TRAFFIC SAFETY AND ENVIRONMENT
– Conflict or Integration –

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Our transport system is not on a sustainable path. Achievements in terms of mobility have come at some considerable environmental, economic and social cost.Sustainability is a long-term concept, also demanding attention to its social dimension. For transport, this underscores a need to link considerations of the environment and traffic safety together. An integrated strategy implies systematic translation of a broad field of goals into a set of mutually reinforcing packages of measures. The focus is on improving the manner in which different actors recognise the need for co-operation and their readiness to implement it. The starting point is in improving communication. There are clear benefits in integration, in regard of both the synergy of actions as well as improved optimisation, but integration may also bring problems.

This article is based on an international survey of an expert group formed by the OECD to review the issues and opportunities of integrating environmental and traffic safety strategies. The group assessed case studies from 12 countries and the European Union, using a classification scheme focusing on the decision contexts and life stages represented by the cases. The group's full report was published in 1997. In its conclusions, the group presents a pragmatic way ahead, and identifies some basic research needs. There are some important persisting questions: how to influence transport demand, how to increase the role of non-motorised traffic and public transport, how to find packages of measures relevant for entire regions surrounding large urban areas, and how to respond to the process of rapid motorisation in developing countries. There are as yet few measures dealing effectively with these issues, or taking them up with a concern for both safety and environment. While the approaches that have shown some success underline the importance of tailoring policies and strategies to the concrete situation of each country, they also demonstrate the importance of the international exchange of know-how.

Key Words: Safety, Environment, Sustainable, Planning

1. SUSTAINABLE ENVIRONMENT– SUSTAINABLE SAFETY

The worldwide concern for the environment and the energy crises of the 70's have underscored the vision of sustainable development and a "sustainable" transport system. Sustainability is a long-term concept. However, a generally accepted and functional definition of sustainability is still lacking in the transport sector. A qualitative definition is that the system should provide[1]:

Transport that does not endanger public health or ecosystems and meets mobility needs consistent with:

- *use of renewable resources at below their rates of regeneration,*
- *use of non-renewable resources at below the rates of development of renewable substitutes.*

Transport being a people centred activity sector, the social dimension must be built into the concept of sustainability. This includes a sustainable environment, but also sustainable safety.

The current transport system is not on a sustainable path. Achievements in terms of mobility have come at some considerable environmental, social and economic cost. There is a challenge to find ways of meeting transport needs that are environmentally sound, socially equitable and economically viable[2, 3].

Today, transport plans and projects generally take account of both traffic safety and environmental concerns, but each factor is normally dealt with individually. Separate strategies may result in conflicting measures and administrative competition. Many actors may be involved in improving or affecting road safety and environmental protection. Political decisions may go one day in one direction, and the other day in another direction[4, 5]. (see Box 1).

To advance policies and strategies in this complex sector of public concern, an international group of experts from fifteen countries was formed by the OECD to review issues and opportunities. More specifically, the group was mandated to study how evaluation methods and planning tools can be designed and used to give equal and co-ordinated consideration to the safety and environmental effects of road transport. The group's report, "Integrated strategies for safety and environment" was published in 1997[6]. This article is based on the group's survey and assessment, in which both authors were involved.

Box 1 : Speed limits in the U.S. : choice between mobility, safety and environment

Speed limits reduce simultaneously the number of road fatalities and the amounts of pollutants emitted. Implemented as a fuel-saving measure after the 1974 oil embargo, the national 55 mph speed limit in the U.S. was generally credited with a reduction in road accident trauma. However in 1987, to favour mobility, limits on rural freeways could be raised to 65 mph by the States and, more recently, federally mandated speed limits were altogether removed, when the 55 mph speed limit had been introduced on the Interstate system in order to save energy and reduce the number of road fatalities. The discussion in the late nineties on reducing greenhouse gas emissions, closely related to fuel consumption, has refueled the speed limit debate.

2. WHAT IS THE POTENTIAL FOR INTEGRATION ?

2.1 Constraints and directions

The frameworks of environmental and safety measures are constrained by economic requirements, cultural factors and commitments made on a global level. The possibilities of integration depend on how policies are developed and how the relationships of policies applying to specific sectors are managed. It is also difficult to superimpose an integrated process on a fragmented organisational structure.

