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BUILDING BLOCKS FOR SUSTAINABLE TRANSPORT

Obstacles, Trends, Solutions

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BUILDING BLOCKS FOR SUSTAINABLE TRANSPORT: OBSTACLES, TRENDS, SOLUTIONS

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Acknowledgement

The foundation for this volume was laid during the project STELLA (Sustainable Transport in Europe and Links and Liaisons with America) funded by the European Commission (Contract GTC2-33019-2000). One of the so-called Focus Groups (no. 4) dealt with Environment, Safety, Health, Land Use and Congestion, in short: the external effects of transport. The Focus Group staged three seminars for which participants submitted papers. From the first two seminars papers selections were made, which — after review and revision — were published in special issues in scientific journals, being the European Journal of Transport and Infrastructure Research (2002, Vol. 2 No. 2/3) and the Journal of Transport Geography (2005, Vol. 13. No. 1). In addition the Focus Group co-chairs, Veli Himanen and Martin Lee-Gosselin, and the scientific secretary, Adriaan Perrels, produced a few overview papers, which were published in Transport Reviews (2004, Vol. 24, No. 6) and in the European Journal of Transport and Infrastructure Research (2006, Vol. 6, No. 1). This book started from a set of contributions of the third Focus Group meeting in 2004. During the process selected papers were reviewed and updated, while along the way some other papers were added.

We like to thank all the contributors of the three Focus Group meetings. The material of over 40 papers and the interventions of other participants during the meetings were of great value to shape our views of sustainable transport and of the research still needed to further the realisation of sustainable transport.

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Preface

It is clear that transport is an important element for the well-being of society. We need to get to work, to travel for business and pleasure and to deliver the products that in large measure determine our lifestyles. Efficient transport systems are essential for keeping economies competitive and improving the quality of life for communities and citizens.

The transport system is a very large and complex system, with global, continental, regional, national and local needs and networks connected to each other, and many separate decisions of individual actors with different goals influencing the nature of the system and its effects. There is a challenge to meet those needs and to find a balance between the benefits and negative effects of transport.

Our increasing demand for transport has created problems that threaten our mobility. Every day thousands of kilometres of European and North American highways are blocked by traffic jams. Congestion adds an extra bill to our economies. Every year over 40,000 people are killed and more than 1.7 million are injured in road fatalities in Europe, and remarkably similar totals are experienced in North America. Important environmental issues including climate change, noise, urban sprawl and land fragmentation are closely linked to traffic volumes. Future oil prices, global climate change and population demographics pose challenges which require mobility which is environmentally, socially and economically sustainable.

Many sectors of society, administrative systems and cultural traditions as well as lifestyles affect transport demand and solutions. That is perhaps one reason why there is no single interpretation of sustainable transport, in spite of the fact that political decisions and strategies have frequently noted that transport must be a key contributor to sustainable development.

Research in transport has a long and impressive history, particularly of course in transport engineering, including design and development of technologies and materials that have provided the vehicles, craft and networks that have allowed spectacular increases in mobility of people and goods over centuries. Transport economics, while a younger discipline, has a history of at least two centuries. In this time span it attempted to understand transport behaviour in many different ways and to design institutional settings for infrastructure and services that enable viable enterprises and create sufficient benefits to justify public expenditures. Recent decades have seen an enormous expansion of transport research and an evolution into other branches of the physical and social sciences, with major contributions to understanding behaviour of individuals and companies, interactions between land use and transport, and systems of management and governance of all aspects of transport networks and services. Researchers in many different disciplines have become involved, and interactions among them have flourished. And relationships between researchers and government agencies have evolved, as the latter have sought greater insight into policy development and integration. The results of these interactions and relationships are evidenced in the increasing attempts of governments to apply policies based on sound research evidence and advice of researchers.

Within the community of researchers, the potential is still being developed, as researchers have recognised the possibilities for collaboration and integration of results. This volume presents the results of some of this collaboration, among researchers in Europe and North American, offering insights into the future of transport systems, and policies necessary to achieve sustainable development. Europe and America have many similarities in their societies; economic prosperity, good transport networks, strong car industries, extensive transport research. But they also have important differences, in the sharing of roles between the public and private sectors, in urban structure, and the shares of public and private transport modes. These similarities and differences provide fruitful grounds to share experiences, to learn from each other and find best practices and key elements for workable solutions for sustainable transport. Learning from each other and closer contacts between researchers and policymakers were the initial impetus behind the STELLA Transatlantic Thematic Network (Sustainable Transport in Europe and Links and Liaisons with America) for which the institutional framework was created by European Union funding. This book is based on that co-operative work of European and American researchers and policymakers. The results make it clear that this kind of co-operation should be encouraged to aid the development of integrated transport systems to meet future economic and social needs.

John Lawson, Ottawa
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Chapter 1

Introduction

Adriaan Perrels, Veli Himanen and Martin Lee-Gosselin

1.1. Framing the Themes

Prior to the coining of the term 'sustainable transport', transport economists were commonly referring to the 'external effects' of transport. The latter concept is important as it is still the cornerstone of many policies and measures that deal with a particular external effect of transport, such as traffic noise or traffic collisions. However, on the basis of the sets of STELLA seminars and discussion papers that dealt with external effects of transport, and more generally with transport and sustainability, the editors took the view that the development of sustainable transport requires a more comprehensive theory, toolbox and policy design than the management of external effects. As a sustainable transport policy portfolio will still encompass the handling of external effects, but goes beyond it, we first introduce these external effects and subsequently make the step to sustainability requirements and their implications for the design of transport policies. The external effects have to do with interactions of the transport system with environment, safety, public health, land use and congestion. In all cases, except for land use and — under certain assumptions — congestion, the external effects are on balance negative, meaning that the causer of the effect does not pay (full) compensation to those who suffer from it, regardless of whether the sufferers are inside or outside the transport system.

