage of ideas, but a shortage of the political will to implement them. There are three essential steps towards achieving the political will. They can be illustrated by three hypothetical opinion polls.

1. Would you like a car and unlimited air miles? Worldwide the answer to this simple question is overwhelmingly YES! In answering, people imagine the world as it now is, but with themselves having access to the greater range in opportunities in life available to the wealthy. This is the implicit opinion poll that still sets the political agenda for transport almost everywhere. Most politicians believe it would be political suicide to resist such aspirations; it would be manifestly unfair, they often add, for those who already enjoy a high level of mobility to pull the ladder up behind them.

Step 1 requires establishing the impossibility of satisfying universally the aspirations revealed by Opinion Poll 1.

2. *Would you like to live in the sort of world that would result if **everyone's** wish were granted?* Assistance with the answer might be given by rephrasing the question - "would you like to live in a dirty, dangerous, ugly, bleak, alienated, undemocratic, socially polarised, fume-filled greenhouse?"[44] This opinion poll asks, in effect, do you want the consequences of BAU? As these consequences become better,

[43] Three years ago I was invited to address the annual conference of science fiction writers in Britain on the subject of transport planning. I made this assertion hoping to be refuted. I was not.

[44] It is helpful when administering opinion poll 2 to distinguish those problems that might conceivably yield to technology from those that cannot. Even if a car powered by a pollution-free perpetual-motion engine were to be developed, most of the social problems associated with business as usual would remain, and possibly be exacerbated.

and more widely understood increasing numbers of people are clear that they would not want them. But the political response has been disappointing. The best that even progressive Denmark or the Netherlands have achieved so far is a response that slows the rate of growth in road traffic in urban areas, does little to slow the growth of traffic in the suburbs and rural areas, and does virtually nothing to arrest the far more rapid increase in air travel.[45] The political difficulty seems to be that the problem, when posed in the form of Opinion Poll 2, implies the need for a grim, grey, virtuous self-denial in order to save the planet. This is not a platform on which many politicians are enthusiastic to campaign. Nevertheless,

Step 2 requires establishing convincingly the unpleasant, and potentially catastrophic, consequences of the continued pursuit of business-as-usual

3. *Would you like to live in a cleaner, safer, healthier, friendlier, more beautiful, more democratic, sustainable world in which you knew your neighbours and it was safe for children to play in the street?* If these rewards could be assembled in a convincing and affordable package most people could be expected to vote for them, especially if the consequences spelled out in Opinion Poll 2 were seen as the alternative.

Step 3 requires establishing that there is a better, realistic, alternative.

A better alternative - and how to get there from here

There is now a torrent of proposals for improving transport systems emerging from consultancies, universities, environmental groups and governments - *The Greening of Urban Transport* is a good, representative compendium.[46] So why has the political response been so disappointing?

Most people (including politicians) are now convinced - or capable of being convinced - of the dire consequences of continuing business as usual. But they are not convinced that life for them personally (or their voters) would be better if they gave up their cars tomorrow and tried to get to work on a bus or bicycle. Anyone who lectures regularly on the subject of transport will have encountered those people who are persuaded that things cannot continue as they are going, but who then exclaim "But me give up ***my*** car?!" Gaining political assent to the necessary changes requires a) addressing the anxieties and meeting the perceived needs of people who have already become dependent on the car, and b) persuading them that the proposed remedies are *fair*.[47]

All the necessary changes in land use patterns are too remote in time to prompt change in behaviour tomorrow, and all the improvements that might realistically be made to public transport will not cope with many of the journeys currently made by car. Thus, the most important part of any politically effective package of instruments that will reduce dependence on the car, will be those elements that address the reasons that motorists give for being unable to give up their cars. Figure 22, an advertisement for a hypothetical "Green Transport Club", is offered as an example of the sort of "package of carrots" that could be developed to meet the anxieties and perceived needs of motorists who fear that they would be stranded without a car.

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[45] Public appreciation of the need to curb air travel, and political willingness to contemplate doing so, lag far behind current thinking about the problems associated with the car. The tiny amount of space devoted to air travel in this project is perhaps symptomatic of this general neglect.

[46] R. Tolley (ed) (1997) *The Greening of Urban Transport.* Wiley, Chichester.

[47] Petrol rationing in Britain during and after World War II was a response to popular demand; the need to restrict consumption was manifest, and the method was seen as the fairest way of doing it.

If it is accepted that it will never be possible for most of the world's population to own cars, then the ultimate objective of a fair, environmentally and socially sustainable transport policy should be the creation of a transport and land use system which permits every citizen the possibility of leading a full and satisfying life without the need to own a car.

Figure 22

Would you like a more car(e)free life?

Would you like

- to be spared the hassle of finding a parking place when you come home late at night?
- to be spared the cost and trouble of buying, taxing, insuring and maintaining a car
- to have a car in your street that you could hire quickly and easily for any journey long or short?
- to have an X% discount on all bus, underground, train & taxi fares?
- to have instant access to information about public transport services - long distance and local- all over Europe?
- to have your shopping delivered to your home free and at the time of your choosing?
- to live in an attractive, traffic-calmed street that is safe for children and cyclists?

Join the Green Transport Club and enjoy all the privileges of membership

THE ECONOMICS OF EST

A Discussion of Werner Rothengatter's Economic Assessment of Environmentally Sustainable Transportation – Scenarios of the OECD

by

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1. Introduction

A significant amount of effort needs to be undertaken for any modelling exercise, particularly when attempting to model something as complex as the interaction of the transportation sector and the economy. Econometric modellers often have a hard time trying to determine the influence of a handful of independent variables on a single dependent variable. Werner Rothengatter's report identified 4,290 distinct inter-relationships in the model. While modellers sometimes deal with this number of interactions, they are usually the same interactions replicated over many spatial or temporal units, not truly distinct variables. This project seems to paraphrase Daniel Burnham "Make no little models, they have not the power to stir men's souls". This is by no means a little model.

To borrow another phrase, this time from the post-modernists, the modelling exercise is resembles a grand meta-narrative, trying to provide a theory or explanation broadly encompassing of a large system. It weaves, to the environmentalist's ears, a very pleasing story. A story that claims we can have our cake and eat it too. The story suggests we can have an "environmentally sustainable" world, where cars are all but banished and everyone cheerfully walks to work or rides on pleasant buses and chats convivially with their neighbors, and there will be essentially no economic impact. Like Camelot, it only rains gently in the evening.

There are many things I am prepared to accept in the normative domain of what the quality of life might and should be like in a different sort of world, an environmentally sustainable world. Perhaps community life will be stronger, and people will know and like their neighbors. The halcyon image of the small town is strong in North American culture, requiring we ignore the reasons that small towns declined. However, from a positive, quantifiable analysis of what the economy, measured as gross domestic product, will be like, I must approach the question analytically and critically.