Considering the relationships of traffic accidents and pollution, as exemplified by modelling, it is apparent that some variables are shared: traffic flow, speed, the composition and fluidity of traffic. On the individual level, there are common characteristics of vehicles, drivers, roads and traffic. The strategies which aim to prevent accidents and pollution and to reduce damage are based on similar principles of action:

- reducing the need to make a trip and its length
- improving the safety and environmental performance of vehicles,
- providing a safer road system,
- promoting the use of modes which perform better with respect to safety and environmental protection and,
- encouraging safe and environmentally friendly attitudes and behaviour.

2.2 Many measures – multiple impacts

Vehicle design standards act at source to reduce emissions and they focus on crash protection. Compliance with the standards does not usually result in conflicting measures. But there are problem cases where special consideration is needed, for instance improved occupant protection of a heavier car versus increased fuel use or more severe impacts on other road users. Or, conversely, vehicle weight reduction to save energy resulting in lesser impact resistance. On the other hand enhanced regulation of vehicle use, vehicle inspection and driver training support both safety and environmental objectives.

Laws define general objectives and basic means of action. At the national level, sectoral policies, such as road policy, road safety policy and policies relating to other sectors, for instance regional planning, can be linked. Taxation, pricing of infrastructures and the level of service offered affect users in their choice of transport mode.

There is currently a general tendency to revise road standards, design, layout and operation. This is probably the area in which there are the greatest number of possible conflicts and convergences between safety and environmental aspects, i.e conflicts concerning roadside trees, noise barriers or de-icing salt use, or convergence in the use of landscaping measures. Table 1 lists measures and tools together with their impacts on safety, environment and energy.

At the local level, many traffic management schemes have been introduced. If the objective is solely to reduce congestion, the effects on the environment and safety are not always positive. Limiting speeds, traffic and parking has positive consequences, but may increase risks outside the area concerned.

Urban structure is affected by several processes increasing travel demand. These are, to some extent, caused by the development of the transport system, especially the role of the passenger car. But travel and traffic conditions are not uniform, and the overall trends are only partially indicative of the actual changes in transport behaviour. Change is a characteristic of vital cities and towns, and no strategy can provide a permanently beautiful or healthy city, but there are means and measures to influence the processes of change. For urban travel, the measures available are those of co-ordinated land use planning and transport policy.

Table 1 Methods to achieve road safety and selected environmental protection objectives (×= Major impact)

Instruments	Impacts			
	Accident	Noise	Air pollution	Energy/CO_2
1. Regulations				
Vehicle standards				
• Active/passive safety	×			
• Size/weight/power	×			×
• Emission (pollutants, noise)		×	×	
• Energy efficiency				×
Town and country planning standards				
• Density, zoning		×	×	
• Construction		×		
Infrastructure standards				
• Safety improvements	×			
• Noise		×		
Vehicle checks	×		×	×
Speed limits (type of road/zone)	×	×	×	
Protective equipment	×			
Control of drunk driving	×			
Working conditions of truck drivers	×			
Driving license	×			
Certification of transport undertaking	×			
Restrictions	×	×	×	
Penalties for traffic offences	×			
2. Public investments				
Roads, streets (design, surface, roadside)	×	×		
Cycle tracks	×			
Roundabouts, squares	×			
By-passes	×	×	×	
Intermodal co-ordination				
• Park&ride facilities		×	×	×
• Combined freight transport	×	×	×	×
Traffic management system	×		×	
Public transport			×	×
Emergency services	×			
3. Economic incentives				
Insurance premium	×			
Fines	×			
Vehicle purchase, annual road tax		×	×	
Fuel tax				×
Road tolls		×	×	×
Urban tolls		×	×	×
Parking charges		×	×	
Public transport subsidies			×	×
4. Communication management				
Education in schools	×			
Driver training	×	×	×	
Information campaigns	×		×	
Voluntary standards	×		×	×
Consultation			×	
Co-ordination between sectors	×	×	×	×

