Final Report

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ICARO

***I**ncrease Of **CAR** **O**ccupancy*
through innovative measures and technical instruments

Contract No PL 96-1056

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Universitaet fuer Bodenkultur - Institute for Transport Studies (AT)

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Vienna, 15th November 1999

PROJECT FUNDED BY THE
EUROPEAN COMMISSION UNDER THE
TRANSPORT RTD PROGRAMME OF
THE 4th FRAMEWORK PROGRAMME

PREFACE

This is the final report of ICARO, a research project funded by the European Commission under the Transport RTD programme as part of the Fourth Framework Programme. The project started in January 1997 with a time-scale of 27 months.

The main goal of ICARO was to evaluate measures for increasing car occupancy rates in European countries. The measures were based on empirical investigations carried out on seven demonstration sites in six European countries, as well as on modelling demonstrations, for four European cities.

This report gives an overview of possible measures for increasing car occupancy rates and describes the different demonstration measures investigated during the running phase of the project. Results are summarised with particular consideration for transferability to other European countries.

The outcome of the ICARO project is a series of recommendations and guidelines for developing car-pooling[1] policies and/or implementation strategies throughout Europe.

[1] In the United Kingdom the term car-sharing is used as a synonym for car-pooling.

PARTNERSHIP

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EXECUTIVE SUMMARY

The ever increasing growth of motorised traffic in and around city centres contributes to a rising level of congestion. The provision of new infrastructure, even where permitted given environmental restrictions and tighter funding, is no longer capable of providing a solution. Indications are also that traffic levels will continue to grow for the foreseeable future.

Nevertheless, an abundance of space is available to people on the move within cars. In peak period commuter traffic, the average car occupancy rate is 1.2, which means that there are twelve people in every ten cars. Transport policies & strategies should therefore actively promote car-pooling and maximise the unused space inside the cars available to commuters. Such policies would provide benefits to individuals, the public and the environment.

Little is known about people's attitudes towards car-pooling and it is primarily the reason underpinning the European research project ICARO - Increase of CAR Occupancy through Innovative Measures and Technical Instruments. **The project has been funded by DG VII of the Commission of the European Communities, within the Fourth Framework Programme for transport research.**

International literature uses a variety of words and phrases to describe the process for increasing the occupancy of cars. The ICARO consortium determined the definition of car-pooling to be as follows:

Car-pooling is at least two people riding in a car usually belonging to one of the occupants, whether one person always drives or the car-poolers alternate driving. Each member would have made the trip independently if the car-pool had not been there. Driver and passengers know before the trip that they will share the ride and at what time they will be leaving. Professional and/or commercial vehicles are excluded. Both the driver and the passenger(s) are considered as car-poolers.

A distinction is made between:
- non-family car-pools: consisting of members of more than one household;
- family car-pools: consisting only of members of one household.

A car-pool should not be confused with an HOV (High Occupancy Vehicle). The latter refers only to the requirement for using an HOV lane or another HOV-facility. The definition of an HOV is: a vehicle travelling on the road complying with a minimum occupancy requirement, for instance of two or more people.

The ICARO project is split into two main areas covering research and practical demonstrations. The research element has evaluated existing measures for increasing car occupancy and considered the different institutional and cultural frameworks of different European countries. The demonstration element included on-site demonstrations as well as computer simulations of additional

measures, aimed at increasing car occupancy, covering a wide range of European cities. The demonstrations can be subdivided as follows:

Real life demonstrations

- Leeds (Great Britain)
  A combined bus, cycle and HOV lane was introduced along sections of the existing nearside lane of the A647 route into Leeds from the west.

- Brussels (Belgium)
  A car-pool centre with matching service was established in co-operation with individual companies to promote car-pooling and to encourage employees to put car-pooling into practice.

- Salzburg (Austria)
  Small decentralised car-pooling parking areas were established at important interchanges on motorways and regional roads surrounding the City of Salzburg. A car-pool co-ordination centre was established in combination with a widespread publicity campaign and several incentives for car-poolers.

- Pilsen (Czech Republic)
  A large-scale information campaign was carried out to introduce the concept of organised car-pooling to the general public and encourage individual companies in the region to take an active part in promoting the scheme. In addition, a car-pooling co-ordination centre with matching service was established.

- Bern, Lyss, Oberglatt and Yverdon (Switzerland):
  Preferential parking for HOVs was introduced at a number of sites and the response of commuters assessed. The aim was to offer preferential treatment to railway customers at locations where parking spaces were limited.