Rothengatter's report presents several alternative methodologies for assessing environmentally sustainable transportation (EST). He juxtaposes the economists cost-benefit analysis, the cybernetician's system dynamic modelling, and a variant called simplified cybernetic modelling. After selecting simplified

cybernetic modelling, he walks us through the methodology provides results from the assessment. Reading the report raises in my mind numerous questions about the principles on which the entire project is constructed as well the assumptions of and conclusions drawn from the analysis.

- Is Environmentally Sustainable Transportation a meaningful concept?
- Is EST actually being tested in this analysis?
- Is a year 2030 time horizon reasonable?
- Does this analysis, constrained to use the operational definition of EST, follow appropriate methods?
- Are the results replicable by other researchers making the same assumptions?
- Are the conclusions plausible?

I will discuss these questions below.

2. Environmentally Sustainable Transportation

The phrase Environmentally Sustainable Transportation seems innocuous. Everyone reading this article probably believes that he or she is for the environment, and that we should take "reasonable" measures to protect it. Of course, there is debate about what constitutes "reasonable", but transportation that is environmentally unsustainable sounds unreasonable. While at the level of the phrase "Environmentally Sustainable Transportation" there may be no objection, the devil is in the details.

Phase 1 of this project was conducted before I became involved. During that phase Environmentally Sustainable Transportation was defined. The Phase 2 Report (OECD 1998) defines Environmentally Sustainable Transportation as:

> Transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes.

What does this mean? Let us break the sentence into parts:

Transportation that does not endanger public health or ecosystems and meets needs for access

At first blush, no one can be in favor of transportation that endangers public health or ecosystems and fails to meet the needs for access. Yet all transportation involves some risk. A traffic accident, train derailment, or air crash injures some part of the public's health, an injury unlikely to take place in the absence of transportation. While all other things being equal, individuals tend to prefer the lower risk alternative, all other things are seldom equal – people are impatient, make mistakes, or just don't care. Certainly there is some social good to be attained from increasing the safety in the system at the present time, at least in certain components. However some danger to public health is necessary in any transportation system, at least in the near term. A perfectly safe system is not only technologically infeasible, it would be infinitely costly. Even high-speed rail has the occasional unfortunate accidents.

If we are only talking about the environmental context, we still need to assume that transportation requires energy. All energy production has some environmental consequences. Burning wood, coal, or gasoline may have different effects than chemical batteries, nuclear power, fuel cells, or solar, which differ still from hydroelectric dams or wind turbines, each process has some environmental externality, probably negative, affecting the public health and ecosystems.

In general society probably believes that, on average, the net benefits to society of transportation and energy consumption outweigh their cost. Electricity powers hospitals that save lives. Gasoline enables food production that prevents starvation in a crowded world. The proper question is perhaps this:

> *Do the net social and environmental benefits from a particular unit of transportation/energy consumption outweigh the net social and environmental cost of that unit?*

Life is full of tradeoffs, they should be recognized directly. We can argue about the relevant categories and the magnitudes of benefits and costs, but the calculus of tradeoffs should remain a neutral arbiter. Absolute statements such as "does not endanger public health or ecosystems" are not particularly useful in making real world decisions.

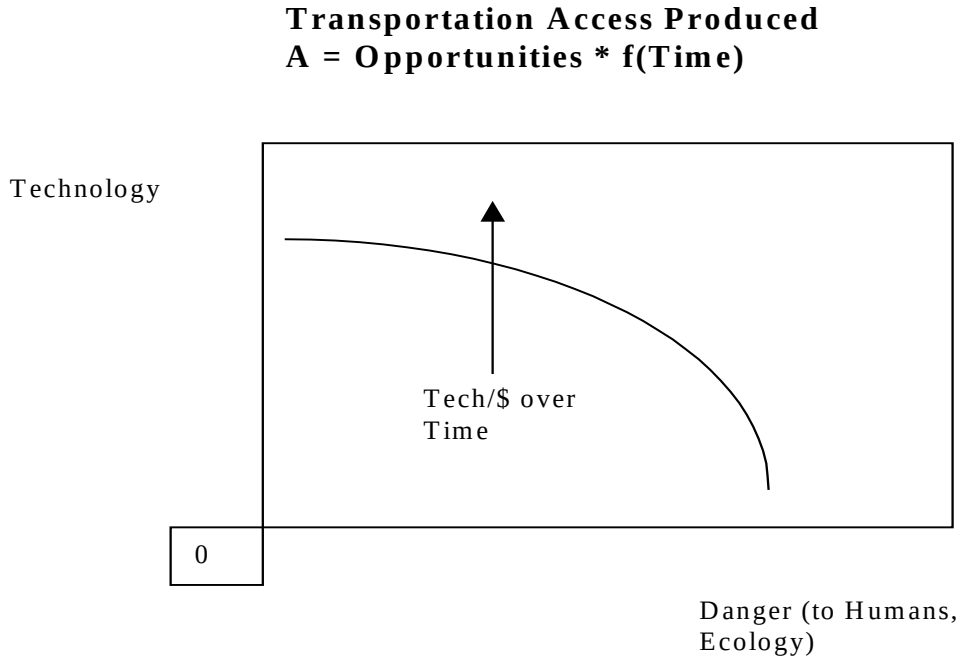
Implicitly the choices in the definition of EST are framed in terms of the following matrix.

		Accessibility	(Benefits)
		High	Low
Public Health or Ecosystems	Safe	Ideal	Little Travel
(Costs)	Dangerous	Dangerous Transport (Today)	Inefficient System

The solid arrow suggests the direction in which the Rothengatter EST3 report takes us on the matrix by changing behavior and lowering benefits rather than relying more on technology and maintaining the benefits of travel. I believe it violates the charge of EST to meet "the needs for access", but what are needs and what are wants is of course open to debate. Clearly there will be less access in EST3 than BAU. The dotted arrow would increase safety while maintaining access, but of course requires more technology to achieve.

Rather than think of absolute endangerment or absolute access, we are better served considering the trade-off the amount of danger for some amount of access. We might think in terms of a production possibilities frontier. Typically transportation geographers define the accessibility of a place as the sum of opportunities weighted by the time it takes the time to reach each. Then 'the amount of access produced' increases with the level of technology (the speed of the transportation system, a function of both vehicles and infrastructure). Access also increases with the danger produced to humans and the ecosystems they inhabit for any given technology level (we can drive faster if we take more risks, burn more fuel, etc.). As technology advances we can travel same distance in less time or travel in the same time with less emissions. Travelling the same distance in less time is equivalent to reaching more opportunities assuming fixed distribution of activities. Technology can thus be used to produce the same amount of access at

lower environmental/safety impact or more access at the same level of environmental/safety impact. The alternative means of reducing the environmental and safety effects associated with transportation is to reduce the amount of accessibility by changing behavior. These extreme versions are essentially scenarios EST1 and EST2 in the OECD report.



