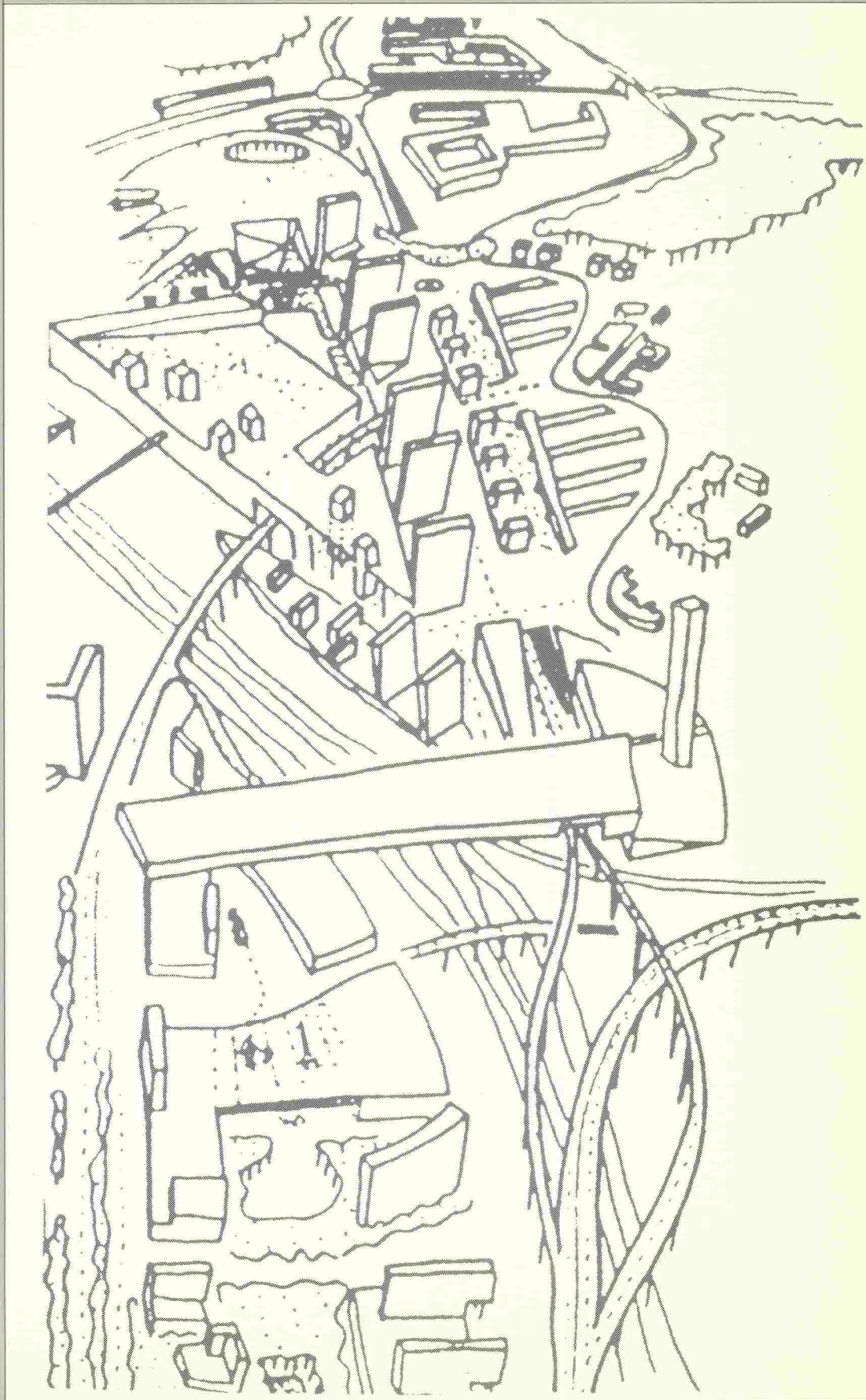
Finnra

A Finnra strategical research and development project

Traffic and Land Use



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Abstract

Key words: Transport, traffic routes, land use, environment, environmental impact

The main theme of the Traffic and Land Use project of the Finnish National Road Administration is the interaction between traffic and land use. Understanding this interaction is a prerequisite for finding the basis for sustainable development of communities. This, in its turn, determines how the transport system can serve the functions of the community in a sustainable manner. The Traffic and Land Use project was initiated in 1991 and implemented 1992-96 as the Finnra strategic research and development project S1. The Transport Ministry, the Environment Ministry, other ministries, the Finnish Association of Local Authorities, transport administrations and organisations, research institutes and local authorities participated in the project. Some of the collaboration projects continue during 1997.

The Traffic and Land Use project has supported including interaction and cooperation between the actors in the field in road administration guidelines and programming, as exemplified by the development of the urban area road network plan into planning the traffic system as a whole or by the emphasis on the entire environment and all actors concerned in urban area main road design. As the project ends, the work is continued in the Finnra Urban Areas research theme and in several cooperative projects, concerning i.a. an environmentally adapted community structure and transport system.

This report presents the research and studies made in the project and in connection with it. Finnra has published 60 reports, other participants 30. During 1997 some 20 reports will be published.

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Introduction

In planning the Traffic and Land Use project in 1991, the Finnish National Road Administration (Finnra) sought methods to implement principles of sustainable development in urban transport. Transportation provides the connections needed by the functions of the city. The sustainability of a transportation system cannot be evaluated as such; it should always be viewed together with the activities and their location, land use. The main theme of the project is the interaction between traffic and land use. This interaction must be understood and mastered before the principles of sustainable development of community structure can be defined. These, in turn, determine how the transportation system can serve urban functions in a sustainable manner.

Finnra has studied urban area road planning and design since the early 1980's. Earlier guidelines deal with the scope of the public road network and road design in town plan areas, road and street network planning, and main through roads in urban areas. The viewpoint of the urban environment has also been foremost in guidelines dealing with traffic safety, pedestrian and bicycle traffic, public transport arrangements, noise abatement, etc.

The Traffic and Land Use project has fostered a linkup of the interaction and co-operation between involved parties with road administration guidelines and programming. This is exemplified by the expansion of road network planning into transportation system planning, as well as the emphasis placed in urban road design on consideration of the environment as a whole and the stakeholders in the area. The work will be continued within the framework of the Finnra Urban Areas research theme and several co-operative projects.

This report on the project and its results was published in Finnish as "Tielaitoksen strateginen tutkimus- ja kehittämisprojekti Liikenne ja maankäyttö" (TIEL 3200467) by the project co-ordinator, Mrs Ulla Priha, architect, M.Sc., and Mr Anders HH Jansson, architect, M.Sc. It was translated by Mr Keith Kosola and edited by Mr. Jansson. The publications with English titles referred to herein have generally been published in Finnish; a reference list is included in the original report. English summaries have been published in 1995 (Finnra internal publications 25/95) and in 1997.

Helsinki, May/October 1997 Finnra Strategic Planning

1 THE TRAFFIC AND LAND USE PROJECT

1.1 Background

Two factors had a major influence on the beginning of the Traffic and Land Use project and the preliminary study compiled as a basis for the work: the emphasis on interactive planning and the emergence of the concept of sustainable development. Road planning is sector planning on the one hand, and overall community planning on the other. Our environment is implemented and functions in an interaction between transportation planning and land use planning. To improve the results of both of these sectors, more information about this interaction was needed.

Traffic and land use pilot study; Finnra research reports 24/92, TIEL 3200079
Review of the literature on traffic and land use - literature by topic area; mimeograph 1992
Interaction between traffic and land use, synopses of the literature; Finnra internal publications 43/93
Research project on the interaction between traffic systems and community structure; Ministry of Transport and Communications, Publication 23/92

In the spring of 1991, the second Parliamentary Transport Committee set a goal of developing land use and traffic so that necessary transportation would be realised with minimum traffic generation. This indicated that the principle of sustainable development had also been embraced by the transportation sector. After a round of interviewing experts, the preliminary study of traffic and land use concluded that sustainable development means at least the following:

- a compact urban structure that minimises the need for travel
- a city structure and form that favours public transport use, reduces car traffic demand and guarantees equal opportunities of travel for all
- integrated residential and workplace areas that reduce the need for travel
- keeping city centres competitive and intact, and should they become congested, forming controlled sub-centres accessible by public transport.

The interviewed experts felt there were too few methods and not enough will to realise these goals. Development proceeded in the opposite direction.

Objective

The objective of the project has been to produce basic information about the interactive relationship between traffic and land use and study the effects of various solution models. It has also promoted increased interaction between land use and transportation planners. The research program has been implemented by defining 3 - 4 themes per year. These themes have been:

- traffic in small and mid-size urban areas
- traffic and land use models
- transportation system planning
- impact of changes in the regional plan system
- urban region transportation
- distribution and practical application of information.

The project also implemented a program initiated in 1992 by the Ministry of Transport and Communications that examined the interaction between the transportation system and community structure.

Organisation

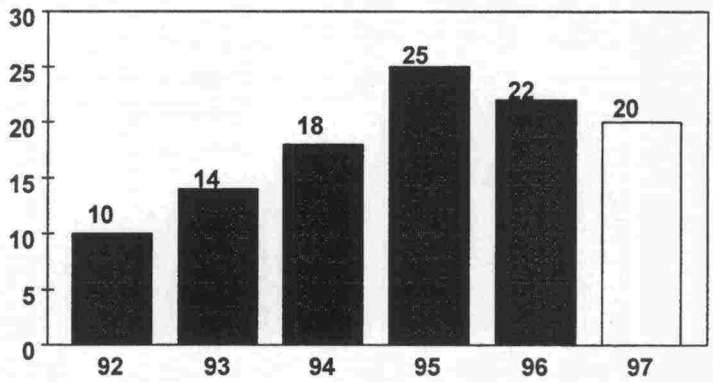
The project was defined in 1992 as the Finnra strategic research and development project S1. It was intended to be a 5-year project (1992-96), but collaborative projects continued on into 1997. A total of about 10 million FIM and an average of 3 man-years of work per year have been invested in the project. The project was directed by a management board:

Erkki Koskinen	Finnra, chairman -94		
Jukka Isotalo	Finnra, chairman 94-		
Juhani Tervala	Ministry of Transport and Communications -95		
Kari Korpela	Ministry of Transport and Communications		
Mauri Heikkonen	Ministry of the Environment		
Kari Ojala	The Association of Finnish Local Authorities		
Maisa Siirala	The Finnish Environment Institute 95-		
Sulevi Lyly	Helsinki University of Technology -95		
Pekka V. Virtanen	Urban Planning Continuing Education 95-		
Matti Kerosuo	Rail Administration 95		
Arja Aalto	Rail Administration 96-		
Jorma Lähetkangas	Finnra, Savo-Karjala region		
Aulis Nironen	Finnra, 95-		
Raimo Tapio	Finnra, -96		
Kari Karessuo	Finnra, 96-		
Mervi Karhula	Finnra, 97		
Saara Toivonen	Finnra		
Markku Linnasalmi	Finnra, -95		
Elina Hellstén	Finnra, 95-		
Anders HH Jansson	Finnra	Ulla Priha	Finnra, project co-ordinator

1.2 Results and their utilisation

Information produced by the project has mainly been published in Finnra's own publications. Interaction has been improved by taking up projects that stakeholders and co-operative partners are also interested in. This has made it possible to develop a consensus on cause and effect relationships and to outline mutual courses of action.

Figure 1: Traffic and Land Use project publications



Publication: ***67% Finnra publications***
33% other

Funding: ***60% Finnra alone***
40% co-operation

Mode of working: ***33% no other stakeholders***
67% with stakeholders

Studies and development work in small urban area road design have led to new guidelines. Also, an earlier guideline on road and street network planning in urban areas was expanded into transportation system planning. The co-operative effort has placed Finnra in the forefront in Europe as far as traffic and land use models are concerned.

The following special issues related to urban transport have been studied:

- links between transportation energy use and urban structure
- change in urban structure (fragmentation, attraction of traffic corridors)
- impact of shopping centres
- development of city centres
- promotion of public transport
- adapting a fast road traffic corridor to urban structure
- noise abatement in the townscape.

Research reports and new guidelines have been distributed widely. The most important publications have been sent to all local authorities. Results have been actively presented at seminars and educational events arranged by different organisations and in professional publications. The project has arranged annual training seminars, based on summary reports of the most significant results of the year. In addition, seminars were arranged in 1994 in several cities dealing with the theme "Urban areas and travel". The theme has been presented each year at exhibitions.

Summaries of publications:
Traffic and Land Use, summaries of publications; Finnra internal publications 29/95 and 1997 (in English; in Swedish, publ. 33/95 and 1997)
Annual reports:
Transport serves and changes the community - the interaction of land use and transportation; Finnra research reports 18/94, TIEL 3200228
Car society - studies on land use and transportation; Finnra research reports 35/95, TIEL 3200312
Car free city? - studies on land use and transportation; Finnra research reports 51/96, TIEL 3200419
Guides and general reports:
Transport and urban structure; Finnra research reports 40/94, TIEL 3200249
A Finnish community and sustainable development, redirecting land use, energy consumption and production, infrastructure and transport; Technical Research Centre of Finland (VTT), research notes 1703, 1995
Toward a sustainable town; seminar report, SAFA 1994
Urban areas and travel; The Finnish journal of housing and planning 4/95
Co-ordination of traffic and area planning in Finland; COST 332, mimeograph 1996
Building the environment; Ministry of Education video 1996

Interaction and innovation have been encouraged by arranging idea and design competitions. Four educational trips were arranged with co-operating sectors during the course of the project.

Idea competition for the centre of Savonlinna; Architectural competitions 7/92
Joutseno centre design competition; Architectural competitions 94
Roads & Environmental Art, open design competition for noise barriers in Rauma and Vaasa; Architectural competitions 1/95
Idea competition for the Airport road and its surroundings. Oulunsalo-Kempele-Oulu; Architectural competitions 4/96
Pappilanmäki idea competition, Kuopio; Architectural competitions 5/96
Idea competition for main road 3 from Haaga to Ring III, results of a design competition; Uusimaa road region 1996
Kankaanpää portal, idea competition

Noise protection and road milieu structures in the townscape - excursion to France and Spain; Finnra research reports 26/94, TIEL 3200227
Finns in traffic - on the road and by the road in central Europe, a travel report; Finnra and others 1996

The project has supplemented other environmental studies conducted by Finnra. Interaction between transportation systems and land use plays a major role in the May 1996 policy document, "Moving towards sustainability, Finnra's environmental policy and environmental goals 2005". One of the main areas of the policy deals with interaction between transportation systems and land use as follows:

> *The Road Administration develops transport system planning in extensive co-operation with all those involved. An interaction is sought between the transport system and the environment that contributes to developing a sustainable regional and community structure.*

1.3 What happens next?

Finnra has been a catalyst in the study of interaction between traffic and land use. As the project comes to an end, the next phase has already been started. The Ministry of Transport and Communications, the Ministry of the Environment, the Ministry of Health and Security, the Ministry of Trade and Industry, the Association of Finnish Local Authorities, Finnra and the Rail Administration have started the LYYLI program, "An environmentally favourable urban form and transport system".