- Graz (Austria)
  An organised hitch-hiking scheme was introduced and tested in areas with little or no public transport provision. The objective of the scheme was to use car-pooling as a feeder service for the public transport.

- Rotterdam (The Netherlands)
  A guaranteed ride home scheme was introduced in the Rotterdam area to encourage car-pooling. The demonstration included a public awareness campaign.

Modelling demonstrations

- Leeds (Great Britain)
  In addition to the real life demonstration in Leeds, effects of several scenarios for the HOV lane were tested to provide answers to a series of “What if? questions, e.g. sensitivity tests, a possible 3+ occupancy level scenario.

- Madrid (Spain)
  The effect of raising the minimum car occupancy on the existing HOV lane in Madrid from two to three people was modelled.

- Salzburg (Austria)
  The Salzburg modelling scenarios were based on the real life demonstration described above and on the Madrid experience. The possible effects of an HOV lane on motorways around the city of Salzburg were assessed.

- Thessaloniki (Greece)
  The possible effects of an HOV lane into the city centre of Thessaloniki were assessed.

Results

The evaluation of the surveys at the different demonstration sites shows that people in general have positive attitudes towards car-pooling as an environmentally friendly mode of transport. The responsibility for the driver and inconveniences were often mentioned as negative aspects of car-pooling.

As a result of accompanying information campaigns, each real life demonstration achieved a high level of acknowledgement. Visible measures combined with specifically targeted information led to the best results in terms of public awareness.

Establishing close partnerships between car-pooling organisations and companies is one of the most effective ways to promote car-pooling. Analysing the types of car-pooling trips confirmed that very often successful car-pools consisted of employees from the same work place. Therefore, initiatives targeted at the workplace are the most promising for the promotion of car-pooling. Companies can support car-pooling in many ways (matching service within the company, promotion campaigns, setting up the working schedule, reserved parking facilities for car-poolers in the company's own grounds, financial benefits,...).

Surveys comprising matching centre data have shown that interest in organised car-pooling exists to a certain extent. The main reasons for contacting the matching centres were matching requests of would-be car-poolers. More than half of the people who contacted the matching centre in Salzburg were in search for a partner for their daily trip to work (175 persons). In Brussels about 1500 people were interested in the mediation of a car-pooling partner. The modal split of the people who want a match shows a high proportion of car-drivers. Most of them are driving alone at the moment and are willing to pool their cars. It is evident that the quality of the matching lists improves with the number of people registered.

One of the most effective ways of increasing car occupancy is through the provision of infrastructure measures, such as dedicated lanes for HOVs and buses. In Leeds, the only demonstration site where a new HOV lane (1.5 km) was introduced, the car occupancy rate increased from 1.35 to 1.41. Here car-poolers gained a time benefit of over 3.5 minutes by using the HOV lane.

In addition to the matching centre and the HOV lane, the impacts of many other measures were analysed for the demonstration sites of the ICARO project such as :

- legalising "wild" parking facilities at road junctions etc. to provide meeting points for car-poolers;
- preferential parking for car-poolers at the work place and at railway stations;
- guaranteed ride home scheme or half price ride home by public transport;
- "Shake and Ride" (car-pooling as a feeder for public transport).

None of these individual measures significantly influenced the car occupancy rates during the running phase of the project, but they were appreciated by the target groups. These incentive measures can be seen as an additional service for current car-poolers or as an element of promotion. Several conclusions and recommendations can be drawn from these real life experiences as follows:

- Experience from various demonstration sites indicates that general promotion campaigns in themselves are not effective. It is strongly recommended to focus on target groups, particularly companies or users of the facility.
- The results from the Brussels and Salzburg demonstrations indicate that the majority of people contacting matching centres are interested in “five days per week nine to five” arrangements. A general matching database should contain at least 500 – 800 of these sort of records to be effective. Matching in a single company can be on the basis of around 100 records.
- Interest in preferential parking is limited, especially where no severe parking shortages exist. Many people also enjoy free parking at their workplace, as shown by the Swiss demonstration.
- Park and Pool areas can be introduced at limited cost as shown in Salzburg. This sort of measure will not significantly increase car occupancy, but is a useful tool to complement other car-pool measures and raise the profile of car-pooling.
- There is no convincing proof that guaranteed ride home schemes are influencial on the decision of people to car-pool, based on the Dutch research.
- The value of car-pooling as a feeder to public transport is very limited as can be seen from the Graz demonstration.
- HOV lanes can be effective in promoting car-pooling if of the convert-a-lane type, as in Leeds. They should not be considered as stand alone schemes, but should be part of a package of measures, including some of those mentioned above.