(a) Use of renewable resources at below their rates of regeneration

Again we have a seemingly innocuous statement on par with apple pie and motherhood. This statement completely ignores the dynamics of markets. **What, in economic terms, will lead to the regeneration of renewable resources**? The answer is their price, which depends on scarcity. In order to provide the incentive, or even the realization, that resources need to be regenerated, they must at least some of the time be used at rates greater than their rate of regeneration.

(b) Use of non-renewable resources at below the rates of development of renewable substitutes

This statement is very similar to the previous, yet not quite as coherent. If we use 50 barrels of oil, or 1% of the world's supply, what does that correspond to in terms of "rates of development of renewable substitutes"? A problem here is the comparison of stocks and flows. Non-renewable resources are a stock, renewable resources are by definition flows, flows that may depend upon a capital stock (for instance investment in solar panels), but flows in terms of continuous power produced without exhaustion. This statement is not particularly enlightening in its present form.

Again it is scarcity (as a result of overconsumption) which increase prices which provide the incentive for alternatives. The failure to be able to centrally plan for replacement technologies in the past (remember Oil Shale?) should be taken as a lesson about the future. The right prices reflecting real market conditions (including real externalities) along with clearly assigned and enforceable property rights will lead to the incentives that the private sector requires to provide clean transportation. Command and control quantity

regulation of vehicles to conserve a scarce resource and limit emissions will not produce the same incentive.

Operationalizing EST

The report proceeds to provide specific standards that it asserts are environmentally sustainable. There is a disjoint between the definition and the standards, there is no evidence that the standards will provide EST in the absolute, in fact they are missing several environmental impacts:

- Transport-related emissions of **nitrogen oxides (NOx)** have been reduced to the extent that the air quality objectives for ambient NO2 and for ozone levels as well as for nitrogen deposition are achieved.

- Emissions of **volatile organic compounds (VOCs)** have been reduced to the extent that excessive ozone levels are avoided, and emissions of carcinogenic VOCs from vehicle transportation have been reduced to meet acceptable human health risk levels.

- Emissions of **particulates** have been reduced to the extent that harmful ambient air levels are avoided.

- Climate change is being prevented by achieving per-capita **carbon dioxide** emissions from fossil fuel use for transportation consistent with the global protection goals for the atmosphere.

- **Land** surface in urban areas is used for the movement, maintenance, and storage of motorised vehicles, including public transport vehicles, such that the objectives for ecosystem protection are met.

- **Noise** caused by transportation should not result in outdoor noise levels that present a health concern or serious nuisance.

Implicit in the objectives is an admission that there is some "acceptable" risk to public health and ecosystems. Harm from a given amount of pollutant depends both on the amount of pollution and the sensitivity of the individual (ecosystem component) receiving that pollutant. Are we to believe that at even these more rigorous standards, there is no harm to any individual or ecosystem? At any rate, as noted in the Phase 2 report, there are any number of additional factors which could be included and aren't (we note here: water runoff, small particulates of different sources and types, other emittants, etc.). These objectives do not ensure the goal of environmentally sustainable transportation, suggesting that the goal is poorly drafted.

3. Time Horizon

Another issue which goes beyond Rothengatter's work as it is a ground rule on which his analysis was performed, is the question**: Is a 2030 time horizon meaningful for analysis?** I would argue that presently almost nothing could be known about the world in 2030, 32 years from now. All forecasts that far into the future are little but poorly informed speculation. Begin by asking: **Where were we 30 years ago, in 1966?**

What was known scientifically about the environment? It was recognized that pollution was bad for your health. Yet there were almost no air pollution laws or regulations and no restrictions on vehicle emissions. The scientific literature on the magnitude of the health or economic damage was quite sparse. The hole in the ozone layer was unknown (and possibly non-existent) and aerosols with chloro-fluorocarbons were not suspect. There was no evidence that a significant global warming was taking place, though the greenhouse theory had been around since the turn of the century. In fact, we had to go through a period in the late 1970s when many scientists believed that the earth was actually cooling (the so-called new ice age) before we have come to our present "truth" that it is warming.

More significantly, regarding communications, the world has changed significantly in 32 years. In 1966 there was no Internet, no personal computer, no cellular phone. Long distance calls were expensive and rare, dial telephones could be obtained from the telephone monopoly in any color as long as it was black, and satellites were just beginning to serve overseas communication. In the United States there were 3 broadcast networks, color TV was still not in most homes, there were no home VCRs, and there was no cable TV to speak of.

Air travel was expensive, and in the United States, passenger rail services were still privately provided (though losing money). Many cities had private transit buses, which were also losing money. The interstate system was just under construction, with the beginning of an urban freeway revolt, and noises were being made about building new urban subway systems in San Francisco, Washington D.C., Atlanta, etc. The fashion has since switched to light rail. Cars were large and heavy, Japanese cars were considered low quality, minivans and Sport Utility Vehicles were unknown, and pickup trucks were a rural phenomenon. The original VW Beetle was the most popular import (suggesting that some fashions do come around).

Politically, there was a Cold War and a Vietnam War that had yet to peak - the communists ran the Soviet Union from Moscow and capitalists governed the Republic of Vietnam from Saigon. The United States was embarking on Johnson's Great Society Program. The Dow Jones Industrial Average had almost reached 1000 points. No one had heard of OPEC - now we barely remember OPEC. We were still on the Gold Standard.

While some of the changes between then and now could be predicted, I would venture that no one could foresee all of them, and how they would affect particularly environmental and transportation policy.

The time horizon involved in this study is simply too long to be meaningful for accurate forecasting. Wouldn't a more incrementalist approach – 20% of the change between the baseline and EST in 20% of the time (6 years) be more accurate for forecasting, more reasonable for decision-making, and more likely to accomplish something?

While there have been significant technological changes in these 30 years, basic human behavioral preferences have remained remarkably stable in the face of those changes. For instance, take journey to work times, which have been relatively unchanged for at least years. Data for the Washington D.C. area shows that morning commute times remained at 28.5 minutes between 1958 and 1988, and more recent data do not shift the value significantly (Levinson and Kumar 1994). This in the face of the construction of an interstate highway system, heavy rail system, two oil shocks, significant increases in women in the workforce, increased vehicle ownership, continuously rising congestion along with metropolitan growth, and increasing trip distances. This of course is no guarantee they will be such in the future, but it is certainly a better bet to assume that stable factors remain stable and dynamic factors remain dynamic than vice versa. If we accept unpredictable technological change and strong human preferences for certain behaviors, then why would attempts to shape behavior without technological improvements even be considered so far out into the future?