An environmentally favourable urban form and transport system (LYYLI):
Proposed preliminary studies and projects; Ministry of Transport and Communications reports and memos, B:18/96
Research and development programme 1997-2001; Ministry of Transport and Communications reports and memos, B:18/97
Environmental problems, measures, object towns and methods; VTT research notes 1839, 1997
Preliminary study of the social aspects; STAKES, Themes 44/96

The objective of the program is to search for solutions where necessary transportation is handled with minimum traffic, using as safe and environmentally friendly modes of transportation as possible. This means solutions should be found that save energy, guarantee a healthy environment for different social groups and protect nature.

The program is directed towards target urban regions, where comprehensive courses of action are examined which will

- unify urban structure
- reduce passenger car traffic
- favour public transport, cycling and walking
- guarantee the vitality of city centres
- favour production and service structures that take the environment and different social groups into consideration
- improve the operational conditions for green logistics.

According to Finnra's research and development program 1995-97, the work of the project will be continued under the 'Urban areas' theme. The studies started within the framework of the project and continued under this theme deal with road management in valuable built-up areas, main corridors in urban areas, development of urban centres, the effects of shopping centres and experiencing roads. A further aim is to develop guidelines for planning and design of main roads in urban areas and urban area policy.

Finnra's *urban strategy* comprises elements developed in the Traffic and Land Use project:

- transportation system planning
- other collaboration with land use planning
- specification of the extent of the public road network (continuity, terminal connections)
- regional surveys of main road corridors in urban areas
- development of quality standards (esp. the quality standards of cityscapes along main road corridors).

Transportation system planning development plays a major role when basic policies are implemented in regional and local projects. Instruments and methods that extend beyond individual sectors are needed in the collaboration between Finnra and local authorities, representatives of different modes of transportation and users.

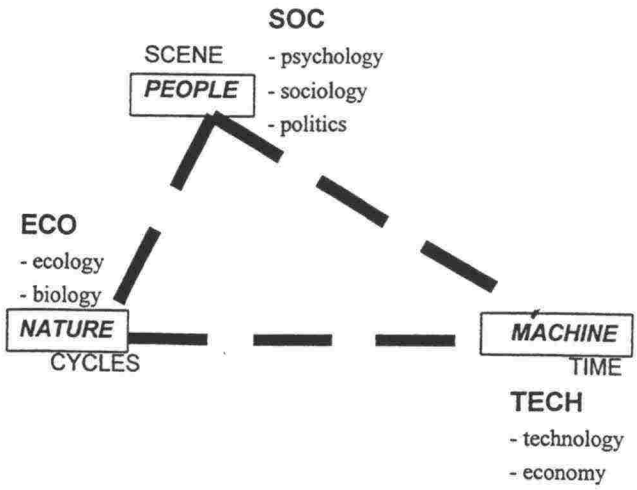


Figure 2: Environmental planning involves different logical views that need to be combined. There is no common basis for evaluation, and therefore no single method of planning (research report 44/94)

2 THOUGHTS ABOUT INTERACTION

Interaction between transport and land use, planning that influences this interaction, and Finnra's role in the process were objects of general evaluations made during the course of the project. Common to these evaluations is the conclusion that urban planning needs to be reformed. The present planning system is rigid and bound to the production of certain types of results. As problems and tasks become increasingly complex, planning requires both stronger principles and more flexibility. There is a need for specific, long-term goals and genuine commitment to those goals, but also for packages of measures that can be quickly modified according to the situation, place and mode of co-operation between different interests. Development of regional planning may be of great significance in the creation of a new system.

2.1 A friendly city

Harmony between cities and traffic; translated from the book "Zur Harmonie von Stadt und Verkehr", Transportation planning society 1995
Sustainable development and urban structure - the urban puzzle; Finnra research reports 15/94, TIEL 3200225
Ideas on traffic and land use planning; Finnra research reports 44/94, TIEL 3200253
Integration of land use and traffic in urban areas; Finnra research reports 81/96, TIEL 3200450

The search for the basic principles of a friendly city has extended to current European publications, such as Herman Knoflacher's book "Harmony between cities and traffic". His book's main theme deals with restoring city structures to a healthy basis by making walking the basic mode of transportation. Uncontrolled growth of cities, automobile traffic, automobile parking and even public transport destroy cities. Rearrangement of the transportation system, such as removal of parking spaces from in front of residences and off the streets, help stop this destruction. "If a city is built like an excitingly written, continuous novel for a human being, in other words, a pedestrian, then survival does not necessitate escape from the city."

In their report, 44/94, Kai Wartiainen and Vesa Peltonen seek a perspective on the development of land use and road planning. "The main characteristic of communities is complexity. All things are always examined from several simultaneous perspectives ...the quality of the traffic environment and other environment is evaluated in many ways, using human criteria for the realisation of happiness, that affect people's lives, and not as an implementation of simplified mathematical design models, curve radii or calculated plan densities."

In order to take different interests into consideration, several viewpoints need to be dealt with at the same time (cf. figure 2). Planning has to accept the concept of a rubber band-like network that sets in place according to the conditions prevailing in society at each given moment.

In his research report, 15/94, Markus Lindroos examines the effects of traffic corridors and motorisation on the Finnish urban structure. We use more than one square meter for roads and parking for each square meter of building area. The human point of view of city development is also emphasised in this study: "A sustainably developing city is a dynamic puzzle with never-ending new solutions, at the present moment and in the future. Preservation of the quality and functionality of the environment we live in comprises the assembly instructions. In this puzzle the pieces change their shape, new pieces appear and old pieces need to be rejected. We learn to assemble the pieces in new ways. The 'correct' solution may be short-lived. Man is the most important factor in this urban puzzle. He assembles the puzzle and is part of it, lives with it."

In a literature review (research report 81/96) Elisa Sanasvuori examines factors that have influenced building of Finnish cities, the present state of community structure and the transportation system in urban areas, and sustainable methods of unifying community structures in urban areas and reducing motor traffic. In order to reduce traffic demand and the hazards caused by traffic, transportation planning has to be dictated by land use planning, because the location of activities significantly influences the demand.

Cutting down on the amount of driving is seen as necessary on the one hand, and impossible on the other. When feelings enter the discussion, it is locked into contradictory positions. Rational discussion about travel according to the principle of sustainable development will be possible only after the object of discussion is clearly outlined.

2.2 Corridors and networks

Interaction between roads and land use planning; Finnra research reports 49/95, TIEL 3200326
Fill-in redevelopment, possibilities for a sustainable interaction of land use and transport in urban areas; Finnra research reports 23/96, TIEL 3200391

National main roads form the framework of the public road network. They connect cities to each other, but the design principles of these roads differ greatly from the type of design needed in urban areas. This difference is also expressed in the old statement that Finnra knows how to design rural roads, but not urban streets.

However, common features are to be found. This can be seen at the regional planning level, as is shown in a couple of studies. One problem apparent from Anna Saarlo's research report (49/95) on the influence of roads on land use planning and regional structure is that national-level planning happens too much at the local level, through separate projects. Local interests and viewpoints do not reach the national level, rarely even the provincial level. The correct forum for linking land use and transportation planning would be regional planning, but at the present it does not have enough influence.

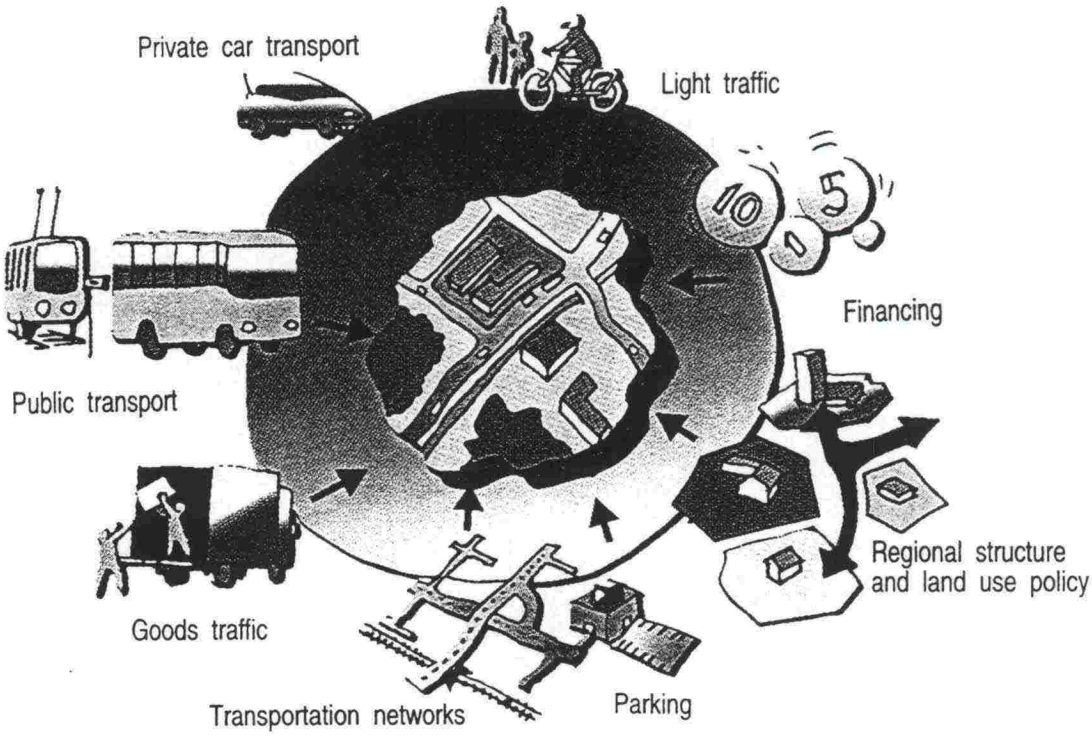
Risto Linkovuori's and Hannu Kivelä's research report (23/96) shows that regional viewpoints and identities are emphasised as a result of renewed regional administration. The significance of regional plans in community planning could be noticeably increased. Correspondingly, local authorities could develop close-range administration in the direction of smaller areas and local units. Linkovuori emphasises the concept of supplementary redevelopment in urban area development: restoring city centres, balanced corridor development in built-up areas, traffic calming, combining new construction and the principles of maintaining and improving existing structures.

Environmental policy analysis of the European route E18 project; Finnra research reports 45/96, TIEL 3200413

In their analysis of the E18 project, Rauno Sairinen, Vesa Kanninen, Sari Puustinen and Jukka Sirviö again take up national main roads, this time to clarify the relationship between road construction and environmental policy. The road project, which has been presented as one entity, is implemented piecemeal: stretches of the road have been built, often in the midst of contradictory discussion, where traffic problems have been the greatest and funding has been available.

Environmental arguments associated with the project can be summed up as a stand-off between 'traffic proponents' and 'environmental proponents'. Traffic proponents view the environment from the road, environmental proponents view the road from the environment. Finnra, and the regional road administrations in particular, are squeezed by many interests. Finnra's role is on the one hand to build and maintain roads, and on the other to reduce the environmental impact of traffic. This creates a contradiction. Environmental demands pressure Finnra to convert from new construction to maintaining existing roads and reducing the amount of traffic. This change is difficult and slow.

Figure 3: Functional environment of transportation system planning (MoT brochure 1994)



3 TRANSPORTATION SYSTEM PLANNING

One of the first transportation system plans made in Finland that also took land use aspects into consideration was the "Helsinki Metropolitan transportation system plan 2020" (PLJ 1994, Helsinki Metropolitan Area Council publication series A 1994:1). At the same time the Ministry of Transport and Communications, the Association of Finnish Local Authorities, Finnra and the Finnish State Railways developed an urban area transportation system planning general model. The core of the model is moving from sector planning to mutual planning and mutual examination of transportation systems and urban structures.

The transportation system viewpoint has been successful in implemented plans, but the link to other urban structures is still not satisfactory, and solutions to reduce traffic demand have not been found. The same problems are evident internationally. Key issues related to implementation are securing sufficiently strong commitment at regional and local levels and arranging financing for mutual projects without conflict with sectoral financial management. Finland's regional development system offers the possibility of moving away from sector-specific operation, but the search for sustainable operating models is still under way.

3.1 Development of transportation system planning

Transportation system planning in urban regions; MoT brochure 1994 (in English)
Planning of transport systems in urban areas; Finnra transparencies 1993
Transportation system plan; Traffic & road network guideline 1996, TIEL 2120004

The basic prerequisite for transportation system planning in urban areas is simultaneous planning of different modes of transportation and urban structure. It is essential in improving one mode of transportation that other modes and their effects are taken into consideration. Balanced development of the entire system makes it possible to use the individual parts more efficiently.

The transportation system planning process is the key to interactive land use and traffic planning. As part of urban structure planning it also provides a basis for individual project plans and designs. Transportation system planning is long-term strategic planning. It results in:

- transport policy objectives related to the division of responsibility among different modes of transport
- proposals for land use development

- goal-oriented transportation networks
- system implementation strategies
- packages of measures for developing the system and individual development projects
- assessment of the social, economic, traffic safety and environmental impact of the system
- a proposal for monitoring the development of the transportation system.

The local authorities are responsible for transportation system planning. Regional road administrations and regional development councils participate in the work. Organisations responsible for rail, bus, freight, air and water transport participate as appropriate. Planning is done together with residents, industry and commerce, other authorities and various organisations. The transportation system planning guideline was made by Finnra, the Ministry of Transport and Communications, the Ministry of the Environment and the Association of Finnish Local Authorities. The consultant was SK-consulting.

A revision of the metropolitan area transportation system plan has begun. It is linked to the development of the vision of the future of the area, PKS 2020. The revised plan will be decided upon in the beginning of 1998. Oulu, Tampere, Hämeenlinna, Lahti and Rovaniemi have plans ready. Preliminary studies of the Vaasa area have been conducted and work has been started in the Turku and Jyväskylä areas. Kuopio is developing a model and tools for urban planning together with the Ministry of the Environment, among others.

The goal is for every urban area with over 50,000 inhabitants to have a transportation system plan or to be developing a plan by the year 2000. About 30 areas have over 20,000 inhabitants, and transportation system planning will most likely also reach them. The model is not only intended as a tool for these areas, but it is also suitable for smaller built-up areas and special locations.

Transportation system planning in a developing rural built-up area, the case of Kausala in Iitti municipality; Finnra research reports 22/96, TIEL 3200390
Tourist area transportation system, Levi as an example.

The facilities for developing public transport in a small built-up area are limited. However, pedestrian and bicycle traffic service levels can be improved noticeably. The main questions to be discussed in transportation system planning are traffic safety, the quality of the traffic environment, and the direction of future urban structure development. In Kausala planning was linked to a study of the development of main road 12.

The plan (by Plancenter) proposed development of the road in its current location, because a by-pass could have unexpectedly large impacts on the future of the area.

The Levi tourist area is one of Finland's forgotten towns. Large tourist areas have sprung up around specific types of recreational activity and the needs of one season. They have not been seen as 'genuine' urban areas. But the volume and density of construction in these areas, and at certain times of the year the traffic volume, are greater than they are in many small cities. The transportation system plan for the Levi tourist area (Plancenter) aims at developing a ski bus system and building pedestrian routes, that together would reduce passenger car traffic by 30 %, even when the area grows.