From the analysis of the results obtained at the four modelling sites some general prerequisites for the implementation of HOV lanes could be identified:

- significant time-savings for car-poolers should be possible;
- relatively high initial proportions of HOVs, which could benefit from the use of the HOV lane (e.g. at least 20 % of the cars);
- additional measures, like promotional campaigns, or park-and-pool facilities are needed;
- buses should benefit from the HOV facility

The conversion from an existing general purpose lane to an HOV lane can result in greater congestion for the users who are not permitted to use the HOV lane, and can bring about diversion to other corridors, thereby raising their congestion levels.

Conclusion

Car-pooling can have significant advantages for people in individual transport situations, mainly significant cost or time savings. However, it can only be regarded as an appropriate response in specific situations, for example, in the case of non competitive public transport. A number of site – specific characteristics as well as mobility behaviour of potential users should be taken into account, in order to achieve good and permanent results. Car-pooling should be embedded in "Green Commuter Plans" or "Travel Wise" campaigns and should be considered as part of any transport policy in the urban/metropolitan framework. The aim should be to reduce the dependence on cars by promoting various alternatives. Car-pooling is one such alternative.

The potential for car-pooling is somewhat limited, as it seems to be quite difficult to co-ordinate different people's trips. At a theoretical maximum, 30% of the car-users have the freedom to choose car-pooling as an alternative. This is still more difficult as there is a tendency in work time schedules towards flexible working hours, which are a serious obstacle to car-pooling. For matching services, it is important that the number of potential car-poolers exceed a critical number. Consequently, bigger demonstration sites have higher numbers of interested participants and a greater potential of success. It is also important to focus all campaigning efforts on specific target groups such as commuters or companies rather than to concentrate on general publicity campaigns.

Generally it can be said that the idea of car-pooling is generally accepted and rated positively by the population. Some prejudices still have to be overcome, as seen in the comparison of experienced and inexperienced people. The surveys have indicated that incentive measures do have a positive influence on car occupancy rates, not by merely halting the current decline but actually increasing the occupancy level. Evidently the more restrictive an implemented measure is, the more influence it has on the car occupancy rate, but the less accepted it is amongst the population.

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1 INTRODUCTION

The ICARO project investigated the possibilities of increasing car occupancy through innovative measures and technical instruments (Task 5.2/17 in the Transport RTD Programme of the European Commission DG VII: Identification and evaluation of the interdependence of various components of the UTS on the occupancy of cars). ICARO commenced in January 1997 with a 27 month programme to March 1999.

ICARO focused on transport policy research, with the principal aim of delivering valuable accessible recommendations and guidelines on increasing private car occupancy at both local and national levels.

ICARO undertook a combination of both research and demonstrations, concentrating on the latter. The inclusion of demonstrations in this research project was important to test and demonstrate the impact of measures in real life situations, not only in theoretical modelling situations.

1.1 Objectives of ICARO

The objectives of ICARO were:

(1) To identify best practices concerning technical instruments and organisational measures to increase car occupancy

ICARO has prepared an overview of the current best practices on the increase of car occupancy in a number of European countries and additionally included the US and Canada.

(2) To identify and understand the institutional, legal, financial and cultural framework on the increase of car occupancy

ICARO examined the institutional, legal, financial and cultural framework on transport and traffic in the participating countries and in all other EU-countries. Institutional, financial, cultural and/or legal barriers can hinder car-pooling and van-pooling schemes. Some taxation regulations, insurance laws and other legal dispositions favour the use of single-occupancy cars or inhibit car-pool and lift giving schemes. ICARO identified these barriers and has provided recommendations to overcome them, enabling a car-pool friendly framework to be constructed .

(3) To carry out a number of real life demonstrations on techniques and innovative measures to increase private car occupancy

Seven demonstrations at sites in six European countries were undertaken, involving a combination of innovative and technical measures for increasing car-occupancy. The demonstrations concentrated on simple and easy to implement schemes on the one hand and on HOV lanes, as an infrastructure measure, on the other hand.