3. CHOICE OF INDICATORS TO EVALUATE ENVIRONMENT/SAFETY PROJECTS

Indicators are needed to measure the incidence of problems as well as their impact on people's lives. Table 2 presents the main indicators of particular relevance. When suitable indicators have been developed, the indicators of individual factors need to be combined, so that an overall effect, of a project or policy, can be calculated to assist decision making. However, it is rare for decisions to be made in this way, and evaluation frameworks generally only guide or advise decision makers. There is no universal set of indicators, but rather several sets to meet

Table 2 Key indicators for integrating safety and environmental aspects

Group of indicators	Indicator
Road and Traffic	Total vehicle-kilometers
	Volume of road traffic per unit of GDP or per capita
	Person-kilometers and ton-kilometers
	Average speed
	Annual average daily traffic
	Length and density of the road network
	Modal split
Risk and Safety	Casualties
	Severity
	Monetary cost
	Accidents per million vehicle-kilometers
	Public perception
	Target achievement
Environmental Impact	Noise
	Vibration
	Air pollution
	Energy consumption
	Barrier effect and community severance
	Visual intrusion
	Disruption during construction
	Water pollution
	Biological diversity, flora and fauna
	Cultural heritage and landscape values
	Other environmental impacts
Economics	Taxation and subsidies
	Price structure - fuel use, road use
Process and Management	Degree of co-operation between different ctors
	Quality and number of local integrated safety/ environmental programs
	Competence levels and motivational aspects

the needs of specific conceptual frameworks and purposes.

The key indicators most reflective of the sustainability of the transport system are modal split, motor vehicle mileage and energy use. However, such global indicators are insufficient to evaluate the efficiency of measures to reduce for instance dependency on motor vehicles: detailed indicators are needed which take into account the societal benefits and productivity of motorized travel, which are not constant on a vehicle-kilometer basis. Examples of indicators useful in such a system are:

- speed of cars at non-separated crossings;
- proportion of transport not dependent on use of fossil fuels;
- proportion of pedestrians separated from car traffic.

Walking and cycling are especially sensitive to the environmental quality and safety of the route, mass transit to how efficiently stops and terminals serve their catchment areas, how regular and frequent the service is, etc. Some groups, such as children and older people, can be more sensitive to the effects of traffic than others, and should be given special consideration.

4. LEARNING FROM CASE STUDIES

4.1 Decision context and first experiences

The objective of the group's case review was to reflect the nature and extent of the integration of safety and environmental considerations in contemporary road transport planning. A large number of examples could be found to illustrate the state of practice with respect to either safety or environmental issues taken alone, but these cases were excluded by definition from the review.

The cases from 12 countries and the European Union were extremely varied in nature, scope and geographical coverage. The review set out to identify the diversity of case experience using a classification scheme. From a preliminary review of the cases received, it was observed that cases could best be classified using a matrix composed of two dimensions (see Table 3):

- *First dimension, decision contexts:* The form and geographical extent of the cases could best be distinguished by the institutional context. Three categories on this dimension concerned the management of road transport facilities, while the fourth was added to cover experience with safety and environmental regulation affecting vehicles and road users.
- *Second dimension, the "life-stage" of case experience:* Cases can consist of the establishment of policy and of evaluation methodology, "talking and planning", to use the stages identified in a Canadian report on urban travel and sustainable development, as well as examples of implemented practice, "acting and accomplishing". An intermediate stage is represented by the evaluation frameworks used to assess policies.

In only a few cases was there a conscious effort to

treat safety and environmental objectives within an integrated framework.

A distinction must be made between the *co-ordination* and the *integration* of safety and environmental questions. The former means that there is simultaneous consideration of the two, usually employing different methodologies. The latter implies that a trade-off between the two is made explicit to some degree, although not necessarily within a quantified framework.

Co-ordination is much more common than integration. It is also, in general, less influential and less transparent. However, where either occurs, it can be said that the outcome is typically positive in the sense that the decisions taken are perceived to be closer to the interests of the whole community than the alternatives which might otherwise have prevailed.