Transportation system planning is based on principles of mutual responsibility for the environment, good land use planning and well-thought-out transportation planning. The new concept has been taken up to draw attention to these principles, not to create a separate, nation-wide planning system. In considering the possible benefits of the new procedure, one should also call to mind already existing modes of planning, real estate policy and other tools.

Figure 4: Has transportation system planning been successful in supporting urban reintegration (adapted from Martti Perälä's presentation at the Ministry of the Environment seminar on planning for integration, March 20, 1997)

- The role of the different modes of transportation:
  Car traffic, public transport, bicycle and pedestrian traffic are included in all plans. Rail traffic where it is relevant. Freight traffic is missing from some plans.
- Connections to land-use planning:
  Land use has not been closely linked to planning very often.
- Local authority co-operation and decision-making:
  Local authority co-operation has been realised in all plans. Decisions have usually been made by each authority separately. Plans have been approved as directives or as guidelines for subsequent work.
- Transportation policy supportive of integration:
  Some degree of transportation policy specified in all plans, but not always closely linked to the community structure.
- Ensuring the prerequisites for public transport, bicycle and pedestrian traffic, planning of areas favouring them:
  Centrally included in all plans. Nearly no harmonisation of urban structure to support them. Little discussion about the location or planning of areas that produce large amounts of traffic.
- Attractiveness and accessibility of urban centres:
  About half of the plans especially emphasise the role of urban centres.

3.2 International experience in support of planning

Development similar to transportation system planning is carried out in many countries. Information about different approaches and experiences has been gathered in support of our own work. Anders Jansson has gathered material from European Transport Forum seminars, for example, for Finnra's internal publications 16 and 51/96.

Transportation system planning and land use, three perspectives; Finnra internal publications 16/96, TIEL 4000137
Cities and an environmentally adapted transport system; Finnra internal publications 51/96, TIEL 4000158
Germany and the Netherlands; working strategies to avoid traffic? Finnra research reports 31/97

In 1989 Norway initiated a project, TP 10, integrating transportation and land use planning in the ten largest urban areas. Critical evaluation of the project indicates that successful integration would have required a new administrative and planning system with a better balance between administration, financing and other resources of the different sectors of road transport.

In the UK, the intent has been to develop the transportation system especially for urban areas using land use planning guidelines (PPGs). However, the new policies are most visible in projects initiated by the cities themselves, mainly inspired by Local Agenda 21. In these projects various sectors of city administration, inhabitants and business work together in developing operative solutions: bicycle and parking strategies, car pools, workplace commuting arrangements, pedestrian path networks, land use decision-making.

Many countries are also searching for models for developing cities so as to keep traffic demand, commuting, and car trips under control. Because growth in traffic demand is linked to fragmentation of the city structure, and because passenger cars are held as the main cause of this, a return to a more compact structure is seen as a model for arresting the growth in passenger car traffic. However, a straightforward interpretation of the high-density model has also received criticism.

In his study of European practice, Vesa Kanninen reports the experiences of development projects in Germany and the Netherlands. Avoidance of traffic appeared to be one of the cornerstones of integrative planning. This requires a suitable regional and land use structure, land use within this structure that causes as little traffic as possible, and organised mobility.

According to these experiences, a compact city structure is advantageous. It is essential to tie important activities and new construction to the existing public transport network. Area development should be favoured only if the availability of shops and services can be guaranteed. Leisure activities should also be based on nearby facilities. A suitable walking distance is less than 2 km.

Local authorities have a pivotal position in realising traffic avoidance strategies. The creativeness of strategies and the implementability and acceptability of projects differ. People's commitment to projects depends a lot on whether or not they have been able to participate in their development. The most important prerequisites for implementing a group of measures are money, often in the form of state subsidies, and commitment, which means strong enough belief in a common goal to be ready to make compromises. The basic problems of realisation are uneven distribution of benefits and disadvantages, costs and profits, with respect to different involved parties and regions, as well as time spans.

In the discussions in both Germany and the Netherlands, development of a special procedure for evaluating impacts on traffic has been proposed for projects that may have significant effects. The procedure is similar to environmental impact assessment.

3.3 Regional planning and traffic

At the time the Traffic and Land Use project was initiated, overall renewal of the building code and of the public roads act was expected. When a building code revision seemed to be imminent, Matti Narsakka was asked to examine how planning would be affected by this revision and the laws governing environmental impact assessment procedures and regional development.

The impact of changing environmental management structures on road administration design and decision-making; Finnra research reports 41/94, TIEL 3200250
Regional development and road planning; Finnra research reports 48/95, TIEL 3200325
Sustainable development in regional development activity; Finnra research reports 59/96, TIEL 3200426

The revisions were not realised as expected, so subsequent studies concentrated on regional development as it had evolved through new legislation, in 1995. Joining the regional boards of planning with the provincial associations to form regional development councils created a new model for planning.

Regional planning is now the responsibility of the councils. They function as regional development authorities, and also channel EU project funding. This model is still under development. The role of regional planning is still unclear, and the plans and programs emphasise traditional investment projects even though the involved parties lack the resources to realise them. Nevertheless, the model holds the potential for sustainable regional development. The new framework helps in moving away from sector dependence and in acting on the basis of realistic provincial possibilities and needs. Regional planning serves management of the regional structures and projects. The regional development model also supports the implementation of transportation system plans.

Regional development can be carried out in a sustainable manner if the participating organisations are capable of identifying the special traits and goals of development, and if they succeed in renewing their ways of operation and practice. At the least, the regional road administrations and councils should strive to place their activities and their impacts in a broader framework. Then it would be possible for them to consider incorporating sustainable ways of operating in their organisations and modifying the operations toward coordinated, comprehensive, sustainable regional development work. The councils need to be capable of keeping this process under their control.

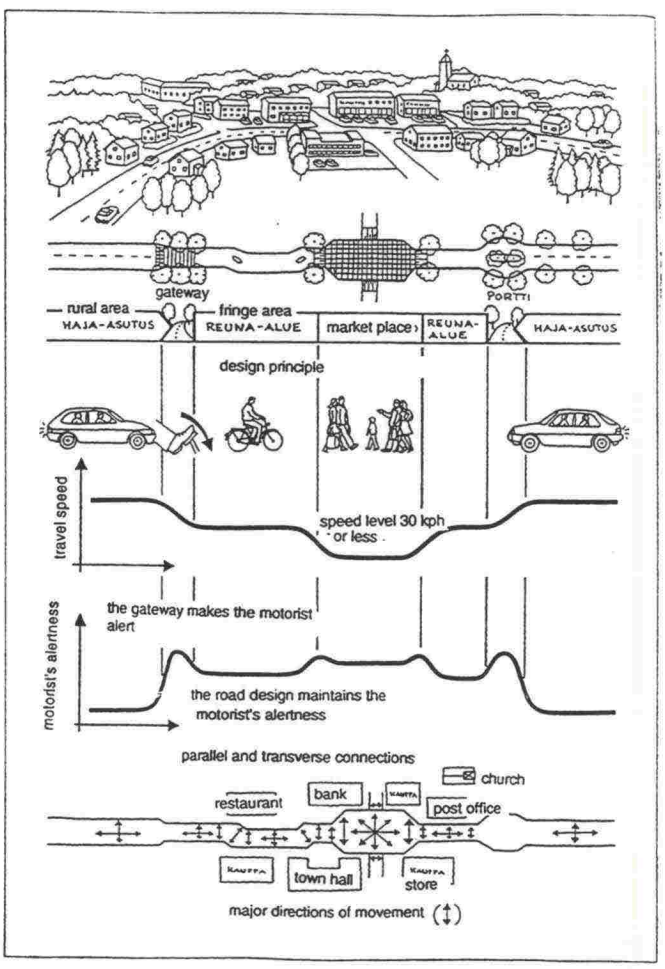


Figure 5: Principles of segmentation of an urban road (research report 37/94)

4 ROADS IN URBAN AREAS

Finnra's first guideline concerning planning of roads in urban areas was made in 1984. The guideline, "Roads in urban areas, planning traffic corridors and their environment" discussed ways of adapting urban roads to their environment. However, a study (LT Consultants) of urban roads realised in the 1980's indicated that successful adaptation required new methods.

Roads constructed in built-up areas in the 1980's; Finnra research reports 20/92, TIEL 3200076
Lighting in built-up areas, inventory of six areas with analysis and conclusions; Finnra research reports 73/93, TIEL 3200197

The roads had developed in a positive direction, but much was still needed with respect to the environment. The townscape usually was not taken into consideration. The road environment was part of the road, not part of the urban structure. Accident levels were lower, but still quite high. Average speeds were near the speed limit and peak speeds were high.

Lighting was given particular scrutiny because of its increasing significance in urban design. The inventory compiled by LT Consultants indicated that although lighting had been developed to adapt better to the built-up areas, and a search for distinctiveness was evident, the solutions did not always fit in with the situation and environment.

The Traffic and Land Use project developed new guidelines and guides for designing urban roads, participated in several pilot projects and monitored their implementation and results. New solutions and planning procedures were tested. The projects have found their role in the activity of the regional road administrations, although the operating model still needs development before solutions precisely suited to the nature and activities of each specific area are found.

4.1 Development of roads in minor urban centres

Development of roads in the centre of towns and villages with less than 10,000 inhabitants was seen as one of the main tasks of the project. The guideline, "Improvement of small city throughroads" by Jukka Turtiainen, Hannu Haapa and Seppo Karppinen described the principles of renewing planning and drew up a model for designing roads in urban areas. A large team of experts from Finnra and co-operating parties participated in the guideline.

Improvement of small city throughroads; Road design guideline 1993, TIEL 2110006 (mimeograph in English)
Minor improvements of roads in built-up areas; Finnra research reports 9/93, TIEL 3200136
Design guideline for urban area central roads; Road design guideline 1995, TIEL2110007

Large investments, such as renewal of roads in urban centres, should always be based on a clear plan for developing the structure of the area and the road network. Good end results depend on co-operative, simultaneous work by those drawing up land use plans, environmental plans and road designs. An open process is also necessary, where property owners, inhabitants and road users are able to participate in the planning phase. Before the plans are developed, the parties involved need to agree on the problems and the goals related to the environment and traffic.

Road segmentation is one of the most important tools in planning an urban throughfare. It identifies and marks the limits of different segments of the road - entry, approach to the centre, commercial street, main throughfare. In each segment, problems and characteristisics of the road and surroundings hould be as uniform as possible. A change signals a new segment. Different design principles are applied in each segment.

The main planning tasks are concerned with cyclists' and pedestrians' safety and improving their status, and adapting motor vehicle traffic to the surroundings, which means implementing speed limits of 30-40 km/h on roads in the centre of the area. Urban area roads should be developed for use by all inhabitants, and they should fulfil the social needs of all users. The designs should attempt to preserve or rediscover the small features, delicacy and details of the road and surroundings. The spatial character should be preserved. The types of pavement material, lighting, equipment and other details should be adapted to the nature of the basic townscape.

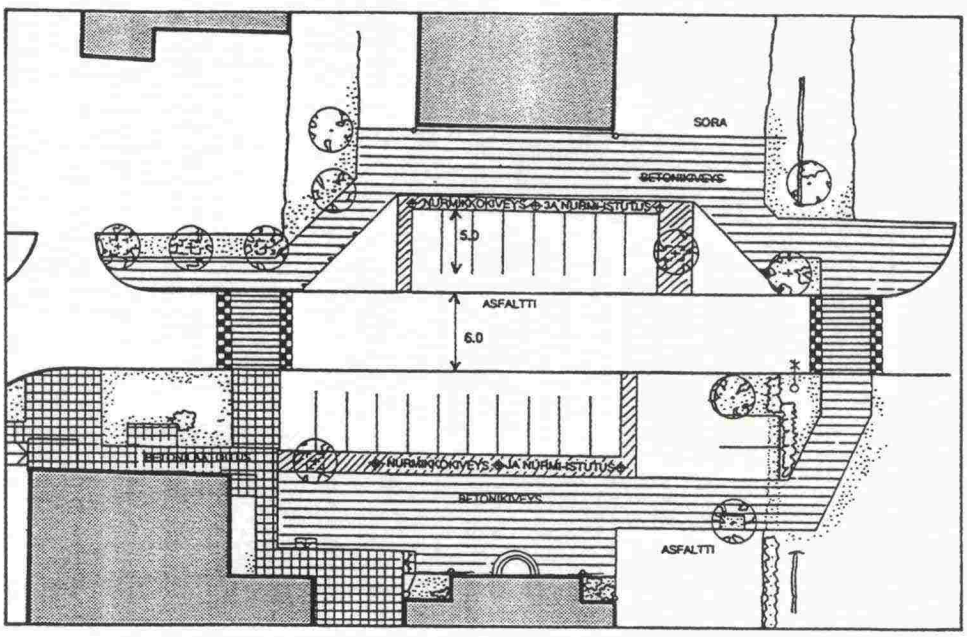
Ray Ottman, Liisa Ilveskorpi and Pertti Savolainen examined minor improvements to urban area roads. They concentrated on measures that improve traffic safety without major rebuilding.

A " Design guideline for urban area central roads" was completed in 1995. The guideline, made by the same group as the throughroads development guideline, deals with main through roads in town plan areas. By nature these roads are commercial streets. The development study examined six sites. Three sites and plans for other areas were also studied in compiling the guideline.

The guideline attempts to avoid setting norms, because urban areas are all different and solutions need to be adapted to each case. The guideline provides principles and examples to aid in selecting and designing a solution. It deals with speed limit selection, space utilisation, cross sections, geometry, intersections, constraints, details of the street, public transport and maintenance traffic, the extent of the road area and questions of responsibility.

Roads in the centre of urban areas vary from small village throughfares to compactly built heavily trafficked streets. To obtain good results of space utilisation, the corridor should always be integrated with the surroundings. A good street is always more than the sum of its parts. The area included in a plan reaches from wall to wall, regardless of the present limits of the road area.

Figure 6: Sauvo commercial square (Design guideline for urban area central roads)



4.2 Urban centre by-passes

Since the 1960's Finnra has invested in by-passes around built-up areas in cases where through traffic has caused traffic or safety problems. The impact of by-passes on urban area development is examined in chapter 7. As the by-passes change urban area structure, these changes affect by-pass traffic.

Traffic safety and milieu characteristics of by-passes of built-up areas; Finnra research reports 37/94, TIEL 3200246

A study by Kari Anttila, Heikki Kanner and Olli Kumpulainen chose 11 by-passes around urban centres for closer scrutiny out of 360 by-passes in the road register. The traffic safety of only three was considered good. By-passes were often built without links to land use planning. Road planning and land use planning functioned independently, and the processes had nothing in common. This has caused several problems:

- part of the old road may have been included in the by-pass, whereupon long-distance and local traffic still mix
- the by-pass cuts through the urban structure, and local traffic crosses the by-pass in many places
- services are spread out along the by-pass, activities conflicting with the standard of the road are located near the road and intersections
- the centre of the urban area where the throughfare was previously located is not redeveloped in accordance with its new role
- the location and layout of intersections of the by-pass may hinder development of the urban structure.