(4) To provide recommendations for successful measures and instruments

As a result of the demonstrations, the modelling effort and the research on best practices and institutional issues, recommendations and guidelines on how to implement a successful car-pool strategy were established.

(5) To disseminate the results to all interested parties

It is important that the research on the increase of car occupancy be presented to responsible people in transport policy forums. It is therefore very important to disseminate the results of the ICARO project to all potential supporters, such as national, regional and local authorities, but also to individual citizens, companies and trade unions.

(6) To identify the need for changes in the legal and the institutional framework and the need of further research

A set of recommendations for changes in the legal and organisational framework to promote car-pooling is provided. Important issues for further research were identified, based on the results of the ICARO project.

1.2 The ICARO Project Methodology

The ICARO project consisted of eight work packages in a logical order (see Figure 1-1).

The project started with a descriptive and analytical work package (WP1) covering the best practices and a brief state of the art review concerning systems, techniques and measures to increase private car occupancy. Some of the results of this work package were used in designing and implementing the demonstrations.

The second work package (WP2) identified the institutional, legal, financial and cultural framework on measures to increase car occupancy. This work was important, because institutional, financial, cultural and legal matters can inhibit or discourage measures to increase car occupancy and could also affect the design of demonstrations.

The bulk of the ICARO effort was directed towards the demonstrations. These were both real life and modelling demonstrations. The real life demonstrations covered three work packages, including the setting up of an evaluation framework (WP3), the actual implementation of the demonstrations (WP4A) and the final assessment (WP5). A smaller work package was attributed to the modelling demonstrations (WP4B). Further work packages dealt with the recommendations and the dissemination of the results (WP6 and WP7). Guidelines for implementing car-pooling schemes were established. The final work package consisted of project management and quality control (WP8).