A recurrent theme was that the evaluation of multiple payoffs *must involve looking beyond the immediate boundaries of the scheme or project* — the whole neighbourhood around a traffic calming scheme, the whole main road network when tolling or a new speed limit is introduced on a motorway, etc. The evaluation methods which work best encourage decision-makers to weigh this wider evidence.

4.2 Enhancing the planning process

There is much room for innovation and experimentation, in interventions but particularly in evaluation frameworks and planning processes. Currently, interurban road transport, notably through corridor management, seems rather more amenable to innovation in planning processes than does urban transport. This may be because it has become normal to involve both transport and environmental agencies and interests in planning interurban transport.

The survey identified several key conclusions to assure success of integrated road transport planning processes for safety and the environment (see Box 2). These

Table 3 Classification of case studies submitted

	"LIFE STAGE" OF CASE EXPERIENCE		
DECISION CONTEXT ⇓	Policy development	Evaluation frameworks	Implemented projects/policies
Major infrastructure	N/ S/ FIN • Comparison of strategic roads policies EU/ N.Am • Private financing, e.g. DFBO policies	F • Major road and multi-modal GB • Trunk roads DK/ N • Highway investment	GB • Twyford Down motorway link
Corridor management	CDN • Quebec main highways with devolution	NL • Amsterdam-Utrecht corridor N • Problem zones on main roads	EU • Main roads crossing towns FIN • Rantasalmi road redesign EU/ N.Am • Telematics
Area transport and land-use planning	H • Action programme N • Transport planning in 10 largest urban areas FIN • Transportation systems planning in urban regions CDN • Greater Toronto study F • 3 scenarios for Lyon GB • Transport planning packages for local areas	CDN • BC highways social costing in Greater Vancouver	DK • Århus CDN • Urban cases A • Graz Tempo 30/50 CH • Zürich EU/ N.Am • Car-sharing associations
State norms, regulations and economic policies	US • MVSS, CAFE and air quality	FIN • Winter roads	US • 55 mph speed limit EU/ N.Am. • Vehicle inspection and maintenance

are critical prerequisites, but do not cover all stages of the planning process.

Box 2 : Practical advice for an integrated planning and evaluation process

1. *Asking leading questions about safety and environmental goals at the conceptual stage of interventions.*
2. *A choice of public involvement which is appropriate to the scale and timing of the problems.*
3. *Detection of instabilities: effects which will become political icons, symbolic fights, etc., to avoid or to use.*
4. *Allowing for the logical paradoxes in what people will accept.*
5. *Due consideration for "points of no return".*
6. *Articulating possible comprehensive "packages" of transportation system qualities.*
7. *Recognising who wins and who loses as a result of a particular decision.*
8. *Making it possible to learn from past failures as well as successes.*

5. PARADIGMS AND TRENDS

The development of road safety concerns has been described as "four paradigms in a century"[7]. Paralleling this, one can speak of similar developments in environmental concerns, and foresee a fifth paradigm for an environmentally sustainable and intrinsically safe transport system (Table 4). But this paradigm implies that the optimal result will not be found in the transport system alone. It demands integration of aspects, institutions, the activities of different administrative levels and in different geographical areas.

The different approaches of traffic safety and environmental aspects are linked to the development of car use and traffic problems. The need for integration begins to be most strongly felt when both aspects are taken up as parts of a national transport policy, with a focus on risk exposure and managing transport modes. The role of the road environment in accidents is emphasised, as is the role of the road as part of the whole environment. The change from looking at separate nuisances to a complex environmental system demands an increasing sophistication in the methods and frameworks used, as well as clear and operational targets.

In the foreseeable future, it is unlikely that technological change will eliminate the problems connected with transport and traffic. Developing functional integrated strategies may be an inescapable requirement. Such travel demand factors as social, economic and cultural circumstances are only indirectly influenced by government or administrative action, through economic and