The study proposes a specification of types of by-passes which would help in defining their traffic-related and structural role, and their further development.

Figure 7: Types of by-passes (research report 37/94)

BY-PASS WITHIN URBAN CENTRE	**BY-PASS TANGENTIAL TO CENTRE**
A URBANIZED STREET	B TRAFFIC STREET
"CENTRE ROAD"	50...60 km/h
40...50 km/h	definite starting point and end
definite starting point and end	traffic lights possible
traffic lights possible	T- crossings and roundabouts
crosswalks	pedestrian and cyclist crossings grade separated
speed dampers	combined pedestrian/bike and car underpassages
BY-PASS AROUND CENTRE	**BY-PASS TANGENTIAL TO URBAN AREA**
C TRAFFIC ROAD	D TRAFFIC ROAD OR MOTORWAY
80 km/h	80...100 km/h
T- or split-level crossings	T-crossings (rural highways)
combined pdestrian/bike and car passages	split-level crossings (motorways)
pedestrian and cyclist crossings grade separated	pedestrian and bike crossings grade separted

4.3 Valuable built-up areas

Studies of the state of roads in urban areas and surveys of the road environment, in addition to other research by the regional road administrations, have identified sites with valuable milieus which have been saved from major changes brought about by construction activity. However, the townscape has suffered in many valuable areas because structural improvement or maintenance has raised the elevation of the road. It was necessary for Finnra to reconsider operating models for planning and construction in valuable built-up areas and surroundings.

A study of development of road management of built-up areas with valuable environments (Esisuunnittelijat) includes a register of nearly 200 valuable areas. The sites are traditional rural villages where new and old construction, greenery and road surroundings form a harmonious entity. These environments are very sensitive to changes. Road improvement projects in valuable environments require thorough evaluation, and better utilisation of basic information about environmental factors, history and culture.

National and local registers have been compiled of valuable areas, environments and cultural heritage landscapes. However, they are not complete, nor are they always up to date. There is always a need to verify the sufficiency of basic information about a valuable environment before planning or design.

Road management in a valuable environment; Finnra engineering news 29/97
Background information about valuable built-up areas; Finnra internal publications 1997

The "Road management in a valuable environment" guideline proposes implementation of a special co-operative procedure in all projects directed at valuable surroundings. The starting point for co-operation is mutually compiled registers of areas requiring special consideration. The collaborative effort should include regional environment centres, local authorities, museums and associations, regional development councils, and Finnra.

A similar team should be assembled at the initial meeting of the design project. Before starting, the values and problems of the area and the objectives of road management should be dealt with and defined by the collaborative team. Inhabitants should also be given an opportunity to participate in the definition of problems and goals, and in the planning process itself.

In designs for valuable areas, the success of the final result often depends on minor details, and it is especially important that surveys, analyses and resulting proposals made in various phases are transferred to the following phases of planning and design.

During construction situations usually arise where details of the designs need to be modified. In the course of the work one must be ready to specify solutions in more detail, particularly to further adapt them to their environment. The quality of work is also significant for of the end result. Maintenance requires special attention. Maintenance considerations should be included in the design, and data and assessments should be passed on to maintenance.

4.4 Project follow-up

In 1993-96 the regional road administrations studied the state of urban roads as part of the survey of the state of the public roads' environment. Assessment methods were developed in conjunction with a study conducted by the Oulu region

Analysis of built-up areas - appearance of built-up areas; Oulu RRA 1994

Three sites included as examples in the guideline on development of roads in urban centres were chosen for more detailed study and follow-up: before and after studies were conducted of projects in Ylistaro, Rantasalmi and Kuhmo. The Rantasalmi study was completed first (Karppinen, Krankka, Ruuth, Turtiainen, Tuominen, Vienamo):

Improvement of the Rantasalmi road, follow-up results:
Part 1, change in the townscape; Finnra internal publications 20/95, TIEL 4000110a
Part 2, measurements and calculations; Finnra internal publications 21/95, TIEL 4000110b
Part 3, interviews; Finnra internal publications 22/95, TIEL 4000110c
The Rantasalmi urban road improvement, summary of the follow-up; Finnra research reports 41/95, TIEL 3200318

Improvement of the road in Rantasalmi in 1993 made the central area more urban. In places the balance of the townscape is disturbed by a combination of street and road characteristics, such as rows of trees and curbstones, in a free geometric line, and one-sided crossfall of the carriageway. After the renewal no pedestrian or bicycle accidents have been reported to the police. The new crosswalk system was well utilised. Based on interviews, pedestrians and bicyclists were very satisfied with the new arrangements.

It was felt that moped driving was unsafe, because mopeds had to be driven in the midst of other motor vehicle traffic. Motorists accepted the lower speed limit and travel speeds have dropped noticeably in the centre. The amount of motor vehicle traffic has decreased. The amount of through traffic has fallen to half of its previous level. Evening cruising has also decreased significantly. Intersection functionality improved as the amount of traffic decreased and speeds dropped.

Kuhmo's central roads were renewed in 1993-94. Finnra's wall to wall renewal has produced well-balanced results, but according to the follow-up report, the building environment is disorderly in places (Karppinen, Krankka, Ruuth, Turtiainen).

Improvement of the Kuhmo urban roads, follow-up results:
Part 1, change in the townscape; Finnra internal publications 27/96, TIEL 4000142a
Part 2, measurements and calculations; Finnra internal publications 28/96, TIEL 4000142b
Part 3, interviews; Finnra internal publications 29/96, TIEL 4000142c
The Kuhmo urban road improvement, summary of the follow-up study; Finnra research reports 62/96, TIEL 3200429

The curves formed by the bays, turning lanes and divider islands are not always appropriate to Kuhmo's grid plan. Angularity and a tight layout might have defined the overall picture better. The street space is at its best in the peaceful small city-like market square. The 50 km/h speed limit has influenced the choice of action. Traffic safety improved in the commercial street segment and in the direction along the main road, but it wasn't any safer to cross the road in the entry segment. A problem in Kuhmo was that planning of the central road and the by-pass did not support each other. More efficient connections could have simplified arrangements in the centre. A lower speed limit would have made for easier solutions and possibly additional safety.

The before part of the study of the Ylistaro urban road is complete (Karppinen, Krankka, Lepistö, Ruuth, Tuominen, Turtiainen). The after part will be compiled in 1997.

Effects of the reconstruction of the road in Ylistaro on the townscape, evaluation of the initial situation; Finnra internal publications 63/94, TIEL 4000095
Improvement of the road in Ylistaro - traffic monitoring before; Finnra internal publications 23/95, TIEL 4000111
Improvement of the road in Ylistaro, summary of the follow-up; Finnra research reports 1997

Figure 8: Structure of the MEPLAN model (Traffic Engineering and Control, January 1995)

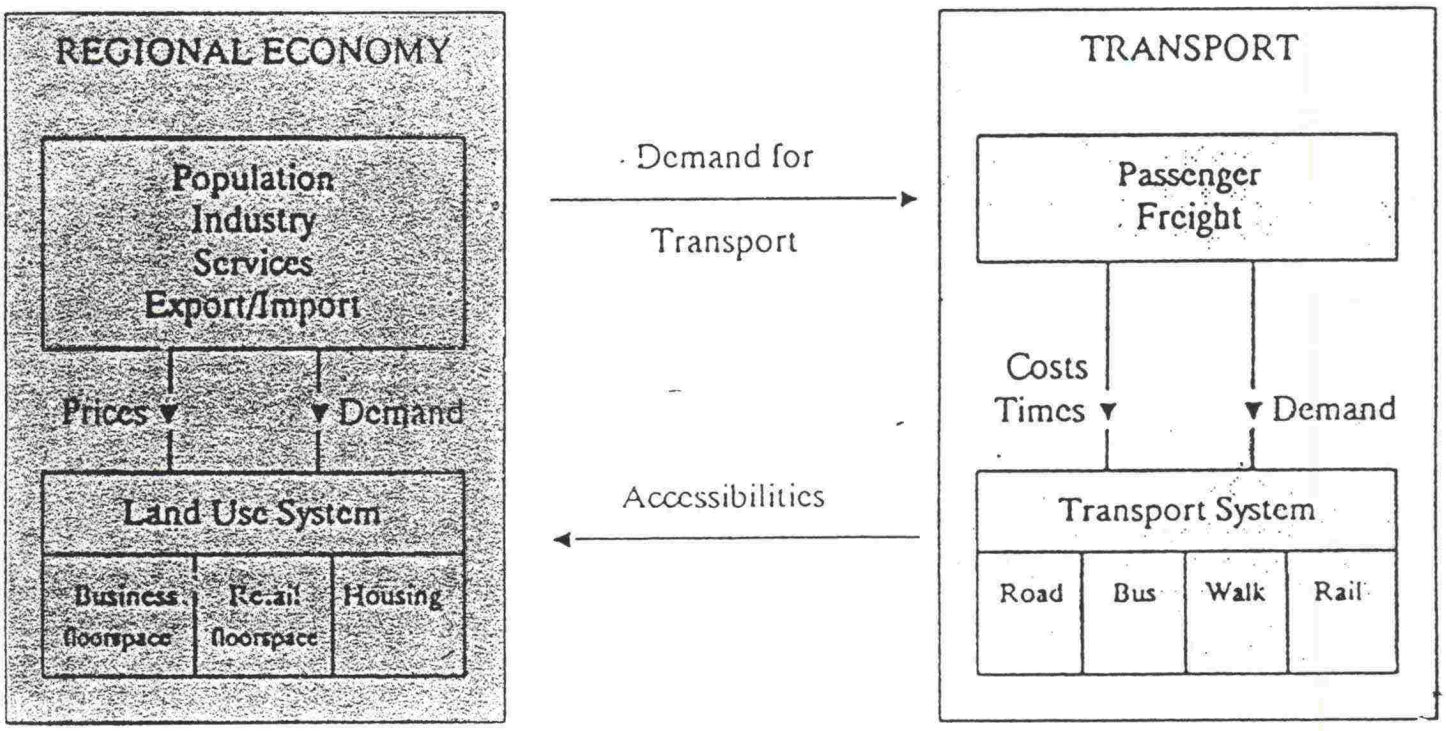


Figure 9: The main impact of the MEPLAN test measures

Factor	Toll Road System	Pasila Highway	Vuosaari Harbour	Marja Railway
All households	Some decentralisation	No major effects	Movement towards the inner city	Increases in the surrounding area
Households without cars	Movement outside the toll ring	Movement towards the inner city	Movement towards the inner city	Increases in the surrounding area
Households with cars	Movement inside the toll ring	Movement into the vicinity of Pasila Street	Major movement towards inner city	Increases in the surrounding area
Employment	Movement outside the toll ring	Movement towards inner city	Movement towards inner city	Increases in the surrounding area
Construction overall	Rises outside the toll ring	No effects	Movement towards the inner city	Increases in the surrounding area
Level of rents	Decreases in inner city, rises in other areas	Major effects in the vicinity of Pasila Highway	Rises in inner city, decreases in other areas	Effects on the surrounding area
Passenger mileage	No effects	Rises a little	Decreases	Rises
Private car mileage	Decreases	Rises	Decreases	Rises
Share of public transport	Rises a little	Decreases a little	Rises	Rises
Share of pedestrian and cycling modes	Rises a little	Decreases a little	Decreases	Decreases a little
Travel speeds	Rise	Rise	Rise a little	No effects
Travel times	Shorten	Shorten	Shorten	Lengthen for private cars, shorten for public transport

5 MODELS

Traditional traffic models have been able to take into consideration the impact changes in land use have on traffic flow by modifying the initial values of the model. The effect of traffic flow on land use was not depicted, and development resulting through interaction could not be estimated. The Traffic and Land Use project initiated adaptation of an interaction model to Finnish conditions. Possible models were examined and compared in a Ministry of the Environment project. The adapted model was based on this study.

MEPLAN pilot survey, a model of interaction between traffic and land use; Finnra internal publications 41/92
Interactive model for traffic and land use, experimental MEPLAN project in the Helsinki area; Ministry of the Environment, Land Use Department research report 9 93
Interaction between traffic and land use, evaluation of effects using the MEPLAN testing model in the capital region; Finnra research reports 17/94, TIEL 3200227 (English presentation in Traffic Engineering and Control, January 1995)
Helsinki region transport and land use interaction model; Uusimaa regional development council publications C25 1997

MEPLAN is a model system developed in the 1980's by the British company Marcial Echenique & Partners. Of the numerous interaction models available when this project was started, MEPLAN was the one most used in different urban areas. An application was developed for the Helsinki area, where extensive material on activities, land use and traffic was available. The development work was a co-operative effort by Kari Lautso and Paavo Moilanen from LT Consultants and the British company.

The structure of the model is based on two main principles: traffic demand is primarily derived from the economic interactions of land use, and on the other hand, the level of service of the transportation system influences the location of land use and the direction of economic flows. A model of Helsinki area traffic was made on the basis of the morning rush hour situation. The model was compared to large traffic-land use models made elsewhere by using it to test part of the activities tested in the extensive international ISGLUTI study.

The tests indicated that the model functioned consistently and logically. The tests also provided clues of how different measures directed at traffic and the city structure would affect Helsinki are development. In addition to the test results shown in figure 9, the model also tested the effects of various growth scenarios, land use control measures and traffic pricing.

The Uusimaa regional development council, with the support of a broad co-operative group, expanded the Helsinki area model to include the entire Uusimaa region. Application of the model as a common land use, traffic, economic and environmental evaluation model is being developed by the SPARTACUS project, within the 4th EU transport research framework program. The project will be ready in 1998. Four European consulting offices participate, led by LT Consultants.

Although the applied model has been simplified, initial data collection and calibration of the model require considerable resources and information. This model is suitable for Finland's largest urban areas. For this reason, LT Consultants were asked to study application of a simpler model:

HLFM land use model, functioning principles and a Finnish application; Finnra research reports 69/93, TIEL 3200194

The HLFM model is a land use forecast software package developed in the USA. It predicts the effects of changes in the transportation system on local land use. This model and a related traffic model are suitable for predicting land use and traffic in mid-sized cities (50 000...200 000 inhabitants). Kuopio was selected as an application example. The model functions best in examining the effects of a new, significant traffic corridor on population and job development in a given area. A functional model was constructed and the changes in land use it predicted were logical. The model has been used later to monitor the Heinola by-pass, among other sites.

A basic problem in applying models is the lack of information about traffic in urban areas. In all except the largest towns, only some cross sectional information about traffic flow on the streets and roads is available.

Traffic volume, energy consumption and emissions in Finnish urban areas; Interim report, MOBILE 218 T, 1996

In the MOBILE 218 T project, the Technical Research Centre of Finland has developed a method for defining traffic volume in urban areas. It is based on aerial photos, GIS and traffic counts. The method was tested in 11 areas in 1996, and in 1997 the aim is to estimate the traffic volume, energy consumption and emissions in Finnish towns. The method will be modified to make it suitable for use by the local authorities.