In the case of land use both positive effects (accessibility) and negative effects (loss of functionality) occur and it depends on an intricate mix of factors whether on balance the contribution of transport for land use in a certain area (and time span) is positive or negative. The standard case is that better access has positive effects on land use, and hence on land value, because the number of alternatives for using the land is increasing. A highly accessible area will have high land values, and thereby a selection process has started that should weed out activities that have low productivity per unit of surface area. Furthermore, the consequently high densities

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and intensive traffic will increase negative spillover effects, making it less functional for some types of activity. Nevertheless, congestion can still occur as an inherent rationing system for transport infrastructure. Congestion charges can diminish congestion and allocate access, notably to the most productive activities. Yet, the extent to which congestion charges actually raise welfare compared to untreated congestion depends on the induced effects of relocation of activities, and of the pass-through of congestion charges to the prices of products and services.

Improved access may have also negative effects at the other end of the spectrum, i.e. in areas with hitherto limited access and limited endogenous market potential. In these circumstances, improved access may result merely in increased export-oriented natural resource extraction and in outflow of labour force to the core area (notably the most talented). This special case is also known as the Voigt effect (Voigt, 1973) and re-introduced in the framework of core-periphery dynamics via the new economic geography literature (e.g. Fujita, Krugman, & Venables, 1999).

The emergence of negative impacts can be studied in the light of subsequently evolving transport problems (see also Dugonjic, Himanen, Nijkamp, & Padjen, 1993). For this purpose transport problems are subdivided into three categories, being *traditional*, *modern* and *post-modern*.

The traditional transport problem — how to get from one place to another — is related to the nature of human activities. The current-day solution for the traditional problem has been the provision of large-scale transport networks with huge volumes of circulating vehicles. This has resulted in the modern transport problem with a large number of accidents, and substantial but dispersed environmental impacts.

The post-modern transport problem can be characterised by two dimensions, namely: the rate of congestion and the degree of sustainability. In densely populated societies it is ever more difficult to provide new capacity for heavily used transport systems, i.e. current congestion cannot be alleviated by traditional means. The post-modern congestion problem can also be seen as a conflict between two countervailing demands: to provide a robust, predictable level of transport service and to provide unlimited access to activities and services whenever and wherever the 'customer' wants. At the same time, growing demands for sustainable development have expanded the scope of environmental impacts that are attributed to transport — from local nuisances or health and accident risks — to include global issues related to the future of the human condition. With respect to sustainability research has shed new light on some of the local impacts, such as the serious health effects of very small particles.

With the introduction of the term *sustainable transport* a new — post-modern — era of transport policy and its supporting research is entered. Sustainable transport is a more normative notion than the concept of external effect, which arose in connection to the so-called modern transport problem. Admittedly, in order to be able to agree on the existence of external effects one needs to agree on a vision how transport markets work and what market failures imply. Yet, over these issues a general consensus exists. The debates concern application details, such as about accurate compensation levels. Assessments of external effects and their 'optimal levels' also tend to be piecemeal (localised, by type of effect, etc.). Sustainability however is a comprehensive forward-looking concept aiming at the achievement of an overall better state of the society. A 'better state of the society' means a better overall level of welfare for the society, while using a widened concept of welfare, including environmental quality and social justice, which can also be sustained for a long time. In other words, whereas dealing with external effects sort of implies that society satisfies itself with keeping nuisances at an acceptable level, sustainability suggests that we can be truly better off.

In this context it should be added that the adjective 'sustainable' is used in different ways. Strictly speaking a system can be termed 'sustainable' when it is in a *sustainable state*. However, in practice the term 'sustainable' is often used while meaning the promotion of a transition towards a sustainable state. So, a sustainable transport policy usually implies a policy package that — at least in some respects — furthers the objective of making transport sustainable, meaning that — *as yet* — the system is not sustainable. A second important difference with the concept of external effects is that sustainability implies not only accounting for social and environmental effects, but also for the economic sustainability of the system.

Sustainability

In public discourses 'sustainability' is often identified with the tensions between economic growth (i.e. the growth of material wealth) and the state of the environment. In this respect 'more sustainable' (than a previous policy) is often understood as ensuring that environmental qualities are maintained even if that would imply some reduction (in the increase) of material wealth. Sustainability has however three pillars, being the economic, the environmental and the social realm, respectively. Expansion in one realm should take care to respect minimum requirements with respect to the other realms. Furthermore, current use of natural and man-made resources should not lead to a decrease of welfare per capita of future generations. Last but not least, the existence of international markets for natural resource use and the occurrence of transboundary environmental problems, such as climate change, acid rain and biodiversity, imply that sustainability and sustainable development need a common understanding and policy framework at the global level.