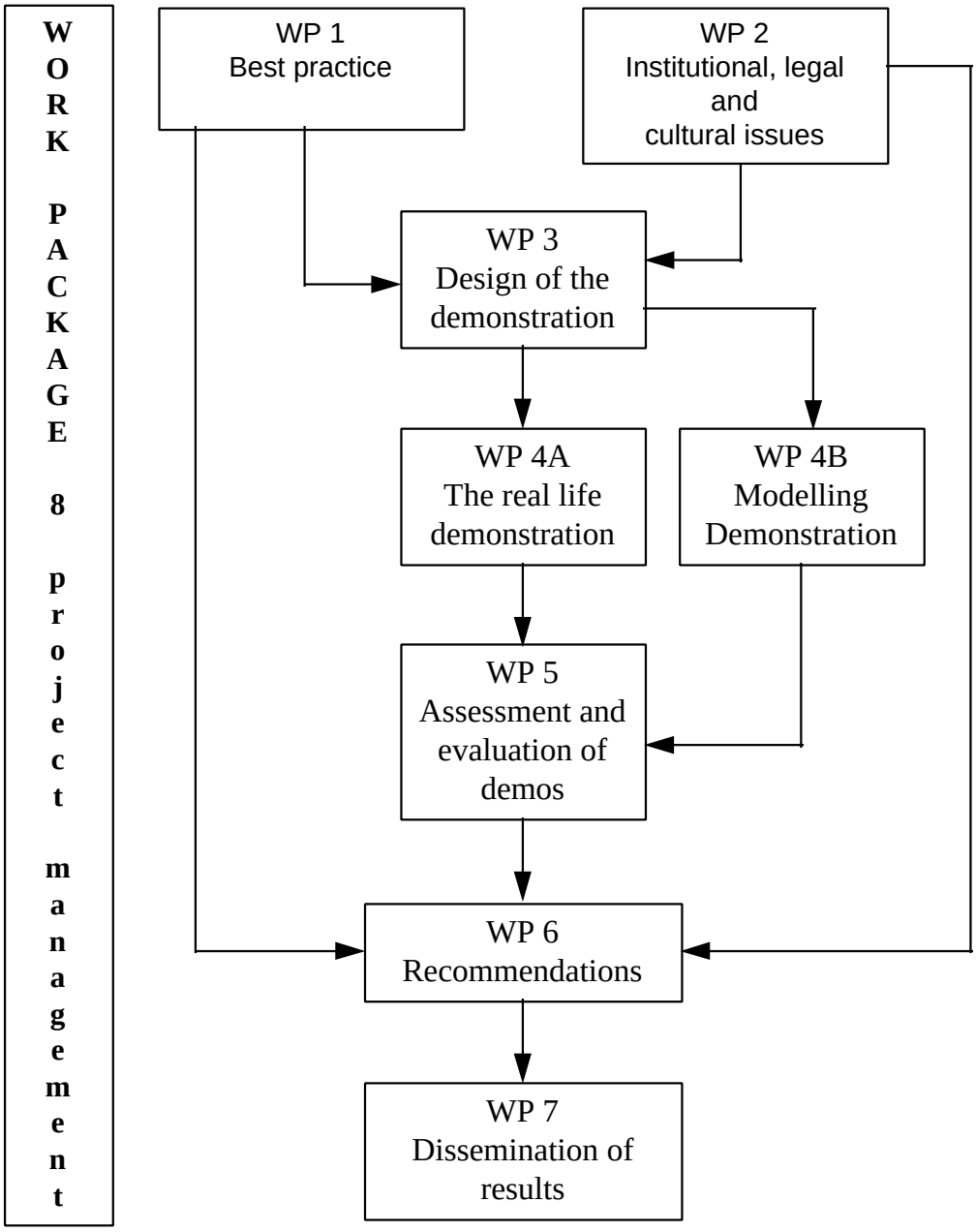

Figure 1-1: The ICARO-project flow

2 CAR OCCUPANCY RATES AND THE DEFINITION OF CAR-POOLING

2.1 Car occupancy rates in Europe

Every workday morning and evening the major roads leading to most European cities are heavily congested with commuter cars carrying one or two people. One obvious contribution to the solution of the congestion problem would be to increase the average car occupancy and this was the goal of the ICARO project. The project identified a number of possible instruments and measures that can have a direct or indirect effect on car occupancy rates.

The interest in increasing the occupancy of cars arises from awareness that scarce resources have to be used sparingly , whether the resource is energy or "road capacity at peak hours". Car-pooling can be helpful in combating the undesirable effects of traffic, such as congestion and environmental damage. It can also improve the performance of the road system, without the need for extra capacity on the road. By combining the trip needs of two car occupants, the road "serves" two people instead of one, without extra demand on road space .

High occupancy vehicles carry a certain minimum number of occupants (two or more persons depending on the site specific regulations). Measures for high occupancy vehicles, such as HOV lanes, can only discriminate on the basis of this number of occupants in the car.

The average car occupancy was measured in some European countries prior to commencing the ICARO project. The results are provided in Table 2-1. No average car occupancy figure was available for a number of countries. Some of the occupancy figures used are therefore a professional estimate or are based on random counts at a limited number of sites.

This data must therefore be used with caution. Comparisons are not always reliable, since counting methods are different from one country to another. Some countries take the trip length into account when measuring average occupancies and other countries do not. The most obvious conclusion seems to be that the average car occupancy for home to work trips is much lower than for other trip purposes. It is necessary to integrate car-pooling into future travel surveys, so that it can be considered as part of any transport policy on the basis of reliable transport data.

The actual car-occupancy rates identified during the real life demonstrations of the ICARO project can be found in chapter 6.2.1.

Country	car occupancy home to work traffic	car occupancy leisure traffic	overall car occupancy
Austria	1.20	1.54	1.27
Belgium	1.20 (2)	not available	not available
Czech Republic (2)	not available	not available	1.5
France	not available	not available	not available
Germany	1.2	1.9	not available
Greece (1) (Thessaloniki)	1.17	1.71	1.49
The Netherlands	1.17	not available	1.66
Portugal (1)	not available	not available	1.5
Spain	1.2	1.8	not available
Switzerland	1.14	2.07	1.62
United Kingdom	not available	not available	not available

(1) random counts at limited number of sites
(2) professional estimates

Table 2-1: Average car occupancy in some European countries

2.2 Definition of car-pooling

Car-pooling is the mobility-scheme given the most attention in ICARO and is quite widely known. The international literature uses various descriptions to define the process of increasing occupancy in cars. A short introduction to the topic may be helpful.

The United States is the homeland of car-pooling. The ETC handbook (A Commute Management Guide for Employee Transportation Co-ordinators, (1990)) states:
"Car-pool is two to seven people sharing an employee-owned automobile to and from the workplace".

The Transportation Co-ordinators' Handbook - South Coast Air Quality Management District - (sine loco, sine data) adds to this definition:
"*Car-pools exists when two or more people commute in a car usually belonging to one of the commuters, whether one person always drives and the other(s) contribute to the expenses - or the car-poolers alternate driving responsibilities"*.