6 TRAFFIC VOLUME

What factors affect traffic volume? This question has been studied in the Traffic and Land Use project by examining the effect of city structure on transport energy consumption, by estimating the effects of road projects and transport-oriented activities on traffic, by examining the significance of the price of fuel, and by looking into the possibility of using new technology to influence the amount of workplace commuting.

The conclusions of the various studies explain the development in car use or traffic volume in different ways. The differences often exist because different questions have been asked. From the standpoint of passenger car use, the degree of motorisation stands out as the most important factor. There are no longer any geographical differences in the degree of motorisation in Finland. Half of the growth in the amount of travel during the recent decades is the result of motorisation. However, car ownership has less effect on the way cars are used than do the travel conditions offered by the structure of localities. Compactly-built, densely-populated city structures with mixed land use are advantageous with respect to traffic energy consumption.

A new traffic corridor brings some increase in traffic, although the number of completely new trips is only 2-3 %. Activities situated along the corridor can have a much more significant impact on traffic volume and direction.

The studies of the possibilities of reducing the amount of commuter car traffic place emphasis on workplace arrangements, where the involved parties include the local authority, employer and employees. Another important question of car use is development of leisure time travel. Long shopping trips are by their nature also leisure trips. The price of fuel affects traffic volume, but it isn't likely that such price increases could be implemented in Finland that they would have a significant effect on the amount of travel.

6.1 Energy consumption of traffic

A study was initiated in Norway in the beginning of the 1990's with the aim of testing claims presented concerning the relationship between city structure and energy consumption. The study covered 22 Norwegian cities, 97 Swedish cities, commuter areas of 15 Swedish cities, 30 residential areas in Oslo and 6 companies in Oslo.

A report by the head of the project, Petter Naess, was published as Finnra research report 9/94. The primary conclusion was that the most important factor of city structure affecting traffic energy consumption in the city was the surface area of the built-up area per inhabitant. The greater the surface area, the greater the probability of high traffic energy consumption.

Transport energy demand and urban structure; Finnra research reports 9/94, TIEL 3200220
Connections between energy consumption by road traffic and urban structure, a pilot study; Finnra research reports 10/95, TIEL 3200288
Connections between road traffic energy consumption and urban structure in Finnish towns; Finnra research reports 14/96, TIEL 3200383

Matti Matinheikki conducted a similar study in Finland. A pilot study covered 20 towns, and the actual study covered 35. The towns were grouped by size, and various key figures were calculated. Nine were scrutinised more closely. The Helsinki area was not included in the study. Energy consumption was based on the amount of fuel sold in each town, and the close connections between towns in the Helsinki area would have introduced too great a risk of error in estimation.

The energy consumption of road traffic in the two groups with the smallest towns was nearly the same: 33.4 GJ/inhabitant per year in areas with less than 20,000 inhabitants, and 31.5 GJ in areas with 20-50,000 inhabitants. The average for towns in the largest group was 25.2 GJ/inhabitant per year, which is noticeably lower. Cities with large populations seem to have better conditions for lower consumption. This was confirmed by a comparison of the consumption of the 10 most populous and 10 least populous towns: 24.9 GJ and 34.1 GJ. Location of the town in southern or northern Finland had little significance.

Correlation and regression analysis was use to study the relationship between structure and energy consumption in three models. The relationship was best depicted by the variables "boundary length of built-up area per inhabitant" and "surface area of built-up area per inhabitant". Good correlations were also obtained using built-up area population, the number of inhabitants in the town and the length of the trip to work.

There was no regularity in the level of road traffic energy consumption in towns with less than 30,000 inhabitants. The consumption level was lower and more even when the population exceeded 30,000. Based on the material, factors depicting land use density correlated well with road traffic energy consumption. As the density variable increased, the level of energy consumption decreased.

Low road traffic energy consumption is likely if

- the population of the town or built-up area is large (over 30,000)
- the built-up area boundary length / inhabitant is low (< 5 m/inhabitant)
- the built-up area surface area / inhabitant is low (< 2200 m^2 /inhabitant)
- the total building floor space / built-up area surface area is high (built-up area floor space rate $e_a > 0{,}025$)
- the percentage of multistorey apartment buildings is high.

A radial structure was the most advantageous urban structure as far as energy consumption is concerned. Point-like and ribbon-like structures had higher consumption.

6.2 The impact of a new route

A new route improves the level of service for car traffic, in particular. Many activities that produce traffic locate along it. It is often said that a new route also generates more traffic. Two studies examined the functioning of these mechanisms in Finnish conditions.

Traffic generated by junction-oriented land use; Finnra research reports 55/94, TIEL 3200264
The traffic generated by a new road investment; Finnra research reports 13/95, TIEL 3200291

Sari Korpinen examined the interaction between intersection-oriented land use and traffic. Nine sites with significant changes in land use were chosen for study. All the sites were located along good traffic routes near large traffic volumes. The amount of travel generated by shopping centres is typically 40...50 trips per day for each 100 m^2 of floor space, but the figure is 100 or more for warehouse-type stores. Travel generated by industrial firms was determined for two firms, and theoretical figures were assigned to the rest. Theoretical figures assigned to the two firms corresponded well with reality. For industry, location didn't bring surprises to land use or transportation planners; few conflicts arose during planning, and the effects were predictable.

Hannu Lahelma and Hannu Pesonen estimated the amount of traffic generated by a new traffic corridor in the cases of the Hämeenlinna motorway on main road 3, and the Heinola by-pass. Based on these studies and other material, it was determined that traffic switching from other routes increased traffic on the new road by 10-15 %. Changeovers from other modes to cars were less than 1 %. The amount of new traffic generated was 2-3 %.

It is difficult to estimate the long-term effects of a new route. Changes in traffic due to other reasons, other developments in the population and other changes in land use form an entirety, and it is difficult to isolate the effects of one road segment.

6.3 Influencing people's use of cars

Price of fuel and car use by households; Finnra research reports 73/95, TIEL 3200349
Information transfer saves time and trouble, reduction of the use of energy for work-related passenger transportation; LINKKI program publication 10/96

One of the traditional and most noticeable economical methods of control is fuel pricing. Statistics Finland's consumer barometer surveys were used in Saara Pekkarinen's study of the impact of changes in the price of fuel. The surveys were conducted in March of 1990 and 1991 and in February of 1993 and 1994. Nominal prices rose over 9 % during this period, real prices, about 2 %. The change is small compared to the recession that hit during the same period, and the surveys showed no effect on car use.

Households do not react much to expectations of small price increases. The 1991 survey asked how great a price increase would cause households to significantly reduce their use of a car. The threshold value was slightly over 2 FIM/l. In 1994 the same question produced a value between 2.4 and 2.7 FIM/l. A threshold value of 2 FIM would also cause households to abandon the thought of purchasing a second car. A 3 FIM rise would influence their trading in a car, selection of the mode of travel or ownership of more than one car. A 5 FIM increase would cause them to get rid of their car or move.

Based on the responses by the households, present structures and services are so car-dependent that a significant increase in price would be needed before households would cut down on their use of a car. It's another thing if a combination of different methods could be devised. Integration of community structures and transportation systems should be foremost, so that a generally accepted level of well-being and quality of life is also possible without a car.

Efficient use of data transfer equipment is one method of influencing the need to travel. The traffic and land use project participated in the LINKKI program "Information transfer saves time and trouble" study (Veli Himanen, Pirkko Kasanen and Mervi Lehto) focusing on work and a reduction in work-related passenger traffic.

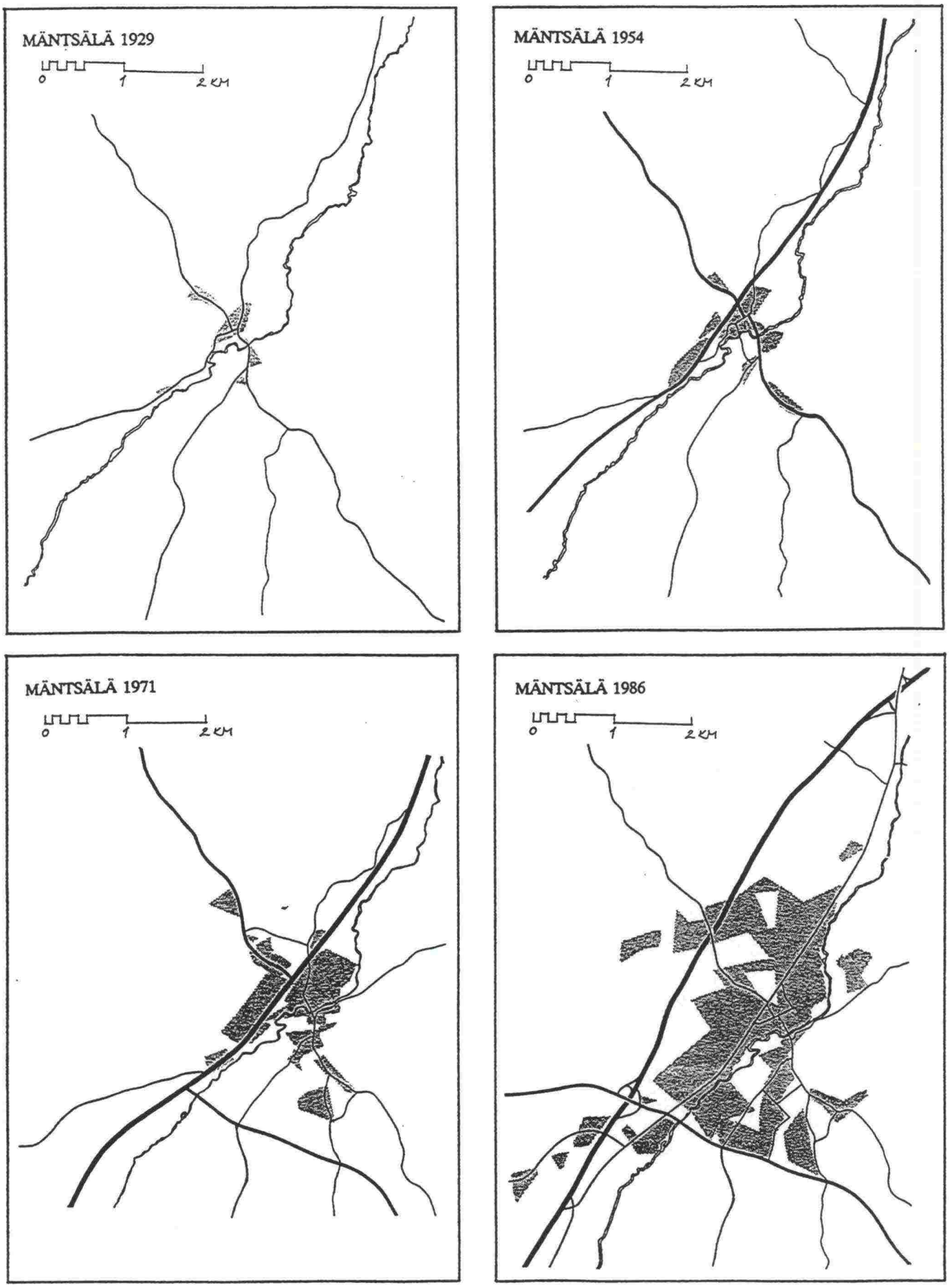
Activities that could possibly reduce the amount of passenger traffic include telework, flexiwork, telemeetings, tele-education, telematic distribution, retrieval and transfer of information and services, situation of firms in the same facilities as their main interest groups, virtual offices and local information centres. The reduction in travel could come from shorter commuting distances from home to work or from less travel needed during the workday.

Research has concluded that the savings potential of work-related passenger travel is approximately 1400...1500 GWh per year. The lower limit exceeds the energy consumption of domestic air travel and the upper limit is equivalent to the total consumption of domestic air and rail travel. Small apartments are one factor limiting telework. Only 15 % of the population lives spaciously enough to permit setting aside one room for work at home. Then again, available space also influences a person's willingness to do telework. The question of space drops the estimated energy savings potential to about 400 GWh.

The energy consumption of information-related work equipment was about 470 GWh in 1994. Part of this energy has been used to heat buildings, but in summer it has also increased the need for air conditioning. The consumption of individual machines is decreasing, but the number of machines is increasing. A certain number of them would be used by teleworkers.

Structural conditions also affect the possibility of making choices. Structures change in the long term, e.g., as relative costs change, but it is difficult to influence them in the short term. Energy consumption is affected more by structural changes than by telework. Often it is a question of using telecommunication and telework to ease the pressure for more travel caused by structural changes.

Figure 10: Generations of by-passes in Mäntsälä (By-pass and built-up area)



7 CHANGES IN CITY STRUCTURE

In 1983 the research office of the National Board of Public Roads and Waterways (TVH) published a preliminary study, "Effects of by-passes" (TVH 713239). It concluded that by-passes affect different kinds of businesses in different ways. Service stations, restaurants, coffee shops and hotels tend to locate near roads. With the advent of the Traffic and Land Use project, it was noted that by-passes had more far-reaching effects than this. Changes in the road network had significant effects on the development of the whole land use structure.

Activities, starting with workplaces and services, locate near by-passes and main roads, especially near intersections. This tendency is often reinforced by land use plans and policies of local authorities competing for business, regardless of the possibility of serious consequences from the standpoint of existing centres, service structure and traffic safety.

During the period of motorisation, urban regions have grown, while the density of their centres has decreased. The reason behind this trend is the increase in living space. In searching for a more spacious living environment, people have exploited the possibility cars have offered of acquiring cheaper lots farther away. Even so, current city structures include areas suitable for pedestrian traffic and public transport. Often these areas were originally planned on this basis. Better exploitation of these areas would slow down the rate of motorisation and the need to increase motor traffic.

7.1 By-passes

Over half a decade after the preliminary study, the effects of by-passes were again studied. Nine rural built-up areas with by-passes built between the 1950's and 1980's were the object of a study, "By-pass and built-up area", initiated in 1989 by Heikki Kukkonen and Kirsi Uotila. It was completed as part of the Traffic and Land Use project.

By-pass and built-up area, a study on the effects of a by-pass on the structure of a built-up area; Helsinki University of Technology, Faculty of Architecture publication B 22, 1992
The effects of the northern by-pass of Kouvola; Finnra research reports 66/92, TIEL 3200116
Impacts of the by-pass road on the Heinola urban area; Finnra research reports 91/95, TIEL 3200366

The most significant of the changes to built-up area centres caused by by-passes is gradual migration of the centre to a new location. As recently as the 1960's small and mid-size centres clearly showed their original location near an intersection of important roads. A by-pass brings competing intersections alongside the original main intersection, decreasing the traffic-related significance of the old centre. Final migration of the centre is certain when the local authority or state administrative offices are moved to the new location. This process begins no later than 5 years after the by-pass is completed. In a good 30 years the process is complete.

Industry exploits a by-pass most quickly. It does not need to locate near an intersection, other land along the road suffices. This is why a small industrial area is one of the first forms of built-up land use to appear along a by-pass. This type of land use also has a tendency to expand and attract other services and, eventually, residences.

Residential construction may migrate as slowly developing roadside building, usually in the form of single homes or groups of homes. This is followed by ribbon-like residential building along the road, which eventually leads to town plans and more building. Another form of migration takes place when the local authority acquires a piece of land for residential construction along one or both sides of the new road. This is quickly followed by more building and a network of roads or streets.