Within and across disciplines there is a scientific debate going on about the minimum requirement levels for each of the realms. The discourse is often referred to as 'weak sustainability versus strong sustainability' (for an elaborate discussion of the discourse see e.g. Neumayer, 2003). Both sides agree that sustainability can be understood as the guideline that mankind should aim for a way of generating welfare for current generations which does not put at risk the possibilities of future generations to achieve at least the same welfare levels. Adherents of weak sustainability do think that virtually all economically exploited services and products from nature can be somehow substituted either within nature or with the aid of man-made goods and services. The implication of this assumption is that there are no physical constraints to ever expanding material wealth, even though there could be regarding the pace of increase of wealth. In contrast, those that adhere to strong sustainability think that the carrying capacity of ecological systems and of the entire Earth has absolute limits. As a consequence substitutability has its limits as well. Breaking through these limits leads to damage beyond repair, and consequently sustainability policy should be guided primarily by instruments derived from absolute admissible limits to environmental loads.

Different societies and different groups within societies may have different opinions on adequate minimum requirements for each realm. Since transport policy has to operate at several geographical levels, the variation in the valuations of the minimum requirements implies that an actually feasible sustainable transport policy involves a complicated selection from a large range of alternatives.

Current differences in opinion on key issues such as whether a sustainability strategy should be based on a 'weak' or a 'strong' sustainability paradigm, which is exemplified in the divide over the Kyoto Protocol, demonstrate how long the road is towards comprehensive sustainability policies. Furthermore, even when a consensus on an appropriate sustainability paradigm for policy making arises, there is still considerable leeway with respect to the burden-sharing between sectors, and the sustainable transformation pathways that can be chosen.

Sustainability is obviously a comprehensive concept encompassing all sectors. For that reason the assessment of the degree of progress towards sustainability of the transport system has always to be embedded in an assessment of the interaction effects with the rest of society. In summary, a transition towards a sustainable society has a two-tiered implication:

1. The transport system itself has to become appreciably cleaner, substantially reduce its material requirements, be sufficiently productive and should have as few as possible socially adverse effects.
2. The way the transport system functions and the alternatives it offers should enable — or at least not disable — other parts of society to remain within its trajectory towards sustainability.

Whereas the first implication already describes a major challenge for the transportation system, the second one crucially extends and complicates the domain of co-ordination. The transportation system as such could be transformed into a sustainable one in various ways. It depends however on the societal and economic context (point 2) as to which of these alternatives are fitting into the overall system. Even in that case there is probably some leeway, but amendments of (apparently) unfit solutions may become more expensive in social, economic and ecological terms.

The difference between sustainable transport and external effects of transport should be kept in mind throughout this book. Virtually, all investigations regarding the improvement of the sustainability of the transport system will in fact entail the assessment of external effects. Yet, as explained above, understanding the mechanisms behind external effects and the options to contain them only provide building blocks for sustainable transport, but do not automatically result in such a state. Indeed, when we want to make the transport system sustainable we have to deal with the external effects, however the evaluation of the right balance of different effects is of an integrated nature, intending to serve various objectives and covering various dimensions.

1.2. A Closer Look at External Effects

The current catalogue of environmental and health impacts of traffic and transport infrastructure (see also Commute, 2000) may include issues and causes such as:

- climate change (greenhouse gas emissions);
- acid precipitation (pollutant emissions);
- respiratory disease (effects of pollutant emissions and road dust on travellers and roadside inhabitants);
- stress disease (noise, congested traffic);
- promotion of obesity-prone lifestyles (car dependence);
- trauma (collisions between vehicles and people and other large mammals);
- modified plant, animal and aquatic habitats (fragmentation, noise, chemical contamination, road kill);
- biodiversity (loss of habitat, migration of exotic species);
- soil quality (erosion, chemical contamination);
- water quality (chemical contamination, loss of natural filters);
- landscape (cuttings, structures, aesthetics);
- land take (right of way, structures, parking);
- neighbourhood severance (noise, physical barriers, traffic volume) and
- built environment (loss of heritage, loss of pedestrian comfort, aesthetics)

A number of technological responses have mitigated some of the listed impacts. For example, the introduction of catalytic converters in new gasoline cars, together with some other actions, has reduced transport-related pollutant emissions (Chapter 2, Figure 2.4). Despite such achievements poor air quality remains a major problem in European cities (EEA, 2007, notably Chapter 2.2). Road-related emissions per capita are higher in North America, but in many cities downward trends of concentrations are reported for quite some agents (US EPA, 2003), even though the same source also reports a tendency towards an increasing number of days with unhealthy air quality ($AQI > 100$) in many cities.

Unfortunately, greenhouse gas emissions, notably carbon dioxide, cannot be 'cleaned up' with foreseeable technology, and must essentially await the widespread introduction of radically more fuel-efficient propulsion technologies than the current generation of internal combustion engines. It is obvious that a realisation of a sustainable transport system requires fundamental changes in the energy sources and propulsion technologies in order to reduce the volume of greenhouse gas emissions from transport and to break away from the overwhelming oil dependency of the transport sector.

Environmental assessments are still fraught with measurement and cost estimate problems, especially in relation to the ultimate health effects. The political will and ability to internalise external costs of environmental damage in transport investment decision-making vary substantially between countries, but also by type of external effect. For example, for various air emissions, there are reasonable estimates of the eventual contribution to certain types of damage, as well as of the reduction costs (e.g. the EU projects: ExternE: http://externe.jrc.es/reports.html and UNITE: http://www.its.leeds.ac.uk/projects/unite/). However, as regards the effects of traffic noise the understanding usually does not extend beyond the level of (acceptable) nuisance and contribution to various health stress factors. So, in contrast to emissions no (systematic) estimates are available about the eventual short-term and long-term societal cost effects of noise. In general the impacts of internalisation are usually judged to be minor compared to the travel time savings that have been the major driving force in investment evaluations. This is also a policy area where it appears to be extremely difficult to reconcile various interests.