Table 4 Change in paradigms : safety and environment

	Paradigms				
	I	II	III	IV	V
Aspects	1900-1925/35	1925/35-1965/70	1965/70-1980/85	1980/85-present	Present-2010/20
	The car	The situation	The traffic system	The transport system	The transport system within the environment
Car availability	Less than 25 per 1000 inhabitants	Between 25 and 250	Between 250 and 500	Over 500	Different cars for different tasks
Disciplines	Law enforcement	Car and road engineering Psychology	Traffic engineering Traffic medicine Advanced statistics	Advanced technology Systems analysis Sociology Communications	Holistic systems approach Anthropology
Unwanted effects	Collision	Accident	Crash and casualty	Suffering and costs	System malfunction
Research	Statistics: "what"	The cause of accident: "why"	The means: "how"	Multidimensional	Cooperate and integrate
Organizational form	Separate efforts based on trial and error	Coordinated effort on voluntary basis	Programmed efforts, authorized politically	Decentralization, local management	Towards supranational targeted actions and incentives for local, regional levels

social policies, but among those clearly influenced by public action, the transport system in its land use context is a central one.

6. TOWARDS INTEGRATED STRATEGIES

6.1 Benefits, but also problems

Based on the survey and the assessment of performance, the working group emphasized two major advantages of an integrated process:

- An increase of the benefits if an action serves both the reduction of accidents and of environmental disturbance. Actions can also gain better public acceptance, if they can be shown in a larger context.
- A better optimisation if an action is positive for one sector but negative for the other. As the framework of the decision is enlarged, it is possible to detect actions which damage the whole system instead of improving it.

But there are also problems. The sphere of action grows and so does the number of criteria. The decision process is more complicated and one must look at a broader scale of impacts. Long-term effects are introduced and the question of process interaction needs to be dealt with on a more sophisticated level as the system expands.

6.2 The thrust of an integrated strategy

The working group gave its own definition of what an integrated strategy means (see Box 3):

Box 3 : Integrated strategy – defining some key features

In an integrated strategy, a broad field of goals is systematically translated into a set of mutually reinforcing packages of measures.
The focus is on improving the manner in which different actors recognise the need for co-operation and their readiness to implement it.
The starting point is in improving communication.

The definition is fairly general, but it points to some important aspects of integration. Integration does not mean adding different strategies together into one report. Integration is a translation process. Many kinds of goals are set, some support each other, others conflict. These conflicts cannot be avoided, even by using sophisticated prioritisation methods. Such methods only change the goal conflicts into conflicts about how the weights or money values should be assigned. Conflict resolution means accepting that perfect or total solutions can never be achieved in the real world. It means developing practical measures that serve conflicting goals as well as possible.

The definition points out that it is especially important that the actors in the field understand the need for co-operation, and also that co-operation demands skills and training. It is not realistic to expect that all actors share the same goals. In the form of alternative scenarios, visions of the future clarify the different aims of the actors involved. But co-operation demands that the actors do have a common view of the present, and of what the problems are.

The measures proposed should form mutually reinforcing packages. Each measure, as such, needs to be practicable, and understandable, but to be efficient these measures must be combined into packages. This is of course a basic kind of strategy: advancing step by step, package by package. There is also a risk in this type of strategy, that the steps never reach the goals. That is why it is important that the broad field of goals and strong visions of the future should be always present in making and implementing the strategy and that the process is truly systematic.

6.3 Different operational levels and time horizons

The contents of strategy are different on the national, regional and local level. These levels should interact, but not be bound too tightly together. In a very centralised system, the national level goals and organisations are so strong that regional and local initiative cannot develop, and this means that the measures proposed will not be as effective as would be needed. Again, in a very decentralised system, the large scale aspects, for instance the use of economic incentives, are very difficult to handle.

For all levels, the common need is a firm connection to land use planning. In many countries, this connection is actually rather weak. But the role of land use planning is essential, because it creates the conditions in which the transport system operates. A practical problem is that strategies and land use plans usually have very different time tables and organisations.

Long-term strategy demands a high level of integration. Its focus is political, dealing with society as a whole and the goals set for its future. When the strategy

is implemented in administrative action plans, the cross-connections between different actions and the needs for co-operation can be clearly identified. For co-operation, the most important development need may be teaching sector administrations to make their action plans together and bring in the public as well as business and other actors into the work.

Short-term action should be divided according to the responsibilities of the actors involved and they should act in contact with each other, co-ordinating their measures as necessary. Formal integration does not have very much to say at this stage; sector expertise and efficiency are the crucial factors.