The northern by-pass around Kouvola, on main road 6, was completed in two phases, in 1973 and 1978. According to Anu Tuominen's 1992 report, the most significant effect of the by-pass on land use was the birth of the Puhjo service area at the intersection of the main road and the Kuusaantie road connecting the centres of Kouvola and Kuusankoski. The area affected the development and local balance of workplaces in the cities. Initially, the area significantly weakened Kuusankoski's centre. Later the same effect extended to the centre of Kouvola. Both cities have attempted to revive their centres, but so far the location and attraction of the service area has been overwhelming.

In 1995 when Timo Kärkinen, Antti Meriläinen and Riitta Väkeväinen examined the effects of the by-pass built around Heinola in 1993, a new service area for road users and a recently opened shopping centre near the intersection were attracting buyers, especially from the rural area around Heinola. They did not hurt the specialty stores in the centre of town. The by-pass was a noticeable improvement from the standpoint of the travel, traffic safety and satisfaction of Heinola's residents.

7.2 Along main corridors or off to the side

Interaction between traffic and land use on highway 3 between Helsinki and Tampere; Finnra research reports 65/92, TIEL 3200115
Effects of a traffic route on the community structure of its immediate surroundings; Finnra research reports 22/93, TIEL 3200148
Location of industry in Finland, from waterways to highways; Ministry of Transport and Communications, publications 52/94

Main road 3 between Helsinki and Hämeenlinna is Finland's longest continuous stretch of motorway. Risto Murto, Jorma Mäntynen and Jere Maula studied the effects of the main road on land use planning in 14 local authorities along the route. The motorway from Helsinki to Hämeenlinna was not open yet when the plans were made. The main road had little impact on the direction of expansion at the end points at Helsinki and Tampere. No special activities sprang up near the interchanges in Helsinki. Neither was there any vigorous growth along southbound route 3 in Tampere. But, the pressure to expand industrial areas that did not explode in Helsinki did so immediately outside the city. Industrial and business space planned along the northbound route from Helsinki comprised a growing share of the workplace floor area of entire towns.

Timo Halme examined the development of the area influenced by main road 3 before the motorway was completed, based on Statistics Finland's census data gathered in 1970, 1980 and 1989. He studied the areas near the main road between Nurmijärvi and Tampere. The greatest changes in the population occurred in the core of the cities. The residential areas spread and their density was reduced. People moved from fringe areas toward the centres. As the share of old people increased in the population, younger people moved to areas surrounding the centre along the main road. These areas were the newly-grown commuting regions of Tampere and Helsinki. People in distant areas moved to local centres. The share of old people grew the most in rural areas, but also in the largest core centres.

Workplaces moved toward the city centres and the roads. Usually, the number of workplaces grew sharply within 1.5 km of the intersections, and workplaces were centred near the roads.

Areas that lost relatively large numbers of workplaces were more than 10 km from the road. Retail jobs were located in the city centres, but during the study some of them moved to the main traffic corridors and centres of suburbs and the number of workplaces decreased in the core centres.

In their study, "Location of industry in Finland - from waterways to highways", Kimmo Koski and Pekka Lahti search for answers to how industry has been located in Finland since the turn of the century, how transportation networks have developed in our time, and how decisive an effect they have had on the location of industry.

Already in the early 1900's, transportation networks had a strong effect on industry location. Finland was just beginning to develop communications and industry, and forestry decisively linked the two to each other. The impact of roads was negligible at this stage. The effect of railroads was weakened because their development was controlled more by administrative and military aspects than forest resources, the cornerstone of Finland's economy. At this stage, waterways were instrumental in determining the location of industry.

Over the decades, the influence of waterways has weakened much quicker than their share of freight transportation volume has fallen. Ton-kilometres transported by water routes did not begin to drop until the 1980's, while the location of industry was mainly defined by main roads and railroads already in the 1940's. Railroads had the greatest influence on location from the 1920's to the 1940's, but it began to weaken in the 1950's. The share of goods transported by road and by rail was equal at the end of the 1950's. Since then the importance of road traffic and main roads has increased steadily. However, not until 1993 did the share of industrial buildings located along main roads equal the share along railroads in all the provinces in Finland.

The effect of a new main road on the location of industry is strongest about ten years after the road is built, but the impact of city entry roads, by-passes and motorways is visible immediately. However, examination of trends in location does not suffice to determine the significance of transportation networks in establishing new firms. For example, a noticeable renovation of the main road network in Oulu province implemented in the 1970's affected the development of the location of industry, but it undoubtedly was not the decisive reason for the industrial upturn, which began already in the 1960's.

Reasons for the location of enterprises near traffic junctions; Finnra research reports 5/94, TIEL 3200216

Risto Murto investigated reasons why firms locate where they do by asking representatives from 20 firms. The reason common to all industrial companies for moving from their old facilities was that they had become too small or their location was logistically weak.

Local authorities competed among themselves to attract these companies. Quick, flexible actions by the administration were important to the firms. Stores attempted to locate in places where there was a lot of people. Retail stores were very active themselves, and they made proposals concerning their location. The store chain main firms usually participated in the process, and then rented the facilities to the storekeepers. Good logistical location, preferably near an intersection of main roads, was essential for wholesale businesses. Motor vehicle dealers emphasised the proximity of main roads. Restaurants looked for locations with good visibility and easy accessibility.

Thirteen firms mentioned good traffic connections as the primary reason for their location. An active local authority and good benefits stood out as a secondary reason. Traffic connections were most important for stores. Customers were the most important factor influencing location.

Changing countryside based on location information; Nordia bulletins 2/97
Attraction factors in sparsely populated areas and the travel behaviour of their inhabitants; Finnra research reports 24/97

A "Sparsely populated areas and the cost of travel" project initiated in the autumn of 1996 is studying factors influencing choice of location, travel habits and travel costs of people living in sparsely populated areas. In an interim report Jaakko Kauppinen has examined rural areas on the basis of location information.

Although rural areas cover about 95 % of Finland's inhabited surface area, their inhabitants account for only 1/4 of the total population. The rural population and inhabited area is continuously shrinking, and the age structure in isolated, sparsely populated areas is getting older. The population near the main road network has not decreased as much as in other areas.

7.3 City structure and motorisation

In built-up areas, the period of motorisation has been a time of vigorous population growth and spreading. A research report by Risto Linkovuori and Hannu Kivelä, "Structure of built-up areas and the era of motorisation", explored the development of 20 cities from the beginning of the 1950's to the present day.

Structure of built-up areas and the era of motorisation; Finnra research reports 61/94, TIEL 3200270
Internal structure of the town - disintegration of urban structure, commuting traffic and the change in the functional structure of the core centre; City of Kuopio publication ER 1995:1

Motorisation began at the end of the 1950's, when passenger car import limitations were removed. No difference is noticeable in the process of motorisation in different cities. Households with more than one car did not become common until the 1980's. Common to the most motorised cities is a relatively small built-up area and relatively little bus traffic. The least motorised cities have a relatively large built-up area.

Availability of public transport seems to depend on preconditions created by the structure of the built-up area and surrounding region. These preconditions include, above all, high population density, population potential, ribbon-like corridor-dependent structures and links to other built-up areas. If bus traffic is busy, train traffic is quiet, and vice versa. However, the availability of public transport has little effect on motorisation.

The effect of motorisation is apparent in the development of the number and quality of roads and the fragmentation of the urban structure. Public roads that previously mixed with the street network have been separated from the internal traffic of the urban area and utilised as separate main corridors. In some cases the by-pass has become an entry or through corridor because a built-up area has grown around it.

Some cities have examples of successful by-pass solutions, i.e., the corridor is still functional and separated from the urban structure. Successful by-pass solutions are typically located at a suitable distance from the centre of the area and they contain few intersections in relation to the size of the town.

The population density in most of the urban areas has decreased because of local authority mergers and as a result of motorisation.

A simultaneous turning point in the growth of living space and the decrease in population density can be observed in the 1970's. At the same time as the urban regions have grown, the population of urban centres has decreased.

Timo Halme examined the fragmentation of city structure using Kuopio, Jyväskylä, Lahti and Oulu as examples. In each case, the population of the city centre has dropped and the city structure has spread into the surrounding municipalities. Most of the workplaces are still located in the city. Along with the growth in the functional urban area, urbanisation has turned into regionalisation. Dispersal affects traffic volume. Walking is a significant means of commuting only for people living in the city centre. Location of workplaces in or near the suburbs did not appear to shorten commuting distances.

Public transport city - comparisons 1995; City of Kuopio publication ER 1996:1
Motorisation and lack of a car; City of Kuopio publication ER 1996:2

The city of Kuopio's master plan project, headed by Leo Kosonen, has attempted to examine more closely motorisation in one city. The city is divided into zones. Zones I and II represent areas originally planned for pedestrian use, zone III according to the principles of a public transport city and zone IV follows the principles of a motorised city.

The zones differ from each other particularly in the number of people without a car (persons with no car in their family) and people who ride (people who have only random access to a car). Differences in the relative share of people with cars are smaller. Most of the elderly people live in the city centre or areas surrounding it. The share of pensioners with cars is still relatively small. Most of the young people live in zones III and IV, and they need rides to school. This situation will change as these areas get older.

About 31 % of Kuopio's inhabitants have personal use of a car or van. About 29 % have no car. Of the households, 58 % have a car and 42 % do not. A traffic survey conducted in Kuopio in 1995 was analysed by separately examining the responses of people with cars, riders and people with no car. The systems of the city structure and the related degree of motorisation are of primary significance. People with cars do not use buses, and there is no indication their travel habits would change. To avoid growth in car traffic and motorisation linked to city structure, particular emphasis should be placed on reviving the pedestrian city and the public transport city. Most of the people in these areas manage without a passenger car or use one only randomly.

7.4 Indices of change

Two studies deal with methods of estimating change brought about by road projects and the road network.

Developing strategic impact assessment; Finnra research reports 30/96, TIEL 3200398
Land use changes in road surroundings; Finnra internal publications 14/97, TIEL 4000172

A research report on the development of strategic impact assessment conducted by the Technical Research Centre of Finland and LT Consultants looks for methods of estimating the impact of a cluster of projects or measures more extensive than a single road project. The effects on commuting of the E18 development projects are assessed with the help of GIS-based commuting data. According to the study, the projects have no effect on most of the commuting trips made within the area. The effects are concentrated on a few, especially long commuting trips. In examining local economic impact, the study explores how a change in accessibility affects economic viability indicators.

Sami Kuitunen's graduate study examines explanatory variables of the housing market, variations in economic cycles, population increases, the price of lots in town plan residential areas, shoreline lots outside planned areas, completed buildings and floor areas specified in planned areas near roads, as indicators of changes in land use and related trends. The indicators do not show the direction of change in land use quickly, but only after a delay of years.

8 CITY CENTRES AND SHOPPING CENTRES

City centres and shopping centres have competed for customers and traffic flow since the late 1970's. Although the first significant shopping centres were established in the late 1960's, the business sector and decision-makers realised quite late the impact they have on the fate of not only local stores, but the entire service structure. Shopping centres have commanded an increasingly dominant position in the 1990's, but at the same time more emphasis is being placed on the functionality, atmosphere and service capacity of traditional city centres.

The Traffic and Land Use project participated in a study of the effects of shopping centres and in developing methods of renewing city centres. Business and service aspects of pedestrian streets and pedestrian centres have achieved a noticeable role in city centre renewal, partly superseding aspects of traffic and reducing traffic demand. City centres compete with malls by emphasising diversity, nearness and quality of service, also for inhabitants using different modes of travel.

8.1 City centre renewal

Reformation of the Pietarsaari town centre; Finnra research reports 54/93, TIEL 3200179
Nordic pedestrian centres; Ministry of the Environment, Land Use department, research report 5 94
Pedestrian town centres in Finland; Ministry of the Environment, Land Use Department, research report 23 96
A better city centre; Ministry of the Environment 1998 (Publication: **Seven city centres**, Ministry of the Environment 1997)

An 1800 m^2 department store, Tenna, had already located outside the city centre of Pietarsaari when a 4500 m^2 Prisma department store was built there in the autumn of 1989. As a result, the annual retail sales volume outside the city centre grew to 50 million FIM. Of this growth, 19 million FIM was due to an overall increase in sales in the area, 28 million came from a decrease in sales in the city centre, and 3 million from a drop in sales suffered by other stores selling perishables. After this, a 4000 m^2 store was planned for Kesko.

To preserve trade in the city centre, the sales volume lost to the markets should be replaced by increasing the market share obtained from other parts of the area.

A study of the development of the city centre conducted by Nordplan Ab (Sandahl, Westelius, Nedstam) indicated that this is partly possible if the city centre is purposefully developed. A number of proposals for developing the city centre were included in the research report. Realisation of the proposals requires a new type of development organisation based on work done by the businesses themselves, but including representatives of the city.

Renewal of the city centre should concentrate on exploiting and developing existing activities and also attempt to find new forms of social interaction suitable for an urban environment. It is important to have a well-organised, active management team to take care of the activities in the city centre. The team should continuously work at developing the core centre, persuading property owners to work together, increasing storeowners' activity, developing opening hours, marketing, and fostering mutual projects of the city, property owners and businesses.

Trade in city centres has a good chance of success, even in small localities, if it makes an effort to develop its own specialty. Development work must be based on a comprehensive view of the situation, but actual realisation may be comprised of individual, possibly even minor measures. It is important for the involved parties to work together and to gather and utilise the ideas of the people living in and visiting the city.

A pedestrian centre is a solution suitable for the core centre of the city, and it should not be extended too far. It is a basic, street-level solution. A pedestrian centre is not based on new activities brought into the city or the attraction of large stores. If the basic factors contributing to a pleasant atmosphere - walking and biking, specialty shops, a market square, core centre department stores, restaurants and late evening activities - are supported, and if other city centre activities (housing, work, traffic, basic services) are realised with primary consideration given to these factors, then this will suffice to make the city centre vibrant again.

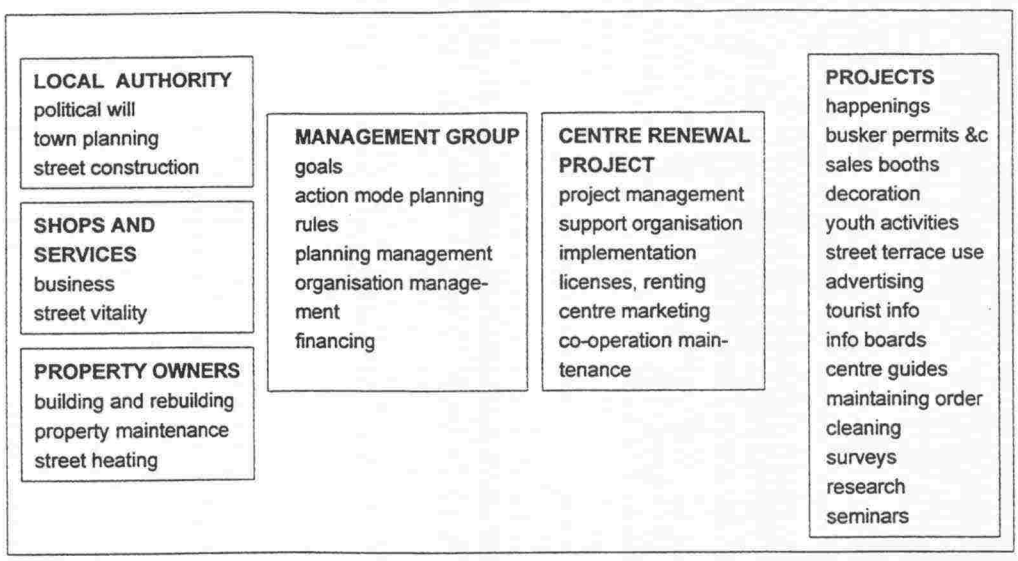
In the Scandinavian cities examined by Mikko Heikkilä, Tuomas Santasalo and Björn Silfverberg, the pedestrian centre is a core area of commercial activity where specialty shops and service firms are concentrated. The only stores selling perishables are small delicatessens. There are few supermarkets, and they are located at the edge of the core centre in conjunction with parking facilities.