4. Method of Analysis

The method of analysis used is questionable, or rather, I would like to be able to question and challenge, and understand the method of analysis, but most of it is too murky. While forecasting is not science, the method of inquiry should still be subject to many of the rules of science, otherwise it is no better than astrology. The forecast, like any experiment, should be replicable from the reported information. However insufficient detail is provided here to do much with it.

Rothengatter quickly dismisses the conventional techniques of cost-benefit analysis (or cost-effectiveness if the benefits are fixed, as they are here) yet his alternatives of cybernetic and system dynamic modelling are not properly paired against cost-benefit. Cost- benefit analysis is simply a systematic way of combining costs and benefits to decide whether or not a project is economically worthwhile. It says nothing of how the costs and benefits are measured. The measurements still rely on forecasts, and the forecasts can be conducted in many different ways as long as they return something on the same base with which to compare. Forecasts with feedbacks, dynamics, and uncertainty can be used within a standard cost-effectiveness framework. Simply put, a systematic comparison between EST1, EST2, and EST3 requires the use of cost-effectiveness analysis and a comparison with BAU requires cost-benefit analysis.

I agree that system dynamic modelling is too complex and vulnerable to many problems. I thought large-scale models were buried after the failure of the forecasts in the Club of Rome Report and urban models documented in Lee's (1973) Requiem for Large Scale Models.

However the use of Simplified Cybernetic Modelling (SCM) as described here is not conducted scientifically in that the assumptions, data, and methods, are not clearly stated. Hopefully this will be remedied in a final report.

To begin – Rothengatter uses the term "Manual Computer", this seems to me permit assuming the conclusion.

- What is the empirical data forming the relationships between variables? The opinions of so-called experts who may or may not be objective. This is particularly of concern when the experts are not identified.

- Who selected the experts?

- Are all experts weighted the same?

This method, will lead to argument over opinion rather than scientifically researchable fact. I am a positive empiricist, I believe (acknowledging that belief in the scientific method is not necessarily arguable scientifically) a model which purports to represent reality should be open, challengeable, and verifiable. I would like to be able to see the assumptions, accept the ones I have reason to believe are true, and challenge those in contradiction with other information, and see how that changes the results. I cannot do that. While values can be normative, political, and squishy, they should only be used to evaluate whether the results are good, whether the right standard is in place – not whether some consequence will occur given a set of inputs. Forecasts should be objective (independent of the forecaster), what to do with them can be subjective. If assumptions must be made in the absence of real-world data, those assumptions should be clearly identified.

5. Assumptions

A number of broad assumptions are identified:

A1. The goals will be met

A2. Policy actions are exogenous

A3. There are no side effects

A4. The results can be compared with the BAU scenario

A5. Aggregation is possible

A6. The analysis is restricted to economic impacts.

These assumptions are probably necessary for a first cut of the analysis. We must proceed from somewhere. But these assumptions should be revisited after the first cut.

In particular, just because aggregation is possible does not mean disaggregation is. Keep in mind that many feedbacks are ignored, especially policy and environmental. Serious economic consequences can make particular policies politically unpalatable. Also the use of policy bundles makes it impossible to determine the cost-effectiveness of individual policies.

6. Direct and Indirect Impact Assessment

Using a path impact analysis approach, the paper outlines a 7 level direct impact assessment method. The indirect impact assessment encounters a major problem. It models the interaction between micro effects on the meso world (aggregation) which is acceptable. It also models the effects of the meso on the micro (disaggregation) which would seem to cost the micro analysis all of its precision and leave us to wonder about the accuracy.

In brief, data analysis is only as good as the least reliable measurement.

7. Preliminary Application

The results of the application are not promising. The report indicates that a major factor in the behavioral shifts is education and moral persuasion. In wartime people can be persuaded to make temporary sacrifice (failure to do so risks community approbation). In peacetime in an open democracy, people are self-interested. People can be persuaded to do things that are not significantly costly or inconvenient - things that don't require out of pocket money or waste time. An example is recycling – which has high compliance in places with curbside recycling. An example of failure is the marketing of carpools and especially transit, which only a small fraction of the American public will use.

I suspect that in the long run, and we are talking 32 years here, more is to be gained from technical shifts that accommodate human preferences than from behavioral shifts.

The report indicates that car costs increase 100%, trucks 175% and air travel 600%. The results indicate only a 5% loss to gross domestic product compared with BAU, less if you internalize externalities.

- Is this reasonable?
- Is policy really exogenous with this magnitude of shift?
- Does this include the bankruptcy of Airbus, Daimler, Opel, VW, BMW, etc.?
- How are exports treated?
- Is the world behaving BAU and Germany EST or is everyone EST?

While money is generally accounted for in national accounts, time, especially non-monetized time, is often not. More time commuting means less discretionary time for all sorts of activities (travel and otherwise). This effect on quality of life might more than offset the perceived benefits of marginally cleaner air. In this scenario every industry would need to locate on railway or face significantly higher shipping costs.

- Is traveller's time valued at all?
- Won't reliance on transit and trains increase point-to-point and average travel times, even after relocation?
- Won't just-in-time production become very costly?

It is a very rosy scenario, a cleaner world and hardly any economic impacts, and those impacts spread out over such a long time that no one would notice anyway. All this without having to assume a major technological transformation. Unfortunately, it seems implausible given the magnitude of the disruption to the transportation sector.

8. Concluding Questions

In summary, in developing my discussion of Rothengatter's Economic Assessment of Environmentally Sustainable Transportation it turned out that I dissent from the project. I challenge the absolutist way Environmentally Sustainable Transportation has been defined. It is clear that the pragmatic operationalization of EST that has been provided is inconsistent with the absolutist goals of Environmentally Sustainable Transportation as defined.

However, if we take the operational objectives as given, then we can look at the report. The economic forecasting exercise is doomed from the start due to its incredibly long time frame, 32 years and its incredible complexity. I suggest there should be a conference in 2030 looking back at this research? More seriously, I suggest that a smaller chunk of time (say 6 years) and smaller chunk of change (say 20% of the way from here to the operational objectives of EST) be modelled.

Unfortunately, key details of the forecasting methodology are not provided, leaving me to conclude that the process does not follow appropriate standards and practices of scientific method because it is not open and it therefore is not replicable. That said, the results seem (and since they are not replicable, I must rely on perception) implausible. Such radical changes in travel behavior, which are the natural consequences of such harsh changes in the cost of travel to users, seemingly leads to almost no change in the gross domestic product forecast by Rothengatter. I have my doubts.