In his article (TEAL (1987), Car-pool: Who, How and Why?) Teal makes the following distinctions:

- Household car-poolers, who commute together with at least one other worker or student from the same household (some 40 % of all US car-poolers.).
- External car-poolers, who share transportation with unrelated individuals and who either share driving responsibilities or always drive.
- Car-pool riders, who commute with other unrelated workers but who ride only and never provide a vehicle.

It is clear that mainly the non household car-pools are of interest to the policy makers. These car-poolers are mainly commuters and can be organised

effectively as they normally have regular trips. Common in all definitions is that car-pool is regarded as an efficient mode for commuting to work. This definition is also used in other European countries. The Dutch Ministry of Transport defines car-pooling as follows:
"Car-pooling is the regular shared use of a car or a minibus. The occupancy rate is 2 or more persons and it is intended for commuters and business travellers".

The Ministry adds business travel to the definition, but other trip purposes are not mentioned.

It is conceivable that car-pooling is used for other trip purposes as well, e.g.:

- Long distance holiday trips
  In a number of countries, agencies match drivers and riders who want to share their journeys across Europe.
- School trips
  Among students, it can be observed that lift giving occurs quite spontaneously. Moreover, in some countries, organised 'school-pooling' (parents who bring their children and the neighbours' children to school) is emerging.
- Car-pooling to events, such as concerts, festivals, shopping etc.
  An example was the "Event-pool" project in Switzerland, which was unsuccessful.
- Car-pooling for shopping
  No cases have been reported to date.

It is therefore both inaccurate and inappropriate to designate car-pooling as a mode of transport for home to work only.

The ICARO definition of car-pool is :

Car-pooling is at least two people riding in a car usually belonging to one of the occupants, whether one person always drives or the car-poolers alternate driving. Each member would have made the trip independently if the car-pool had not been there. Driver and passengers know before the trip that they will share the ride and at what time they will be leaving. Professional and/or commercial vehicles are excluded. Both the driver and the passenger(s) are considered as car-poolers.

A distinction is made between:

- non-family car-pools: consisting of members of more than one household;
- family car-pools: consisting only of members of one household.

There is some confusion between car-pool and other terms that are used in transport and transport research like HOV, car-sharing, van-pooling and ride-sharing.

HOV (High Occupancy Vehicle)
A car-pool should not be confused with an HOV (High Occupancy Vehicle). The latter refers only to the requirement for using an HOV lane or another HOV-

facility. The definition of an HOV is: a vehicle complying with a minimum occupancy requirement, for instance of two or more people.

Car-sharing
In the United Kingdom the term car-sharing is used as a synonym for car-pooling.
However, the term ‘car-sharing’ is used in Continental Europe for a system of people using various cars belonging to a car-sharing organisation. The sharing of the cars occurs here by members of an organisation that owns, maintains and provides the vehicles. In this context the ‘sharing’ of the car means, different people use the same car, but at different times. Car-sharing in this context can be solo driving.

To avoid confusion it is strongly suggested that the term "car-sharing" is used in connection with cars belonging to a car-sharing organisation and that the term "car-pool" is reserved for the joint use of a car for a trip. Car-pool is the standard term used in American literature and the term "car-pool" is known as such in a number of languages, such as Dutch.

Ride-sharing
In the American literature this term is used for all rides in a shared vehicle. It can be a bus or train, but also a car-pool. Ride-sharing is consequently more than car-pooling as it involves all forms of collective transport. Car-pool is only one example of ride-sharing.

Van-pooling
The term van-pooling is used in American literature for pre-arranged ride-sharing when a number of people travel together on a regular basis in a van or minibus, usually designed to carry 7 or more people.

3 OVERVIEW ON NATIONAL CAR-POOL POLICY IN EUROPE

An important point of analysis in the ICARO project is the presence, and the absence, of a car-pool policy or knowledge/awareness of car-pooling in European countries. In some countries car-pooling appears not to have been considered until now. Other countries have a well developed car-pool policy or are at least introducing a number of car-pool measures. Rather than describing this for every country separately, countries have been categorised on the basis of a number of levels of car-pool policy development and awareness, albeit arbitrarily. These various levels are of course not strictly separate from one another. Moreover, the level can vary for different regions within one country. In principle four levels are distinguished.