Heikkilä, Santasalo and Seppo Karppinen continued the study by examining Finnish pedestrian centres. There are 18 in Finland.

The first Finnish pedestrian street was created in Ekenäs in 1966. The centre of Tapiola was also developed in the 1960's with emphasis on pedestrians. Raahe, Pori, Tampere, Mikkeli and Helsinki got pedestrian streets at the end of the 1970's. These were generally rather short side streets. In the 1980's two of Finland's most significant pedestrian streets were built, in Kerava and Oulu. Helsinki's streets were extended. Other projects in the 1980's included Vantaa and Hämeenlinna. Ten cities have begun to build their first pedestrian street in this decade. Projects were planned in over 30 cities and municipalities in the summer of 1994. The greatest obstacles to more extensive construction have been the lack of funds and above all, peoples' attitudes. Regardless of the positive examples of realised centres, business in particular often has a reserved attitude toward pedestrian centres.

The traffic concept of a pedestrian centre is always a compromise. The most successful actual pedestrian areas are only for walking. They are accessible through external feeders. Construction of by-passes and parking garages has supported implementation of pedestrian areas; the centres are easily accessible by car. Orientation in internal city centre traffic and finding a parking place without unnecessary driving may cause difficulty. Development of good walking and biking connections has been slow, and bicycle parking usually hasn't been solved. Public transport routes have been located on streets parallel to or crossing the pedestrian street.

Figure 11: City centre development organisation (Pedestrian town centres in Finland)



The study is being continued as a "Better city centre" project, defining a common guideline or description of the process by developing 7 target cities. The project will be completed in 1998.

Exploiting user surveys in improving the public outdoor area of town centres; Graduate study, Helsinki University of Technology

The use of various tools has been studied in the development of methods of public involvement in road planning and design. One of these tools is the user survey. In Hanna Pikkarainen's graduate study it is applied to improving the public outdoor area of centres. The examples used are the centres of Juva, Orimattila and Juuka, which are simultaneously planning public roads and developing their centres. User opinions and the local atmosphere should automatically be part of the planning process. A user survey is also an interaction tool. User surveys help in mapping consumer behaviour and the values of local people. Interviews can also be used to explore the needs and views of entrepreneurs.

8.2 Shopping centres

A study of the effects of shopping centres; Ministry of the Environment, Ministry of Trade and Industry, Pohjois-Pohjanmaa regional development council, mimeograph 1992
Effect of the Zeppelin shopping centre on the Oulu area; Ministry of the Environment, Land Use Department, study 1 94
Espoonlahti shopping survey, before and after the Lippulaiva shopping centre; Helsinki Metropolitan area council publications, series B 1995:2
The traffic effects of grocery store locations; Tampere University of Technology, Transport engineering research reports 20 1996 (in English)
Large shopping centres and municipal finances, sensitivity analysis; Ministry of the Environment, Land Use Department, Finnish Environment 136 1997
Analysis of the impacts of large shopping centres; research report 1998

The effects of shopping centres were explored in more detail in 1992. The studied sites were the Zeppelin in Oulu (Tuomo Vesajoki, Jarkko Leinonen, Tuula Lind) and the Lippulaiva in Espoo (Vuokko Lehtimäki et al.).

The Zeppelin shopping centre was opened in 1992. It is located at the Kempele interchange on main road 4 a little over 10 km south of Oulu. The centre of Kempele municipality is just over a kilometre away. Customer interviews and traffic counts were conducted just before and a year after Zeppelin opened. After the initial rush of customers, Zeppelin's impact is mainly visible in Kempele, where there are significant changes in the nearby area.

The average length of shopping trips to Zeppelin is about 10 km. Zeppelin's share of the area's sales of perishable goods was a little less than 4 %. Therefore, it has relatively little repercussions outside of Kempele.

Oulu's share of the area's trade dipped slightly. Sales of perishable goods did not increase at all in the city centre. This was partly because Oulu inhabitants shopped in Kempele, but also due to the fact that the number of customers from farther away clearly decreased. The number of customers in Oulu's Raksila centre decreased, but perishable goods sales increased. Zeppelin took long-distance customers away from the city centre of Oulu and from Raksila, as well as customers living south of Oulu. However, the share of customers from Oulu was not high enough to allow Zeppelin to reach its sales objectives, and the shopping centre met with financial difficulties.

According to the before and after study of the Lippulaiva shopping centre in Espoonlahti, traffic on the street network in the Espoonlahti area grew by 7 % in 1993-94, while traffic in Espoo otherwise decreased by 1 %. But, the average length of the shopping trips of Espoonlahti inhabitants shortened from 5.6 kilometres to 5.5 kilometres, because they cut down on the number of trips they made to the centre of Helsinki and Tapiola. The number of shopping trips decreased by 3 %.

Lippulaiva was built to supplement the commercial services of the Espoonlahti regional centre. It offered specialty store services that were previously only offered in Tapiola or Helsinki. Its impacts seem to have concentrated on neighbouring specialty stores, which lost 11 % of their customers. This is 2 % more than the average loss caused by the recession. At the same time, Lippulaiva increased perishable goods shopping regularity in Espoonlahti. Use of cars on shopping trips increased slightly, but use of bicycles and walking clearly grew on short trips.

Risto Murto studied the effects of alternative locations of grocery stores on traffic in the Tampere area. A survey of 1100 customers asked what issues they prioritised in making grocery shopping trips, and what modes of travel their trips comprised. The data was used to compile models of shopping trip behaviour. Three alternatives were explored: construction of new hypermarkets, replacement of existing shopping centres with high-quality supermarkets near residential areas, and replacement of part of the shopping trips with electronic shopping and home delivery.

Construction of four new hypermarkets in addition to the seven existing ones would raise passenger car travel on shopping trips by about 6 % per year.

This growth is not very large, because people would rather drive to the nearest hypermarket. The main question is the arrival of the first market outside the city centre, after which new markets may even lower local traffic as people begin to visit the market located nearby.

Replacement of centres with supermarkets located in the residential areas would decrease travel by 25 %. This alternative indicates how the structure and location of stores could truly lessen people's need to travel. Electronic shopping and home delivery would lower the amount of travel by about 17 %. This is an alternative of the near future, but it is not clear how efficient the system will be.

Shopping trip passenger car volume accounts for 8 % and freight traffic volume for 0.5 % of car traffic in the entire area. This is why the differences between alternative types of grocery trade are negligible compared to the emissions of the total traffic volume.

A study of the effects of large shopping centres was initiated in 1994 as a co-operative project by various ministries and administrations, the Retail Employee Union and the Central Chamber of Commerce. A "Large shopping centres and municipal economy" research report was completed in 1995, and a supplementary sensitivity analysis (Kimmo Koski and Pekka Lahti) in 1997. A summary of the impacts will be compiled in 1997-98.

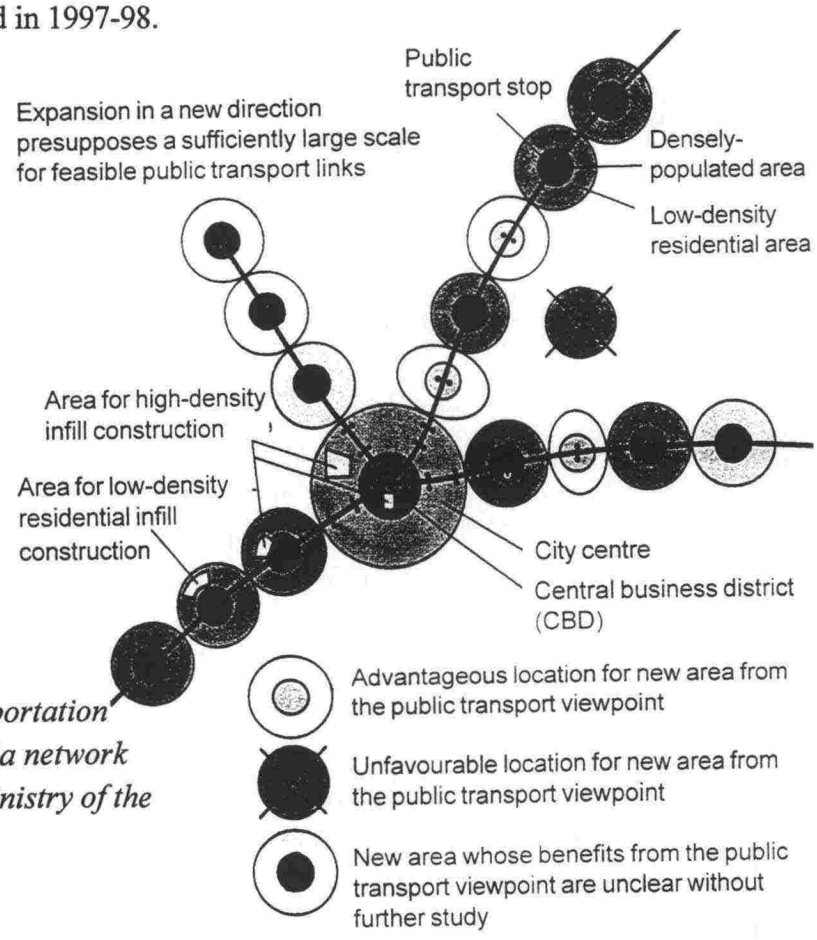


Figure 12: A complete passenger transportation system serving travel chains consists of a network of different modes of transportation (Ministry of the Environment guide 3 95)

9 PUBLIC TRANSPORT, WALKING AND CYCLING

Public transport in land use plans; Ministry of the Environment, Land Use Department, guide 3 95
Promotion of biking in Europe, examples and experiences; Finnra research reports 33/95, TIEL 3200310
Integration of bicycling and mass transportation - applying Central European solutions in Finland; Finnra research reports 33/97, TIEL 3200479

The goal of the Ministry of the Environment's "Public transport in land use plans" guideline is to promote better interaction between land use planning and public transport planning, and to provide land use planners with information about the needs of public transport.

Public transport is of core significance in large urban areas, where car city development cannot replace it or even significantly threaten its position as a city infrastructure. Some mid-size urban areas will lose competitive local transport unless they wish to or are able to influence this development. In small cities, satisfactory public transport connections are difficult to arrange unless new modes of public transport service are found. On the other hand, walking and biking are alternatives worth considering in small cities.

From the standpoint of public transport, a compact city centre is advantageous if it provides quick connections and good stops. Raising the density of the city centre and city proper supports public transport. New housing should also be located in the areas the central business district.

As suburbs age their population decreases. This makes it harder to preserve commercial services and public transport. Suburbs need to be renewed and supplemented, and connections between suburbs should be strengthened by adding new areas to the ribbon structure. Location of workplaces in or near residential areas improve the operating conditions of public transport, even though it does not save in the amount of travel. The trips are in the opposite direction to rush hour congestion, balancing the load on public transport.

As a result of car city development, cities have areas of private homes unconnected to the city structure. It is impossible or too expensive to arrange public transport for these areas. Park and ride facilities could be developed near local stops. If areas of private homes are located near or between apartment building areas, they serve to diversify the population and also provide more public transport users.

New land use should always be located near existing or planned public transport. Planned connections should be realistic. In considering additional construction near the best stops, land use should be favoured that relies on public transport and brings new users.

Maija Vähä-Rahka charted the promotion of biking in some European countries. On this basis she presents proposals of how biking could be fostered in Finland. Most important is to improve co-operation between involved parties - promotion of biking is more than just building bicycle paths. The Ministry of Transport and Communications has primary responsibility, but regional road administrations and local authorities should collaborate in comprehensive bicycle network plans.

A continuous network is important, because the paved area in the city centre will not have many users if the network has many breaks in it. A bicycle route does not always need to be a separate route, but rather a logical, continuous, safe and fluent network. Methods that have been tried and found to be efficient include traffic calming, making intersections more logical, clear signs and road markings, bicycle lanes on carriageways, bicycle parking areas and ensuring bike routes in roundabouts.

Urban areas should not have situations where a car is preferred to a bicycle because of safety or fluency. Pedestrian centres and common streets for public transport and bicycles reduce traffic in city centres. For more safety, driving speeds need to be lowered throughout. It is not enough to just separate the modes.

Bike and ride, promotion of connecting bicycle traffic offers alternatives to car use on longer trips. Bicycle parking near public transport stops should be easy and bicycle transportation should not be costly. Bicycle renting and guarded parking should be developed.

10 MAJOR ROADS IN CITIES

Problems associated with the interaction between traffic and land use in an urban environment are most noticeable when attempting to locate a heavily trafficked road in a city. Whenever such a project has been planned - from the Turku-Piikkiö-Naantali motorway in the 1970's to the Pasila corridor project in the early 1990's - the problems have nearly always created major conflicts.

Urban main road planning and design must be based on detailed evaluation of the city structure, the entire traffic network and the purpose of the road. Other streets and any reassigned segments of a previous main road should be modified to match their new status in the network. The nature, appearance and beauty of main streets were traditionally planned according to their importance in the city structure. The same requirement applies to new main roads. However, because the methods and means must be adapted to the requirements of today's traffic, such quality is difficult to attain. It is necessary to create an 'architecture of motion'. There are examples of this in Finland, but designers haven't been able to decide whether to create a neat everyday environment or a startling monument. The resulting environment can be fairly fragmentary.

Roads that pass cities, by-passes, ring roads and other tangential roads are particularly problematic. They form the major portion of public roads in urban areas. Tunnels may solve problems caused by direct disturbances of traffic, but they are as difficult to connect to the city structure as tangential roads.

10.1 Planning a major road

A search for planning methods was undertaken by outlining the demands placed on a large road by the urban environment and the solutions by which these demands can be met.