Reducing the environmental externalities of transportation is a worthwhile goal. Providing safe, clean, and efficient transportation is a worthwhile goal. Providing accessibility is a worthwhile goal. However, the

analysis must recognize up-front the tradeoffs between achieving accessibility to the activities that constitute human existence and purity of the environment. The appropriate framework for this determination is comparing benefits and costs of alternatives, where we include both private and social/environmental elements in the comparison. It is then reasonable to argue about the economic values of the environment versus travel time and cost (is 1 ton of Carbon emissions spewed into the air worth $1, $10, $100, $1 000, or $1 000 000). Alternatively, if we set specific standards, it is reasonable to debate the costs and benefits of technological vs. behavioral approaches. While I believe history favors relatively more reliance on technology than posited by EST3, I understand that others differ. I also believe that by setting the prices right, and establishing a coherent set of property rights, the market will solve the problem; but again, those with a more favorable attitude towards the wisdom of central planners will disagree. Nevertheless, in the absence of an open, documented, and replicable forecasting process, all conclusions from the report are suspect.

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HOW TO SUSTAIN ENVIRONMENTALLY SUSTAINABLE TRANSPORTATION INITIATIVES?

A Reaction to John Adams's Assessment of the Social Implications of OECD's Environmentally Sustainable Transportation and Business as Usual Scenarios

by

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1. Introduction to Two Modes of Transport Politics: Constraint versus Transformation

John Adams presents a thoughtful and thought provoking assessment of the social implications of scenarios developed by OECD's Project on Environmentally Sustainable Transportation. There are at least two ways to react to his interpretations in an attempt to expand their insights. One approach would probe his claims based on the empirical variation among nations and regions participating in the EST project. While there are real economic, political, and social differences between the EST project participants and the British context from which Adams develops his analysis, I do not feel qualified to draw out such distinctions without undertaking substantially more research than the time frame for this response allows.

The alternative viewpoint that I will apply to Adams's analysis is rooted in a different disciplinary perspective on life - politics. Politics, and the administrative organisations that translate political will into public policy, are ubiquitous in the transportation sector, as well as in the economic and social policies that structure demand for transport. To invoke the postmodern truism that "Everything is political" in this case, I would ask the reader to quickly reflect on transportation policies and project decisions that are most familiar to her or him. Did any of them occur without a conflict over the distribution of benefits and burdens that would arise? Did any of them escape debate about what government's role should be in the finance, operation, and regulation of various mobility options? And did the resolution of those differences not demand a departure from the technical and economic analyses that initially framed the policy or project?

Whenever and however government is involved in transportation and communications, alternative views of the public interest are invoked, deliberated upon, and then sanctioned under the authority of local, regional, national, and increasingly international governing bodies. Our gathering in Ottawa to consider the economic and social implications of sustainable transportation rests upon a political foundation of the debates and decisions that launched the OECD's EST program, and that have structured it's development up to and including this event. Politics thus represents the black box through which technical and economic analyses of transportation options must pass, and are usually transformed, on their way to becoming transportation policy. Environmentally sustainable transportation (EST) will arise by passing through the same political black box that has given rise to the "business as usual" (BAU) scenario.

I hope that my contribution to these deliberations can be to add some political forecasting that will complement the social, economic, and technical backcasting that are being presented. I will do this by distinguishing two modes of political action that influence transport policy, or indeed any policy area. I label one of these the *politics of constraint***.** The politics of constraint is an integral, if implicit, part of OECD's BAU scenario. It represents an authoritative enforcement of what economist Douglas North has termed a "lock-in," a set of ideas, interests, and institutions that mutually support one another and make it extremely difficult and costly to break away from behavioural or technological patterns (North, 1990). An example is the predominance of petroleum fuelled engines for automotive power. At the turn of the century, gas and diesel engines were roughly equal in use to two other sources of automotive power, steam and electricity. But at some point, petroleum powered autos reached a critical mass that locked in this propulsion source to this very day. Economies of scale and network effects made it ever harder to use a car that was powered by anything other than gasoline or diesel fuel because of the cost and availability of alternative fuels. Even California's regulatory efforts to force electric propulsion technology back onto the automotive market and futuristic appeals to embrace the hypercar have made little progress against this lock-in. Hybrid powered vehicles are making the most headway toward introducing alternative propulsion technology because they innovate within the lock-in (by keeping a gas engine in the design).

The other political dynamic that I want to focus on is the *politics of transformation*. This mode of deliberation, debate, and decision-making is implicit in the EST scenarios, because it involves reconfiguring ideas, interests, and institutions to enable a decisive break with BAU. This break would require a policy paradigm shift that goes beyond incremental adaptation of existing ways of doing business. Paradigm shift demands more than adopting new means toward existing ends, an extension of the policy lock-in exemplified by much of current North American research into "Intelligent Transportation Systems." Instead new goals have to be embraced, or at least accepted, and then sanctioned by the governments of the day. Sometimes, the politics of transformation are played out in the electoral arena, such as when Margaret Thatcher won power in Britain by campaigning on a platform of new economic goals which she proceeded to implement (Hall, 1993). At other times, more specialised communities of diplomats, technical experts, and organised "stakeholders" define new policy goals and objectives through collective deliberation and negotiation. The Montreal protocol on the protection of stratospheric ozone, which is leading to the phase-out of CFC's is an example of such a paradigm shift. What both shifts have in common is that the politics of transformation were operative - either in the media, public debate, and at the ballot box or in the meeting halls of scientific conferences and backrooms of international negotiation. These two perspectives on what keeps policy stable for long periods, and what then can changes it suddenly, will hopefully suggest how Professor Adams's "imaginative speculation" on the social impacts of EST might actually come to pass. If nothing else, it will extend Adams's range of imaginative speculation further toward the political.

2. Sorting Out Means and Ends in Transport's Impact on the Social Fabric

If transport constitutes the thread making up our social fabric, then what the garment will look like still depends upon both the expectations of those who wear it and the capacity of those who produce it. Economists remind us that transportation is a derived demand, that it depends on where people want to go and on what goods and services they consume. When seeking to make sense of the gulf between the BAU and EST scenarios, I think that *one must ask whether the transport sector is the place in our economy and society where it is feasible to launch a decisive break with business as usual*? Both the OECD scenarios and the Adams assessment are silent on whether the changes being envisioned would originate as transport policy innovations, or whether they would arise as innovative reactions to changes in other areas of the economy and society. While the relationship between supply and demand in transport is certainly complex, as illustrated by the intricate models that connect land use and transportation, its political dynamics are more straightforward. Most of the time, operating under the politics of constraint, transport

policies and projects, get advanced and adjusted based upon their fit with other policy agendas. To paraphrase another economic expression***, under the politics of constraint, transportation is a policy taker, not a policy maker.*** Based on my own experience, too many transportation specialists inflate the influence of transportation on society at all times, and thereby miss the very real and decisive influence that transportation can have on society at specific moments in history.