For the improvement of traffic safety the progress in social learning appears to be very important. Societies learn to gradually reduce the incidence of accidents, which tends to rise rapidly in the early stages of motorisation. In EU member states for example fatality rates (per vehicle kilometre) for road traffic were about 4–9 times higher in 1970 as compared to 2000. Yet, at the same time relative differences between countries remain rather persistent as catching up with front-runners appears only in a couple of Member States.[1] While overall traffic volumes increased in the EU member states, the total number of road fatalities halved between 1970 and 2001.

In addition to traffic safety, there is also the issue of personal security — meaning either that potential travellers refrain from travelling during certain periods (or switch mode) due to perceived high risks to personal safety, or the actual occurrence of assaults on travellers. This is a reminder that adaptive behaviour has much to do with the amount and nature of risk associated with transport demand. It is difficult to address the set of safety, health and environmental impact issues, and the ways they interact, without recourse to higher levels of abstraction, such as the cultural driving forces behind the apparently very high valuation of private car ownership and use, and the conflicting desires to minimise restraints on car use while maximising the safety of one's own living environment.

To date, the attempts to steer urbanisation have been at best partially successful and are usually accompanied by unintended side-effects. The debate to what extent spatial planning — including transport infrastructure — has been able to guide regional and urban development or merely facilitate it, is still going on. Progress has been achieved at the local level for traffic flow separation and safe living areas, but at more aggregate levels urban sprawl appears hard to contain or re-emerges in unintended ways.

1. This can be derived from the statistics on transport performance and road fatalities in European Commission DG TREN (2006).

Land use and infrastructure planning has become ever more complex both in terms of the assessment methods applied and in terms of decision-making procedures followed. It even leads to paradoxical situations in which the assessment methods have become increasingly complex due to increased and ever more diverse stakeholder pressures, while eventually stakeholders doubt the assessment results on the grounds of those being based on very complex and (hence) non-transparent assessment systems.

Congestion is a phenomenon linked to all heavily used transport systems. In a way it proves that the system is popular and useful. The cost estimations of congestion are still of unsatisfactory quality and thereby provide unsatisfactory guidance to policy making. The lack of reliable and comprehensive cost estimations is not only a matter of data observation and methodological improvement, but relates at a more generic level to the valuation of time. Next to personal and cultural aspects the value of time is closely linked to the opportunity cost of time and hence with the welfare level of a society. This is a social-economic interpretation, but alternative ones, e.g. sociologic or political, may well be just as relevant. We may question whether the imprecision even matters when in many cases only limited possibilities exist for alleviating congestion. However, the experiments with congestion pricing in London City and Stockholm indicate that it is possible to devise effective real-time pricing systems even if we do not know the total cost. It should be kept in mind though that the London and Stockholm schemes include appreciably more measures than cordon pricing.

It is more complicated to define relationships between all five external effects, even though for a successful sustainable transport policy it will be essential to appreciate the effects together. Lingering beneath the inter-relatedness is the hard-to-resolve conflict between the desire to retain and reinforce the fruits from material wealth and the desire to comply with the requirements of sustainability. Figure 1.1 tries to summarise this inter-relatedness within the framework of the sustainability — material wealth conflict.

In Figure 1.1 'well-being' (and its augmentation) is regarded as the objective to which transport purports to contribute. The arrow running from traffic production

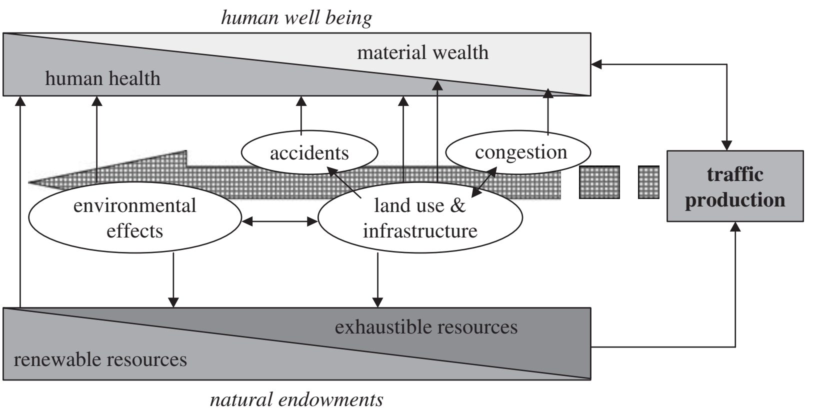

Figure 1.1: Interrelations between natural endowments, traffic production and well-being.

to the joint box ‘human health/material wealth’ denotes the contribution that transport provides to the enablement of (higher levels of) material wealth and better health (via more wealth but also directly by substituting motive power for muscle power). The two components of well-being, ‘human health’ and ‘material wealth’ can reinforce each other, i.e. good health improves the chances to obtain material wealth, whereas material wealth enables to sustain good health levels.

However, misconceived processes to accumulate and maintain wealth, spatially and socio-demographically inequitable distributions of wealth (and sometimes opulence) have negative effects on human health, either directly via the production/consumption systems, or indirectly via natural systems. The external effects of transport, represented by the wide central arrow in Figure 1.1, can contribute to these negative effects.