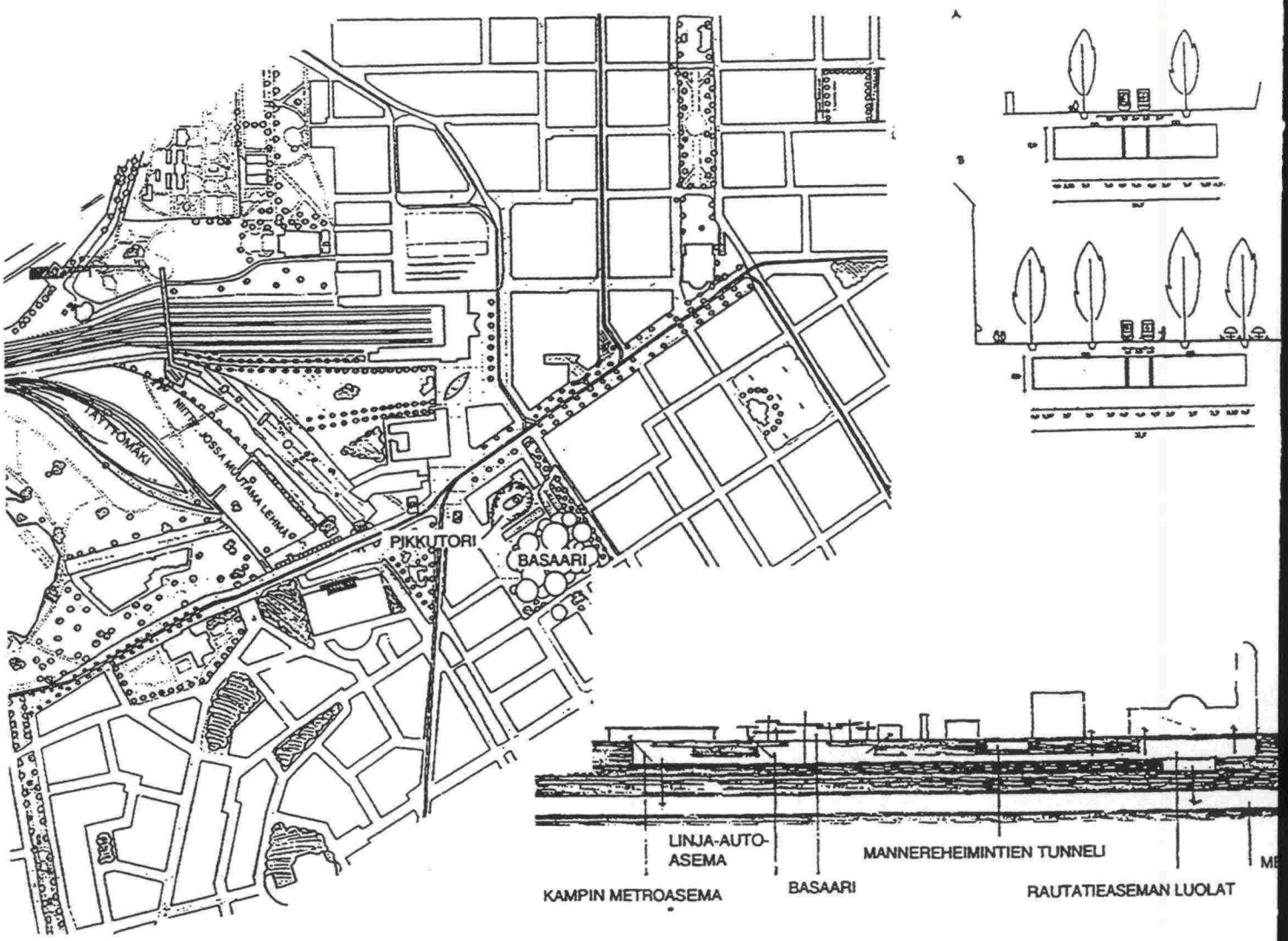
Utopias of an urban motorway; Finnra research reports 36/94, TIEL 3200245
Designing the road environment from the driver's point of view; Finnra research reports 54/94, TIEL 3200263 (video **Driver's viewpoint in planning the environment**)
A vision of a compact motor street; Finnra research reports 42/95, TIEL 3200323
Main roads in the city structure - a planning game; mimeograph 1997
The road as an experience, construction and art; Finnra research reports 16/97
Driving experience, mechanical movement and virtual landscape

Teams consisting of architectural and civil engineering students from the Helsinki University of Technology, led by Heikki Kukkonen, created motorway utopias.

The intent was to develop co-operation in planning a common site. The low number of participants in the course indicated that co-operation may be difficult even at the student level. Learning co-operation was perhaps not held to be especially important. Sometimes it seems nearly impossible among planners stuck in a groove in their profession. However, once work got under way, creative mutual work in the teams was completely natural, because no one needed to protect his or her own territory.

The sites were main road 4 in Ahjo in Kerava, Mannerheimintie, the Helsinki main street, the Helsinki internal ring road and Itäväylä, the major artery of eastern Helsinki. The importance of understanding the significance of each road in a city and the nature and activities of the city structure surrounding it was apparent in all the works. While Mannerheimintie could be developed into the city's living room, Itäväylä should be developed into a new main street toward the east.

Figure 13: Mannerheimintie in front of the Parliament Building (research report 36/94)



Jouko Berg explores road environment design to emphasise the driver's viewpoint in his study of work methods based on the significance of three-dimensional space, motion, speed and time - architecture of motion. The example site is the Linnainmaa area along the eastern by-pass around Tampere.

In going from motorway utopias to a vision of a 'compact motor street', ideas are available in numerous examples in other countries. The problem is to determine their significance relative to Finland's traffic conditions and Finnish city types. In a study by Seppo Karppinen, Hannu Haapa and Maija Krankka, the word *street* strives to express the closeness of the relationship. Unlike a motorway, which is separated from its surroundings, the physical characteristics of a motor street change with the built-up area it passes through. A motor street may also be a functional part of the city street network. Its speed limit should be 60...80 km/h. The motor street vision ponders the characteristics of a good motor street. They are condensed into the following main points:

- first solve the residents' problems, then the technology - improve the environment of the residents around the motor street
- actions are also needed elsewhere in the network
- the goal is fewer disadvantages, not more capacity
- a motor street is part of the city structure
- a motor street also serves local traffic
- a roundabout naturally links a motor street to the other streets
- if necessary, a motor street fits in a small space
- a motor street forms a small obstacle, at its best it creates new connections or activities
- the mouth of a tunnel is merged naturally with the city surroundings
- a corridor has its own identity while it highlights the location
- noise abatement can be efficiently implemented
- a suitable speed level depends on the surroundings and the position in the network.

A planning game called 'Main roads in the city structure' formed an experiment based on the motor street vision. The goal was to use Finnish examples to develop main road design in the city structure. The example sites were the extension of Paasikiventie in Hämeenlinna, and the improvement of main road 5 in the centre of Kemijärvi. The work was completed as a planning game played by teams of experts in different areas of planning. According to participating representatives of the regional road administrations, local authorities and development councils, the method proved to be a good way to develop co-operation between designers.

In their research report on the road as an experience, construction and art, Hilkka Lehtonen, Martti Honkanen, Timo Kalanti, Jani Päivänen, Carita Päivänen and Johanna Pekkanen examined how large roads are experienced as environments. The sites were Länsiväylä and the Turku main road, both west of Helsinki. Although the attitude toward both was rather positive, they were experienced differently. The Turku road is an everyday matter of course to its users, while Länsiväylä is a product with a special nature, an image-builder that fits in better with the image of the city of Espoo than its actual appearance. Because of the changes made to Länsiväylä, the landscape was felt to be more technical. Drivers and people that were highly-educated and professionally visually-oriented, with the exception of architects, had the most positive attitude toward Länsiväylä.

Roads are not usually held as being unique and important. Only people living along a road experience it as something special and permanent, and the disadvantages of the road are foremost in their experiences. Although road art is not experienced by drivers, it is justifiable from the viewpoint of riders, bikers and pedestrians. The problem is to achieve multi-layered surroundings that can be positively experienced at different speeds. In building new roads and improving existing ones, the road can well be considered a unique product. The road can be given its own profile. Road art is one possible solution. This does not need to mean something large and extensive, but rather application of specific themes. New aspects of road art may be found in links to information and control systems.

Timo Kalanti examines driving experience through space and time compression. While the speed of information distribution and communication has increased, the bodies of people sending and transferring this information have slowed down and become passive. A person moving in an information network is in one place physically, just as a driver is sitting in the seat of a car. The car changes the user's relationship with the surroundings; the driver is not in the same space as the surrounding scenery.

Traditionally, the designer of road surroundings has had to strike a balance between visibility and capturing the driver's gaze too long. But, if it is true that while driving, a driver only notices monumental structures visible in the distant horizon, road landscaping can concentrate on using the most startling works of art to direct the gaze of passengers. Shapes and lighting in such a landscape must be startling to even be noticeable. They must be discernible through snow, rain and a wet windshield, and they must compete with the massiveness of road structures.

10.2 A survey of the present state of main road corridors

The regional road administrations have surveyed the state of the main road corridors in their area in 1995-97 as part of the survey of the state of the public roads' environment.

Main road corridors in urban areas - survey guideline; Finnra internal publications 41/95, TIEL 4000118
Main road corridors in urban areas, townscape aspects; Finnra research reports 64/95, TIEL 3200339
The state of the public roads' environment - urban regions; Finnra research reports 1997

Staffan Lodenius and Pekka Seppälä examined the nature of main road corridors as the basis for the survey. Traditionally, main roads have passed through built-up areas and led to city centres. Their scale has changed as land use has expanded, but the structure is the same. The corridors have been moved to the edges of or outside the city centres and built-up areas as urban structure has fragmented, but also to prevent disturbance caused by traffic. New roads pass by as tangents to the growth rings of land use. Their relation to the surroundings becomes unclear and they lose their natural orientation. Tangential corridors are the most typical and most problematic group of public roads in urban communities.

Finnra administers about 1,100 km of main roads in urban areas with 20,000 to 320,000 inhabitants. If the 200 km of main streets that supplement the traffic network and convey local traffic are included, the total length of urban main road corridors comes to 1,300 km. Of these roads

- 50 % are radial roads
- 40 % are by-pass and ring roads
- 15 % are connecting roads.

Plans have been made to build new peripheral roads in every other city with over 20,000 inhabitants and in every fourth city with less than 20,000 inhabitants. Entry roads will be converted to city streets in two thirds of the cities - in the future most of the public roads in built-up areas will be tangents.

Gerd and Klas Hytönen defined the townscape aspects of main road corridors. A main road corridor places immense requirements on designers. The team responsible for planning needs diverse professional skills covering structural, functional and environmental issues.

Information is also needed about the effects of different solutions and the significance of different planning phases. The general townscape-related quality requirements of main road corridor design can be defined as follows:

- conscious planning; the road should be beautiful and a clear goal common to all involved parties should be specified for the design
- adaptation to already-built surroundings
- creation of an identity; unique corridors with a strong identity are best realised through their surroundings
- emphasis on location; it should be apparent in corridor design
- equipment that matches the nature of the corridor
- treatment of the entire space
- treatment and care of areas reserved for future interchanges, etc., to blend with the surroundings, regardless of when the next phase is realised.

The Savo-Karjala region's survey was the first to be completed, in August 1996. The September 1996 report on the state of main road corridors of urban areas in the Lapland region sets the following goals:

> "The goal of the survey is to form a general picture of the state of main road corridors in the cities and nearby areas in the region. Another goal is to find the best characteristics of the main road corridors and identify their critical points and possibilities of improvement. The goal of urban area surveys and related follow-up and interest group work is to acquire information and increase involved parties' commitment to common objectives."

A summary of the surveys of main road corridors in urban regions will be published in 1997. The surveys will form a base for developing the "Main roads in cities" guideline that was originally published in 1993.

10.3 Parallel roads

A network of roads that more directly serves land use is often needed alongside a motorway. When a new road is built, the old road connection is usually left to other use.

Roads parallel to motorways, a pre-study of the characteristics and planning principles of a lower-level road network in a motorway traffic corridor; Finnra research reports 87/95, TIEL 3200362
Heinola's Siltakatu, traffic renovation general plan; City of Heinola 1994

In their research report on roads parallel to motorways, Pekka Tuomiranta, Auli Heinänen, Jukka Laakso, Taru Hurme and Janne Lintilä examine the functioning of a motorway traffic corridor and changes in the traffic network and land use brought about by the construction of a motorway. A parallel connection serves general traffic that is not able to use the motorway. It may also function as a reserve road, a route for special transports or to provide additional corridor capacity.

In Finland, the old highway usually functions as a parallel road. Because most of the traffic of the old road has moved to the new, the technical level of the parallel road and its traffic-related significance no longer match - the level is too high and traffic safety too poor. Land use and traffic plans of the corridor do not always take this into consideration. The new traffic situation may offer a possibility of making considerable modifications to the road, especially in built-up areas.

When Heinola's by-pass was completed, the main street, Siltakatu, was left as the city's main internal street. In the process of planning the by-pass, Finnra did not study the modification needs of the former public road, nor does it normally partake in modification costs. The general plan for traffic renovation of Heinola's Siltakatu (LT Consultants) 1994 presents how the nature and image of the street could be modified to match its new functional role as part of the city street network.

Underground space in land use planning; Ministry of the Environment, Land Use Department, Environmental guide 16 1997

A tunnel is one way to free land area for other use in a city structure. If a motorway needs to be built, from the standpoint of residents, a tunnel is an alternative that most closely follows the principle of sustainable development: a tunnel reduces traffic noise and allows undisturbed crossing of the road area. The resulting eco-corridor lets animals cross. On the other hand, a tunnel does not remove the need for intersections or the effects of intersections on land use. Tunnel construction is inexpensive in normal rock, but furnishing and maintenance are expensive. Cut-and-cover, which is common elsewhere, is expensive, and Finland has only a few examples. Finland does have a large number of underground parking spaces.

Tunnel construction has also been criticised. A tunnel separates the user from the city structure, makes orientation difficult, confines users, weakens the possibility of developing a flexible transportation system.

It offers planners a technical pill as a remedy for the symptoms of traffic problems instead of eliminating the causes of the problems.

In nature areas and in compact cities, tunnels promote preservation of an area's uniformity, functionality and atmosphere. The value of these viewpoints is on the rise, so if new roads or streets are built in such areas, we will most likely see more tunnels.

10.4 Noise abatement

If a residential area is close to the road, even a small amount of traffic may cause enough noise to disturb the residents. However, significant noise hazards usually only exist near large corridors.

Traffic-related noise; seminar mimeograph, Helsinki building department publication 7/93
Information on planned and realised noise barriers; mimeograph 1993
The practice of compensating for noise problems in road proceedings; Finnra research reports 7/95, TIEL 3200285

Noise abatement is one of the main themes of Finnra's environmental research and development activity. The traffic and Land Use project emphasises development of abatement solutions and distribution of information. Noise barriers have been the object of several architectural competitions and one field trip (see pp. 10-11). Abatement has also been discussed in a seminar arranged together with the city of Helsinki.

In her research report on noise problems compensation, Hanna Heikkilä gathered information on how compensation has been paid for noise and on what grounds. The principles used to calculate compensation have become quite established. The noise problems caused by an outdoor noise level exceeding a specified value is estimated as a certain percentage of the real estate value - usually 1.5 % for each decibel exceeding a 55 dB daytime outdoor noise level. However, the environmental hazard law may change this practice, because compensation will no longer be linked to right-of-way proceedings.

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