3.1 Level 1: Car-pooling is almost unknown

In level 1 countries there is limited awareness of car-pooling as a possible tool to help solve traffic and transport problems. There are certainly no experiments or large scale studies ongoing. Even transport officials and politicians are often unfamiliar with the concept of car-pooling. If car-pool is known, it is mostly to an inner circle of specialists, who may have limited knowledge and/or for various reasons do not regard car-pooling as an alternative to solo car driving in their country.

There is usually some "traditional" car-pooling in home to work traffic. This is not considered as a contribution to solving transport problems. Car-pooling is done mainly to save money. Therefore there have been no car-pool experiments either completed or ongoing. If studies have been carried out, they had negative results and no measures are being considered for the future.

For such countries to evolve to level 2, there is a need for awareness raising. Dissemination of results of car-pool experiments in other European countries could play an important role. Perhaps these countries could be tempted to start a few small-scale experiments, enabling them to gain experience.

Countries:
Central and Eastern European countries, Greece, Luxembourg, Norway, Portugal

3.2 Level 2: Starting to consider car-pooling

Traffic congestion, due to the growth in car trips, is a serious problem in numerous cities throughout Europe and in the search for alternatives to solo car use, attention is being given to car-pooling and awareness is rising. Transport officials are familiar with the car-pool concept and are starting to consider it. In countries at this level, some studies and small scale experiments are carried out and monitored carefully.

The car-pool policies or experiments are usually carried out or sponsored at various government levels. Other associations are also becoming interested in car-pooling, e.g. automobile clubs. Some companies have started to promote the introduction of car-pooling, providing small incentives for their car-pooling employees. Most car-pool measures introduced focus on awareness raising campaigns. A few small scale matching services have been organised, but without much success. Infrastructure measures are not well known, although occasionally a company may have introduced preferential parking.

However, there is still some scepticism about car-pooling as an alternative means of transport. Moreover, in some cases public transport is considered as the main alternative and there may even be a fear that car-pooling would be attractive to public transport customers.

It can be expected that the experiments will be extended and the experience with car-pooling will increase. These countries need to obtain convincing evidence about the positive results of car-pool programs and about the need for a coherent set of measures. Evolving to a higher level would involve the introduction of other new measures, such as dedicated park-and-pool areas and the introduction of a structured approach at company level.

Countries:
Austria (before the start of the ICARO project), Denmark, Finland, France, Italy, Ireland, Sweden, Switzerland

3.3 Level 3: Starting to implement car-pooling policies

In these countries, car-pooling is reasonably well known. Car-pooling is regarded as an alternative and is clearly mentioned in policy documents at local, regional or national level. Usually, all actors who could be involved in car-pooling know the concept. Various levels of government have tested or are testing car-pooling. In addition, other actors are taking part in car-pool experiments: NGOs, consultancies, universities, etc., but there is also a clear involvement of the private sector. Pure matching services and information are offered. It is usual in these countries for some companies to have already implemented preferential parking for car-poolers.

Infrastructure measures are also implemented, such as HOV lanes, parking areas for car-poolers at highway interchanges and preferential parking. These countries have also started to communicate about car-pooling and awareness campaigns have been undertaken. Most of these countries have introduced the idea of trip reduction plans or company mobility management. Car-pooling is an important element in these plans.

It can be anticipated that a real coherent car-pool policy can emerge in these countries. Evolving to level 4 would mean that in these countries a fully comprehensive approach is introduced. This would initially require a dedicated administrative unit for car-pool activities. A second requirement would be the introduction of a comprehensive approach and spreading the experience gained to many more potential initiators, such as other authorities, companies,

intermediate levels, etc. Thirdly, authorities should be continuously active in starting new car-pooling initiatives.

Countries:
Belgium, Germany; Spain, United Kingdom

3.4 Level 4: An integrated car-pool policy

Countries on this level regard car-pool as a full alternative and are supportive of the measure. They have an overall car-pool policy, with a general strategy and adequate financial means. There is even some integration with other policy areas (e.g. fiscal policy). Many actors are involved, such as chambers of commerce, unions, employers, lobby groups, etc. They are all stimulated by authorities to take up a role in the promotion of car-pooling.

As a result of these efforts, a whole range of experiments, studies and measures have been introduced. Infrastructure measures are quite common: park-and-pool areas, HOV lanes, preferential parking. It can be expected that in these countries, car-pooling will become a full scale alternative to the solo car. Experiences from these countries can help to guide developments in other countries.