The benefits of transport appear mainly on the material wealth side, whereas most of its external effects (inside the transport system or beyond) sooner or later affect human health. The external effects of transport can be regarded as an example of misconceived accumulation and maintenance processes, in a way that is similar to the role of infrastructure in accelerating core-periphery developments as an example of a contribution to inequitable distribution effects.

Since transport is so dependent on the availability of physical infrastructure, land use and the way infrastructure has been allotted space (or has taken unplanned space), plays a crucial role. Land use functions more or less like an exchange for many internal and external effects of transport, although the feedbacks and non-linearity are more complex than this mechanical metaphor suggests.

A temporal perspective is important to perceiving the possible interactions between the issues. The production (and consumption) of transport in the short run works directly on each of the phenomena (environment, safety, congestion, land use) separately, since the amount, shape and management approach of the infrastructure is largely given. In the medium term the issues of congestion, safety and environment may already feed back directly into land use and infrastructure management. In the longer run the impacts on health and material wealth will affect the volume, composition and spatial pattern of transport directly as well as via planned and market-guided reassessments of land use practices.

Also, through the impacts on the natural endowment — channelled via environmental effects and infrastructure construction and management — land use and infrastructure will be either affected directly (e.g. in case of scarcity of land) or indirectly through interaction between changes in natural endowments and changes in well-being.

1.3. The Key Challenges

The extensive dealing with the various external effects, their interactions and their role in the requirements for a sustainable transport system brought us to the insight that three key challenges can be distinguished with respect to design and implementation of a sustainable transport policy.

The first challenge concerns the radical changes needed due to climate change, the exhaustion of cheap oil sources and urban air quality in medium-sized and large cities around the world, not the least in developing countries. The challenge is that in the next few decades we have to move away radically from the use of fossil fuels. Admittedly, other — notably stationary — forms of energy conversion and energy use have better short- and medium-term prospects for alternative primary energy sources. For transport, a long-term trajectory, e.g. leading to a hydrogen fuel chain and/or electrically powered road transport seems more likely. This means that, in the meantime, the challenges for transport are: raising energy efficiency, finding the economically and ecologically best possible — and probably limited — role for biofuels, minimising exhaust emissions, application of carbon capture and storage in the remaining fossil fuel chain and ecologically responsible development of non-conventional oil reserves (and of the water resources needed in the process).

For some modes, such as rail, these challenges are easier to accommodate than for others, notably aviation. A further complication is that the transformation of the propulsion systems can succeed only when the transportation system is economically viable. An enforced early large-scale transition towards premature expensive clean technologies, may bankrupt parts of the transport system and/or lead to a standstill in uptake of new clean technologies. However a too lenient policy, born out of fear for unfavourable competition effects on industries, threatens the delivery of sufficiently large changes, which in turn may lead to crisis situations due to extremely high fuel prices or even availability tensions. The other complication is that the transition should also honour social limits to change. Also in this case, mere enforcement could lead to political failure due to lack of public support.

The quest for passable transition pathways can be searched for in different ways. In Part 1 — *How to cast the future* — several approaches will be presented.

The second challenge is the need to make firm progress in the understanding of the interaction effects within spatial dynamics, as well as between spatial dynamics and economic and social dynamics (the latter also including demography). First-order effects of land use policies on transportation are often still reasonably well understood, even though sometimes still forgotten in concrete policies. Yet, the indirect effects and the longer-term effects are still hard to assess. Perhaps the direction of the changes is foreseen correctly, but the size of phenomena and the speed of growth or decay can still surprise us. For example, the first successes with congestion charges (as cordon charges) look promising, but it should be admitted that we are still quite unsure about possible long-term effects. There are vast differences in recommendations about optimal city size, depending on the way sustainability is defined. Furthermore, due to evolution in economic and demographic structures, as well as in technology, the preferable size and density gradient of cities may vary over time. We should not forget that new policies have to deal with existing cities and all the spatial, economic and social legacies tied to that. Sustainable city size is also influenced by many other features than the sustainability level of transport. For example, the quality of the building stock, the organisation of space and opportunities to spend leisure time in a diverse way affect both the environmental and social performance of a city.

Several of these issues of spatial interaction processes, for people, goods, services and infrastructure are dealt with in Part 2 — *Spatial economic interactions in a sustainable setting*.

The kind of change implied by a transition towards a sustainable transport system presupposes the existence of sufficient support of the population and of economic sectors. This issue of sufficient and lasting public support for sustainable transport policy is the third key challenge. To understand possible reservations among various interest groups the equity effects of a sustainable transport policy have to be mapped out. Equity can be understood in a broader sense than income (re)distribution only. Also spatial equity, i.e. preventing severe limitations in access for vulnerable groups and regions, can be an issue, whereas changes in transport policies may affect third parties also via changes in external effects. Next to equity considerations there needs to be also a minimum level of knowledge and awareness concerning sustainability in order to enable sufficient public support. Yet, one of the challenges is that both equity and awareness are dynamic equilibria. Despite the risks for social deadlocks with regard to implementing environmentally sustainable solutions in transport, there are possibilities to find common ground.

These issues form the theme area of Part 3 — *Effectiveness and acceptability: the keys to implementation*.

References

Commute. (2000). COMMUTE — *Common methodology for multimodal transport environmental impact assessment*. Strategic final report. Available at http://cordis.europa.eu/transport/src/commute.htm

Dugonjic, V., Himanen, V., Nijkamp, P., & Padjen, J. (1993). The links between mobility and environmental sustainability. In: D. Banister & J. Berechman (Eds), *Transport in a unified Europe; policies and challenges* (pp. 195–219). Amsterdam: Elsevier.