As each of us focuses a good part of her or his professional life on transportation, sometimes motivated by and sometimes resulting in a fascination with the dynamics and techniques of mobility, there is a natural tendency to consider transport as a decisive influence on business, culture, and spatial relationships. New transport technology, or innovative operating schemes are seen to have a direct and powerful influence on the social fabric. And if one views change at a sufficiently aggregated level, these results appear to be confirmed. But if one looks more closely, many technical breakthroughs and innovative organisational practices in transport don't yield an immediate transformation of mobility patterns.

In aviation, the long range passenger jet arrived in 1958, and the "jumbo jet" entered service in 1970. Although today's aircraft are quieter, more fuel efficient, and more automated, their essential speed and capacity characteristics have changed little since the early 1970s. Seen from within the transport sector, these technological breakthroughs appeared to cause rapid and dramatic change as evidenced by the decline of the passenger ship and train for long distance travel. But the policy environment in which these technical advances were introduced was one of constraint. Airlines were, for the most part, direct extensions of government through public ownership. And air transport was also heavily regulated. The very few carriers which did not face either constraint (e.g., airlines like Southwest in Texas and Pacific Southwest in California which were private **and** exempt from U.S. Civil Aviation Administration regulation because they operated within a single state's boundary) succeeded in marrying new technology with a new policy paradigm - that of considering air travel as a mode of mass transportation.

But the large scale explosion of mobility by air (both passenger and freight) would have to await a different political dynamic - one that was part of a broader economic transformation to less restricted and more wide ranging economic activity. Airline deregulation and privatisation was part of a larger trend of market reforms that have intensified global finance, trade, and commerce, into what we now know as "globalisation." It is globalisation, and not breakthroughs in aerospace technology or airline management which have triggered the most profound changes in our use of air transport. Technological innovation was necessary, but not sufficient for this transformation of aviation into a mode of mass transportation.

Looking within the political black box more directly, I can offer you two examples of how the Clinton administration has dealt with America's transportation through the politics of constraint over the last six years. In a speech I heard earlier this year, Lester Thurrow reported on his attempt in 1992 to persuade the incoming Clinton administration to make transportation innovation a top policy priority. Thurrow's argument was that enhancing American transportation infrastructure - from intermodal airports, to high speed trains, to "intelligent" highways was a policy package that would achieve positive results within a four year period, contributing to the President's re-election and strengthening his support in Congress during a second term. Thurrow's advice was dismissed because transportation was not seen as the domain from which to launch a "New Left" realignment of American public policy that Clinton then thought possible. Transportation reform was too mundane to lead off the transformation that Bill Clinton had in mind. The President launched his major transformation initiative in health care, expended a lot of political capital in a failed effort, and saw the Republicans win control of the Congress which is now deliberating on removing him from office. But even in hindsight, it's doubtful that President Clinton would choose transportation reform as the policy initiative that would have put his administration on a more successful course than the present one.

To take another example, in the past three years, I have been peripherally involved in efforts to reform America's intercity rail passenger carrier, Amtrak. Congress, Amtrak's management, its workers, and a range of experts were engaged in various aspects of "reinvention" (Perl & Dunn, 1997). The process became increasingly contentious, as American political institutions tend to draw out adversarial conflict over policy. When the need for leadership by the executive branch became apparent, the Clinton administration resisted pleas for intervention. Amtrak was characterised as a "political pygmy" by sources inside the administration, who claimed that reforming this underperforming component of the U.S. transport system was too modest a task to merit the expenditure of political capital.

These vignettes are not meant to suggest that transportation policy cannot make a decisive break with "business as usual" or even that transportation cannot lead certain initiatives toward sustainable development. What they are meant to suggest is that *efforts to advance EST initiatives beyond the politics of constraint must disaggregate the varied economic and social implications with an eye toward finding - and facilitating - a fit between moves toward sustainable development in society and the introduction of new behavioural and technical innovations in the transport sector*. Occasionally, those within the transport policy community - the organisations and stakeholders engaged in transport - have the keys to unlock the politics of constraint. Sometimes, the transportation sector can introduce new ideas and align a new set of interests that reshape society. But at other times, the key is held by those engaged in transforming other domains, and the policy paradigm shift that could make transport more sustainable must be detected and reacted to. To paraphrase the Israeli formulation of its nuclear weapons strategy***, the transport sector should not be the first part of society to launch sustainability initiatives, but neither should it be the last to do so.***

Before leaving the politics of constraint as a mode of addressing transportation and its socio-economic impacts, it is worth recognising that change is not impossible under these circumstances. Incremental adjustment of transportation policy does occur. An example of such incrementalism that focuses on transportation behaviour are the efforts that are often labelled "Transportation Demand Management" or TDM. I have heard more than one cynical transport professional refer to TDM as "Tinkering and Diddling Around the Margins." Another manifestation of change within the politics of constraint is the support of research and development initiatives. Much of this effort is focused on technology, but some (including the OECD's EST effort) takes a more strategic focus. Under the politics of constraint, it is safe to conclude that the substantial changes in behaviour and technology that are called for in the EST scenarios will not occur, even with incremental adjustments and modest experiments that remain grounded in the goals of "business as usual" activities.

What does it take to launch the kinds of fundamental change in the transportation sector envisioned by the EST scenarios? Professor Adams's three questions to gauge (and focus) public opinion on alternative mobility goals will definitely not suffice. Under the politics of constraint, public officials would (and do) proceed no further than confirming that almost everyone would like a car and unlimited air miles. Emphasising the widespread desire for greater mobility as a starting point for EST deliberations is to invite politicians to perform what Sir Humphrey Appleby (the Whitehall mandarin in "Yes, Prime Minister") once termed a "courageous act." When I lived in Toronto, the chairman of the Toronto Transit Commission performed such an act by suggesting that motorists in the greater Toronto area pay a $25 surcharge on their vehicle registration to support public transport. He received death threats for this contribution to transport policy. There is a time and place to raise the issues that follow from Adams's second and third questions about the consequences of universal mobility and the desire for alternatives to auto dependence, but these must be chosen strategically. At a minimum, reversing the order of these questions is needed to focus society on the gains form alternative mobility options and the costs of BAU *before* tempting people with the illusory vision of unlimited mobility. What follows are two scenarios that would make it possible to translate Professor Adams's "Green Transport Club" experiment into a new policy paradigm.