7. A PRAGMATIC WAY AHEAD

From country to country, the differences on how to implement integration can be considerable, but some recommendations seem evident.

1. In any policy and scheme development, transparency towards all actors, institutions and citizens involved is a prime concern. The consequences in regard of safety and environment should always be taken into account. In developing environmental policy, the safety aspects should be made explicit; in safety policy, the environmental aspects. A common set of indicators should be used.
2. Environmental impact assessment (EIA) has developed as a powerful tool to evaluate the environmental aspects of a project or policy at an early stage[7], while road safety audits are gaining increasing importance in assessing implementation of safety[6]. Carrying EIA to implementation, i.e. ensuring that a sufficient range of environmental concerns are taken into account in implementation, and carrying the safety audit technique forward, i.e. developing its use to serve early stages of planning, may form an efficient way of bringing these concerns together in the total process.
3. Project objectives should include the manner of dealing with such matters as severance and visual intrusion in urban areas, risks to the cultural heritage, fragmentation of natural areas, and water pollution. At present, these are generally seen as external constraints. This perception may lead to serious conflicts in a late stage of planning, because the project can not comply with the constraints, if it has not taken account of the goals such constraints relate to. Especially when large scale infrastructure schemes or wide-ranging regulatory or economic action is proposed, the risks of irreversible change should be carefully considered.
4. Some groups of measures show clearly different relationships to the theme of integration. Measures such as speed reduction and improved enforcement lead to overall safety and environmental quality improvement, regardless of the context of their development. Others, such as traffic management and redistribution, can cause conflicts, if they are implemented without consideration of all aspects and also impacts on other areas and parts of the transport network. But there are also measures essential to either safety or environmental quality with little impact on other aspects. For safety, such are, for instance, measures against drinking before driving, for environment, improvement of vehicle fuel use and exhaust emissions. Resources to implement these measures need to be available regardless of the intents of integration.
5. As a first step, each organisation responsible for a sector should undertake an impact evaluation study in the other sector. This implies a common set of indicators and an exchange of knowledge between the two sectors. At a later stage, the aim is designing an ecological and safe system of transport instead of corrective actions. It demands a higher level of integration between the parties and a new way to organise the process.

8. CONCERTED RESEARCH NEEDED

There are still barriers between the sectors, which can only be reduced by a concerted research effort. A special need is developing tools for testing and assessing policies, based on scientific knowledge regarding safety, environmental pollution and noise. There is a role for carefully designed pilot schemes, to examine both the implementation process and the technical effects of measures chosen.

The models for predicting accidents, pollutant emissions and noise should have a common basis in vehicle and traffic flow data and be developed for use both on the micro level, in evaluating the impacts of changes in a road or area, and on the macro level, in forecasting the long-term effects of changes in vehicle fleet composition or traffic flows. Data bases as well as models

should take better account of all groups of pedestrians and bicyclists. Health effects, especially of atmospheric pollutants, need further research. Further research is needed on the environmental impacts of safety schemes and on the safety impacts of environmental schemes. Professional research is also needed into the social and societal impacts of such schemes.

Considering the planning and design process, further research is needed on process management, on preparing and making decisions, and to find new ways to order complex tasks into manageable components. Better evaluation methodology and frameworks, allowing the taking of multiple relevant dimensions or criteria into account in a transparent manner, are also needed. Research is also needed on efficient ways to influence the members of the public to promote safe and environmentally adapted choices in making travel decisions and implementing them. This is an ethical aspect, which goes beyond the scope of the transport process itself.

In regard of policies and measures, there are some important persisting questions:

- How to influence transport demand,
- How to increase the role of non-motorised traffic and public transport,
- Finding the packages of measures relevant for entire regions surrounding large urban areas,
- Responding to the process of rapid motorisation in developing economies.

There are as yet few measures dealing successfully with these four basic issues, or taking them up with a concern for both safety and environment. While those approaches that have shown some measure of success underline the importance of tailoring policies and strategies to the concrete situation of each country and locality, they also demonstrate the importance of the international exchange of know-how concerning the methods and measures which fit into a given situation.

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