European Commission DG TREN. (2006). *Energy and transport in figures*. DG TREN in co-operation with Eurostat, Brussels.

European Environmental Agency (EEA). (2007). *Europe's environment — the 4th assessment*. Copenhagen: EEA.

Fujita, M., Krugman, P., & Venables, A. J. (1999). *The spatial economy — cities, regions and international trade*. Cambridge, MA: The MIT Press.

Neumayer, E. (2003). *Weak versus strong sustainability*. Edward Elgar, Cheltenham, UK: Edward Elgar publishers.

US Environmental Protection Agency (US EPA). (2003). *National air quality and emissions trends report, 2003 special studies edition*. Research Triangle Park, NC, US EPA, report EPA 454/R-03-005.

Voigt, F. (1973). Verkehr — *Theorie des Verkehrwirtschafft. Berlin*.

PART 1

HOW TO CAST THE FUTURE?

Chapter 2

How to Cast the Future?

Adriaan Perrels

2.1. Distinguishing Types of Projections

Long-term projections for the transport sector, which cover a broad spectrum of trends and effects without loosing too much depth, are rare. The OECD EST project may have been one of the few exceptions. Depending on the lead theme transport projections tend to either be based on dynamics within the transport sector as we know it or on important technical changes (including fuel technology) or on important societal changes, such as demographics and suburbanisation. Issues considered in the context of the external effects of transport in STELLA Focus Group 4 dealt with ageing and its effects on the volume and quality of transportation demand (Rosenbloom & Ståhl, 2002), and with integrated projections of land use developments & transportation developments (Hunt, 2002; Pfaffenbichler & Shepard, 2002). As regards environmental projections for the transport sector there were contributions of Banister and Stead (2002), discussing recent historical trends of energy intensity in transport, a presentation by Sperling (2003) on technology foresight for sustainable transport options, and a contribution by Pastowski and Gilbert (2003) on the quickly growing emission volume of civil aviation. The next three chapters concern studies that explicitly focus on the prospects for a development towards a sustainable transport system and options to promote its development.

The realisation of a sustainable transport system requires fundamental changes in the energy sources and propulsion technologies in order to contain the volume of greenhouse gas emissions from transport and to break away from the overwhelming oil dependency of the transport sector. For this reason the third Focus Group meeting included a larger set of contributions dealing with the prospects for a more sustainable energy use and reduction of greenhouse gas emissions in the transport sector.

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The realisation of a sustainable transport system implies a decisive change in various transportation trends. From this follows that one first needs to know how trends will develop in the next few decades and how these developments in transportations affect sustainability goals. The contributions in Part 1 deal with different aspects of 'casting a future' and apply different methodologies to gain insights.

The title of this chapter can be understood in two ways and both are relevant with respect to the quest for a sustainable transport system. If we think indeed that the future can be 'cast' — in other words 'moulded' — it means that investigations of developments in transportation should allow for a certain degree of *choice* and consequently such investigations should go beyond a systematic quantitative projection of trends and mechanisms as we know them today. As a reference base a so-called 'business as usual' or 'baseline' scenario based on internally consistent quantitative projections is indispensable, but in order to find solutions for the identified challenges alternative scenarios, being either policy oriented or more explorative, should dare to deviate from the business as usual pathway.

Apart from the extent to which the future is regarded as 'malleable' in a prospective manner, there is plenty of leeway for different opinions regarding *how* to cast the future. There are quite different methodologies available to do so. The applicability of those methodologies depends to some extent on the vision regarding malleability of the future, but is also steered by the purpose of the projections, the data availability, etc.

The conceptualisation of sustainable transport, i.e. how to define it and how to represent it through indicators, is as yet an unresolved issue. There is at least pretty little standardisation in approaches and indicators. In earlier contributions of the STELLA network various participants dealt with options to operationalise the concept of sustainable consumption. Black (2002) proposed the development of an indicator based on the difference between a standardised potential mobility indicator and a composite indicator of vehicle stock and fuel consumption. Steg and Gifford (Chapter 11) discuss the use of Quality of Life indicators, involving subjective judgements, as a basis for judging the sustainability of a transport system or of the overall mobility patterns of a country or region. It should be noted that both approaches are primarily focusing on passenger transport even though the approaches possibly could accommodate freight transport as well.

In the three contributions of Part 1 rather different assessment approaches are used. The article of van de Riet et al. is based on decomposition analysis and econometric methods. It provides building blocks for a simulation model, in which drivers are linked to a module with demand choices and subsequent resulting transport demands (demand projections) by mode, purpose or type of good, spatial unit and time period. Subsequently, for each driver (policy) measures are identified. The contribution of Banister et al. starts from the point of view that long term goal setting is indispensable to provide a strategic guidance to markets. On that basis one can subsequently investigate the best possible pathways to the pre-specified targets. This approach is also referred to as 'back-casting'. The description of alternative plausible scenarios of the future is important in this approach as the suggested pathways, i.e. the policy strategies, should be robust in order to be able to deliver in different circumstances. Even though the contribution of Morcheoine and Chateau also involves back-casting, their key issue is about the demonstration of the feasibility of more radical changes in the transport system with the aim to make it sustainable. Such an achievement usually requires a breaking away from business-as-usual tendencies. Therefore these approaches are sometimes called 'trend breach' scenarios. In order to stress the radicality the approach tends to distance itself from mainstream methods.