3. A "Top Down" Perspective on Sustaining Sustainable Transportation Initiatives

A new policy paradigm, meaning a new definition of society's goals for mobility, will require the embrace of new ideas that stem from sustainable development principles, the alignment of new interests that identify these ideas with economic and social gains, and the design of new policy institutions which can implement sustainable mobility policies. Such an outcome places the EST scenario squarely within the politics of transformation. The history of political revolutions demonstrates that transformation can come from either above or below. There is no reason to think that EST could not be attained from either direction, which leads me to imagine a "top down" scenario for transformation, followed by a "bottom up" one.

Potential triggers for top down transformative politics can be found in several policy domains beyond transportation. The three most common motivations to redefine transportation policy paradigms from above in this century have been military security, economic security, and (more recently and partially) energy security. Of these three, economic security seems the most imminent potential trigger for policy transformation, given the current turmoil on world markets. Professor Rothengatter has estimated that the EST scenario could reduce material consumption in Germany by around 3 percent and decrease employment by 1.5 percent compared to the BAU scenario. Under the politics of constraint, such a projection would make EST a non-starter. But given the recent fragility of BAU, and attendant uncertainty of whether it will deliver promised levels of growth, an opportunity exists to link EST initiatives with whatever new strategy emerges to combat the economic ills of globalisation. If the BAU scenario - as manifested in today's global recessionary trends - appears even worse than the slow, but sustainable, economic growth exhibited by the EST scenario, then a link between economic reform and EST could be forged.

Previous examples of policy transformation in which transportation embraced a new role that supported economic security can be found in the 1930s when the U.S. expanded the federal-aid highway program that built the Interstate Highway network's predecessor and Germany created the *autobahn* network. Much of Western Europe's rail network was modernised after the Second World War with Marshall Plan funding justified by economic security. But the EST scenario calls for a more complex linkage between mobility and economic renewal, one that uncouples mobility from economic growth. Toward that end, *efforts in assessing the impact of BAU must specify the short and medium term economic burdens that auto dependence and aviation over-reliance place on a fragile world economy.* If BAU in transport can be shown to make unproductive use of resources, and impose direct and external costs that sap economic efficiency, then the economic transformations that are currently under consideration could be linked a new transportation policy paradigm.

Transformational politics that breaks with the BAU transport paradigm is most likely to be played out at a macro level through international policy networks that extend well beyond those which usually address transportation and environmental issues. In the public sector, finance ministers, central bankers, and world trade regulators will need to take account of the policy alternatives within the EST scenario that complement their changing agendas. Private interests, ranging from corporations who can manufacture efficient transportation and communications technology to banks and insurance companies that come to associate BAU with lower profits and higher risks, would also need to identify opportunities in an EST policy paradigm. *In this "top down" perspective, corporate and government leaders would open the door to a policy paradigm shift in transportation by incorporating it into a larger strategy for short term economic stability leading to long term sustainable growth.*

The same mode of consideration by international policy networks centred on military or energy security could similarly enable a policy paradigm shift in transportation, if either of these domains were to focus on transportation as a key component of global restructuring. But if these top down approaches fail to invoke

the politics of transformation in the transport sector, a bottom up dynamic could also trigger policy change that is inspired much more directly and immediately by the shortcomings of BAU in transport. Professor Adams's analysis notes that some progress has been made in limiting auto dependence in European cities like Amsterdam and Copenhagen, but that these efforts have done little to stem the BAU trend in suburbs and exurban development. This dichotomy is not coincidental, which leads me to draw rather a different conclusion about the gap between urban and suburban/exurban transportation trends. Rather than focusing scare political capital directly on reducing the auto dependence outside cities, as the author suggests, I propose considering how the urban policy networks that have achieved some success, albeit limited, in restricting BAU might be empowered to launch transformational politics that build a new policy paradigm inspired by EST from the bottom up.

4. A "Bottom Up" Perspective on Sustaining Sustainable Transportation Initiatives

In the course of my involvement with the European Union's COST Action 618 project, "Institution Building for Urban Air Quality Management," I have become familiar with certain local policy initiatives that seek to make urban transportation in Canada, France, Italy, and Switzerland more sustainable. These findings are presented in *The Politics of Improving Urban Air Quality* (Grant, Perl, & Knoepfel, 1999). This work has persuaded me that it is possible to build a policy network that can launch the transformative politics needed to break with BAU, if such a network originates in an urban area and grows to embrace a metropolitan region. Cities offer fertile political soil in which to nurture a transportation policy paradigm shift because both the economic and social costs of BAU are most concentrated there***. Long before BAU would generate global costs that are, in themselves, sufficiently ominous and pressing to focus policymakers on the need for a transportation paradigm shift, the economic and social costs borne by residents of the world's major cities (in developing nations as much as OECD members) would reach a critical mass that spurs movement beyond the politics of constraint.*** By linking organised interests which overlap in urban areas, it is possible to mobilise a policy network to adopt the EST scenario as a new set of goals.

Experience shows that even before the air pollution from urban transportation triggers a public health crisis (e.g., this July's smog episodes in Southern Ontario), a wide range of more or less visible social costs will have already built up. Some of this "collateral damage" will be perceived as more problematic, and thus deserving of more immediate action, than the localised human health degradation and global environmental damage arising from BAU. Thus the "bottom up" approach to sustaining sustainable transportation initiatives would emerge from a policy network that first recognises BAU as the cause of related urban ills including congestion, air pollution, safety, overtaxed public finances, discrimination, equity, and the quality of life (Knoepfel, Grant, & Perl, 1999). Taken together, the range of these burdens can mobilise support for a transport policy paradigm shift based on a new respect for property rights - both the rights of private proprietors of urban space which vehicles traverse and the trustees of commonly held resources such as clean air, civic culture, and public safety. Indeed some of the most celebrated deviations from BAU in urban transportation arise from urban highway revolts in which citizens reclaimed their rights to public property that was going to be consumed by the automobile.

The legal definition of most transport infrastructure, and particularly urban road infrastructure, assumes that this property is a public good whose use cannot be restricted and whose supply should thus be expanded to meet travel demand. These public good assumptions also imply that no one's use of urban road space will detract from any other use of that space. But this central premise, which informs the BAU doctrine of "solving" the problems arising from urban mobility by supplying more infrastructure for yet more mobility, turns out to be defective. In actual fact, both traffic congestion and the exclusion of non-motorised traffic (e.g., bicyclists and pedestrians) demonstrate that road infrastructure is not truly a

public good, but at best a mixed good, and in many cases even a private good being supplied at public expense.

By accepting unrestricted "first come, first served" automotive access for urban roads, and enforcing the restriction, and even exclusion, of non-motorised transport, the state implicitly advances the mobility interests of certain drivers and land owners over others, as well as over bicyclists, pedestrians. The same is true for safety, clean air, community life, and access to work, health care, and even fresh food, even though the property right attributed to one user group (travellers and shippers using public roads) to the detriment of others (inhabitants suffering from accidents, air pollution, or exclusion from economic and social life) is much less visible and more difficult to communicate. According to this simplified application of institutional economy to the inequities arising from BAU, *the new transportation policy paradigm will have to define new and more realistic categories of mobility rights and responsibilities within urban areas.* This redefinition will entail a major redistribution of rights to redress the current imbalance between concentrated private gains and diffuse, but mounting, public burdens from BAU mobility levels.

If urban mobility were to be reconceived as an amalgamation of more or less private property rights instead of being a public good, the attendant need to reconcile competing claims would focus a broad range of interested parties on the potential for a paradigm shift. This community would be composed of both the *de facto* owners of property rights which currently govern urban mobility, as well as those citizens who are negatively affected by these current "rules of the road" through pollution, risk, and restricted economic and social opportunities. The deliberation over new roles and responsibilities would engage the following policy actors.

The state itself through *local, regional, or national governments* functions as the primary owner of transportation infrastructure (e.g., roads, railways, parking spaces, transportation terminals, etc.). Public officials and civil servants would face significantly changed expectations of how their role in transportation policy should advance the public interest. Joining the public sector's deliberation over new goals for urban mobility would be *private corporations* that also supply transportation infrastructure through building and running facilities such as highways, tunnels, bridges, and even metros, light rail transit (LRT), and tramways (e.g., Hong Kong and Singapore). Collecting the user fees needed to support private management of transport infrastructure would be facilitated by this property rights approach.

Public transportation agencies would take part in these politics of transformation because of its potential to revitalise their declining market share**.** ***Private car owners*** are the most common "consumers" of urban transportation infrastructure and, as the death threats to the Toronto Transit Commission's former chair demonstrate, would make their views known. Car owners would serve to link political jurisdictions in the deliberation over a new paradigm since the drivers who become part of urban traffic may come from the city, the metropolitan area, or even farther away. These car owners are also the most numerous "producers" of urban mobility externalities since the fuel and vehicle taxes they pay do not cover the full costs of noise, accidents, pollution, and capital investment in road infrastructure.

Public or private parking space owners lease the right to store vehicles on prime urban land on various terms. The prices charged, and the distribution of parking supply can have a decisive impact on the efficiency of urban mobility. *Urban land owners* more generally have a major stake in the terms of urban mobility. Easily accessible urban land commands an economic premium as the development around urban metro stations or suburban highway entrances and exits demonstrates. At the same time, transportation infrastructure that passes through, or near to, property without improving access can reduce its value by bringing externalities (e.g., noise, fumes, physical isolation from other property). From homeowners to big corporations and real estate holding companies, property owners pay close attention to transportation planning because of its influence on their assets.

Local or regional environmental agencies exercise public powers to limit pollution through regulation, inspection, and reporting on the state of the environment. For the most part, these agencies have been called upon to take stewardship of degraded air, water, and land resources long after the public good concept had been entrenched as a cornerstone of urban mobility. Once the "right" to pollute excessively had been handed out to urban drivers, these agencies were given the unenviable task of reasserting public authority to limit the unequal distribution of damages (e.g., protecting the young and elderly who are less mobile and more harmed by air pollution).

Taken together, these (and other) organisations engagement in a reconceptualisation of urban mobility goals would offer the strongest possible impetus for breaking out of the politics of constraint. Sustaining that transformation to the point of realising the new policy paradigm would also require a new institutional framework to govern sustainable urban mobility in the way that existing administrative, fiscal, and political arrangements now govern BAU. A new institutional framework of rules and norms that would have to fulfil at least four conditions.

First, a multistakeholder forum would have to be created to include pre-existing or new organisations take responsibility for five key policy components of sustainable urban mobility. These include: public roads (ownership, construction, maintenance and management of transport infrastructure); traffic police (regulation of access and rules of the road); land use planning (integration of transport infrastructure into the overall scheme of urban development); public transportation planning (development and management of public transportation infrastructure and operation), and environmental management (preservation of natural resources such as clean air, water, and land). A second organising principle ought to be trans-jurisdictional institutional arrangements. Experience shows that effective urban mobility management cannot be limited to the administrative jurisdiction of the central city, but must be extended to the whole metropolitan area. Crossing jurisdictional boundaries does not automatically imply amalgamation or integration into regional bodies. The cumulative policy capacity of organised actors throughout a region may be greater if existing organisations work together, rather than being reformulated into a new structure. The institutional structure behind an EST policy paradigm may thus look more varied in urban areas than the one supporting BAU.

A third organising principle for institutionalising EST is the creation of multipurpose political-administrative arrangements. Although this paradigm shift will embrace the single and overarching objective of sustainable urban mobility, this goal will spread into other policy domains, as noted above. Each of these is associated with a specialised knowledge base, which can create a varying number and configuration of policy subcommunities. As with BAU diverse interests will likely accept a division of labour and specialisation of tasks in making the new approach work. And because of this great diversity of policy participants, their range across multiple jurisdictions, and their reliance on specialised functions, a high degree of horizontal and vertical integration will be called for. The utility of highly integrated political and administrative arrangements is demonstrated in the locations which have made the most progress in articulating BAU alternatives to date.

The final, and by no means least important, ingredient for a successful policy paradigm shift in urban mobility, is a decision-making process that incorporates input into transformation by democratic means. The inevitably redistributive character of EST initiatives will require an institutionalised autonomy for implementation, in that at the end of the day some interests will gain new benefits while others face new burdens. The only foundation that is strong enough to support such an exercise of power is a solid and legitimate democratic base. Obtaining that legitimacy will call for making sustainable urban mobility an explicit political issue, both through referenda on key policy instruments (e.g., user pay schemes like marginal cost mobility pricing) and in campaigns for elected representatives who will carry through EST initiatives.

Following this idealised transformation of the urban mobility paradigm, Professor Adams's three questions would likely elicit the embrace of EST principles. But we are a long way from that point in time. Some will see the bottom up policy paradigm shift sketched out at the urban level as possible, but too limited to attain EST on the scale posed in the OECD scenario. In response, I would suggest that an urban mobility paradigm shift offers an opportunity for EST goals to be demonstrated in ways that could either broaden the bottom up mode of policy transformation, or facilitate linkage with top down initiatives in other policy domains.

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