The method of Van de Riet et al. can be typified as a decomposition analysis as a preparation for a forward looking simulation model. It is policy neutral, which doesn't mean that additional policies would not be recommendable. It can provide a basis for the kind of studies of Banister et al. and Morcheoine and Chateau. Since, prior to aiming for radical changes as is done in the latter studies one needs to know from what trend lines (and undesired levels) one wishes to divert. However, in contrast to the approaches of Banister et al. and of Morcheoine and Chateau the default approach for policy designs based on the type of analysis of Van de Riet et al. would be making projections on the basis of model simulations that include various policies (e.g. fuel or emission taxes, road pricing, cap and trade systems, technical minimum standards, speed limits, zoning policies). A problem of this kind of assessments is that they are often based on 'graduality', meaning that the underlying models in fact only allow for a certain range of change within a certain time span, among others owing to the fact that radical technological and institutional changes are usually not included. As a consequence the simulations may indicate that the achievement of the targets is very expensive or technically barely possible. In the case of the so-called back-casting and trend breach approaches innovation options get much more room, but the downside is that such approaches easily turn out to be unclear about risks of non-achievement (i.e. related to dependency on not yet fully proven innovations and/or optimist cost assessments). In fact these alternative scenario approaches assist to highlight on what issues to concentrate research and development efforts, including social issues, such as social dilemmas that block promising options.

2.2. Key Sustainability Indicators in Transport

Since economic growth still implies growth of transport performance as well (Banister & Stead, 2002; Van de Riet et al., Chapter 5) the so-called eco-efficiency of transport[1] has to improve in order to compensate for the volume growth of transport. In that way at least a decoupling between economic growth and environmental impacts starts to emerge. A next step is the decoupling of economic

1. Eco-efficiency of a certain activity (in this case transport) can be defined as the amount of natural resource use (including emissions) in physical terms in relation to the output of the activity, either in physical terms (e.g. tonkilometre, tkm) or in value terms (euros). As regards the natural resource use one can either use a collection of separate indicators (e.g. gasoline consumption/tkm, NO_x emissions/tkm, etc.) or use a weighted compound indicator (e.g. in CO_2 equivalents/tkm).

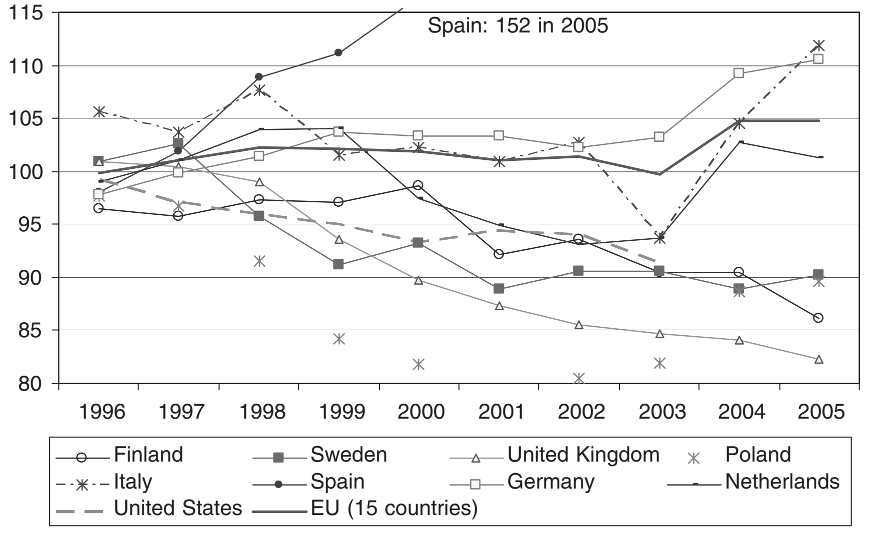

Figure 2.1: Inland freight transport intensity of GDP (1995 = 100). *Source*: Eurostat.

growth and the development of transport performance. For a transition to a genuinely sustainable transport system also the latter type of decoupling needs to be realised.

The eco-efficiency of transport is improving in quite some countries when it is compared to the development of GDP, but the picture is altogether rather mixed. Figures 2.1 and 2.2 provide an overview of the developments in roughly the past 10 years for freight transport and passenger transport, respectively. The indicator 'transport intensity of GDP' is defined as the transport performance, expressed in tonkilometres or passenger kilometres, per unit of GDP. It should be stressed that the figures concern only inland transport (road, rail and barges), meaning that sea and air transport are not included. When considering the USA and the EU15 group[2] there appears to be a difference between freight transport and passenger transport. For passenger transport both areas show a mild reduction in transport intensity (which could be regarded as an improvement in eco-efficiency), whereas for freight transport the USA also shows clearly improvements, but the EU15 group does not. Furthermore, within the EU15 group there are significant differences between countries. Finland, Poland, Sweden and the UK show reductions in transport intensity both for inland freight transport and inland passenger transport, whereas Germany and the Netherlands show reductions for inland passenger transport only. Italy and Spain show no improvement

2. The EU15 group comprises of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

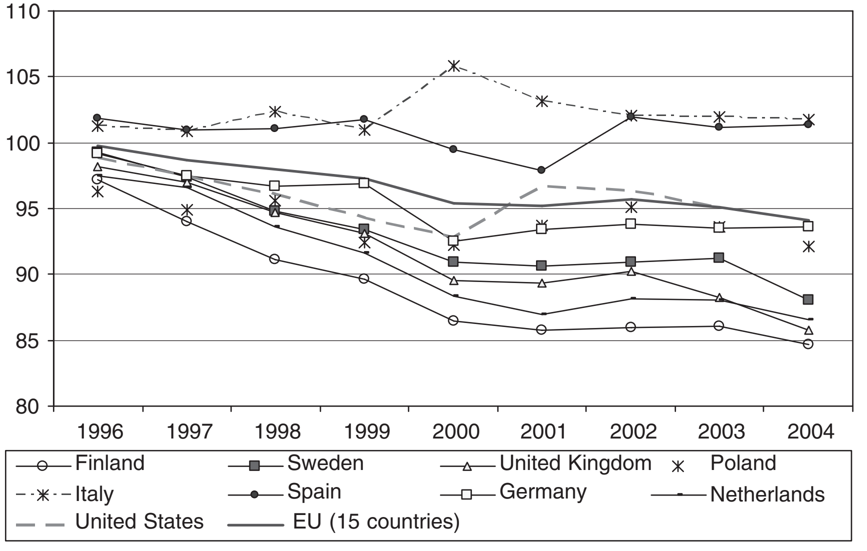

Figure 2.2: Inland passenger transport intensity of GDP (1995 = 100). *Source*: Eurostat.

for either of the transport categories. For Spain freight transport intensity of GDP has been rising even quite significantly (and hence suggests a deterioration of eco-efficiency).

One has to be careful however with further judgements in this case. In the first place it should be stressed that the variations in economic growth are affecting the development of the indicator. In this case both the speed and the composition of economic growth matter. If services and high-tech industries contribute the greater part of economic growth the eco-efficiency of freight transport (i.e. tonkilometres/unit of GDP) will improve. However, a resurgence in output from extractive and heavy industries usually means the opposite. In other words as regards the eco-efficiency of freight transport the material intensity of an economy is important. All in all it means that it is possible that either the eco-efficiency can improve even though there were not extensive explicit efforts to this end or the eco-efficiency does not improve even though there were substantial efforts to this end at the micro-level.

It is also important to realise the effect of not including sea and air transport. For example for intra EU trade flows so-called short sea shipping is quickly gaining importance. However for the freight flows within the USA that option is much less important. Conversely air travel has already a significantly higher share in the modal split of the USA as compared to most EU countries. One should also realise that the amount of intercontinental shipments and trips is increasing fast. The transport intensity effects of those hauls are neither included in Figures 2.1 and 2.2.

The changes in economic structure and the growth in global trade have indeed important implications for the overall amount of emissions from transport. Even if

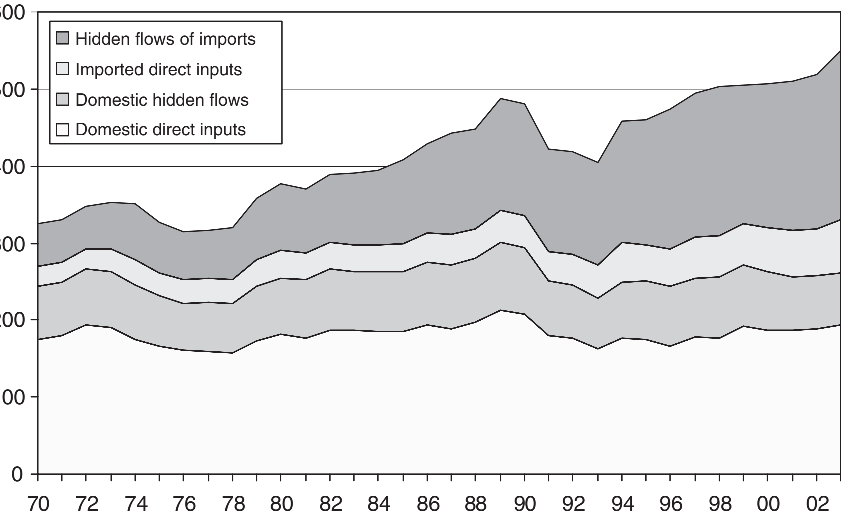

Figure 2.3: Composition and development of the total material requirement of Finland in million tonnes of natural resources. *Source*: Statistics Finland/Thule Institute.

transport systems as such get more eco-efficient when related to their output, it may still be that the global economy is barely getting more eco-efficient. This ties in directly with the relation between the structure and pace of economic growth and the amount of freight transport services needed (measured in tonkilometres or vehicle kilometres). The rise of high-value industries and services in many EU countries and Northern America has gone hand in hand with increasing input of raw materials (including energy) from abroad. As a consequence the domestic economies and also transport sectors of these countries are getting ever more eco-efficient and partly even cleaner in absolute terms, but if one tries to trace back the total impact of the product chains involved a different picture emerges. This is summarised in Figure 2.3 by showing the development of the constituent parts of the so-called total material requirement (TMR) of the Finnish economy (see also Mäenpää & Juutinen, 2001; material shown here includes more recent observations). For Germany, the United Kingdom and other EU countries similar assessments have been produced (e.g. Gazley & Bhuvanendran, 2005).

The sum of domestic flows has not been growing much since 1970. Technology improvements for emissions and logistic developments can more than compensate for this and consequently the eco-efficiency of freight transport has improved in Finland. However, when the freight flows from overseas are included, including the induced (‘hidden’) ones, the eco-efficiency improvement of the overall production and consumption system is not obvious. For example, only recently emission limits have been imposed on ships by the EU. Furthermore, in many of the developing countries to which the induced (hidden) flows should be attributed eco-efficiency