Countries:
Currently the Netherlands is the only European country on this level.

The map below gives an overview of the state of the art in Europe, as described in this chapter.

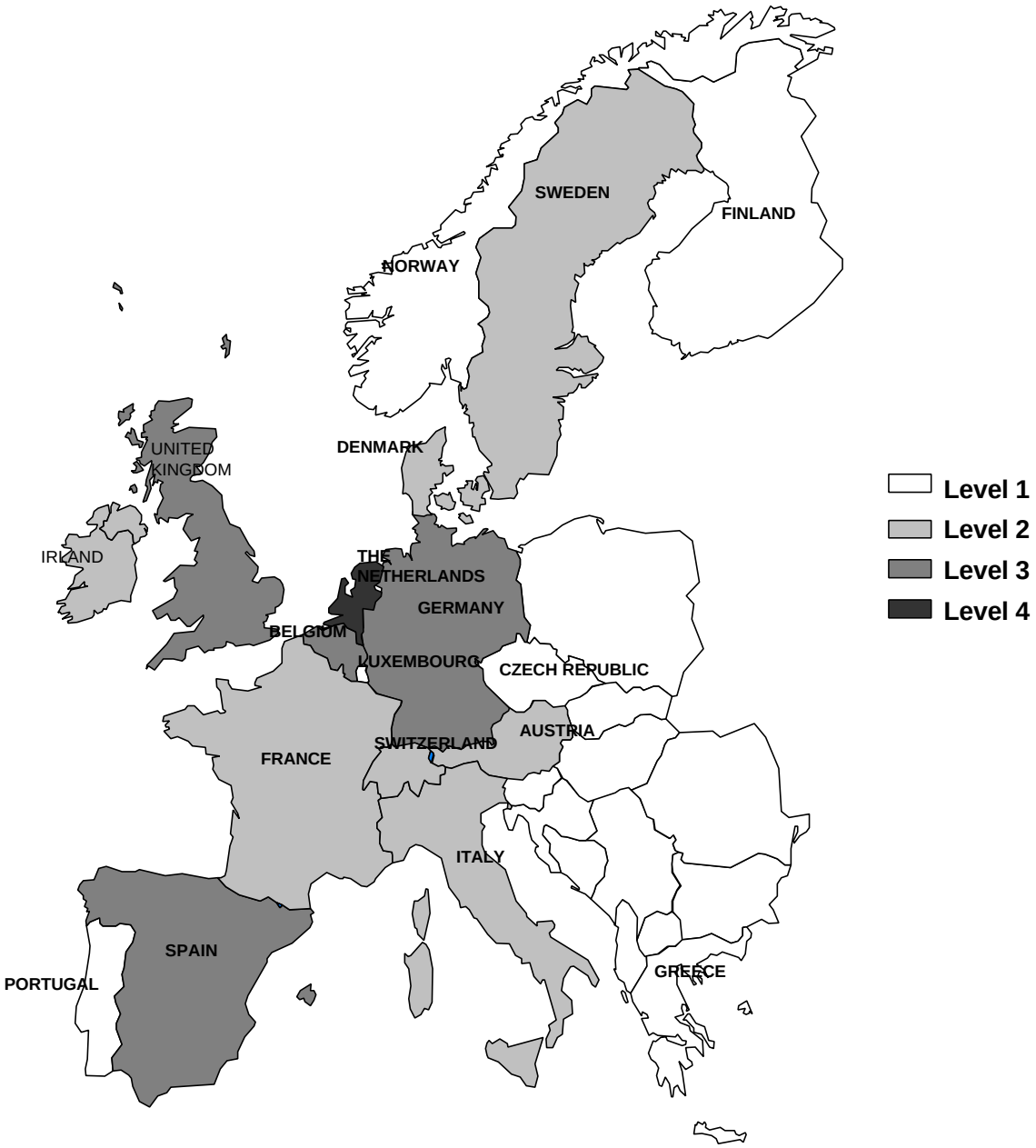

Figure 3-1: Levels of car-pooling policies in Europe

4 OPPORTUNITIES FOR AND BARRIERS AGAINST CAR-POOLING IN EUROPE

4.1 Legal issues

One of the objectives of the ICARO project was to collect important information on the legal situation regarding car-pooling in Europe, to identify barriers and to recommend solutions.

Most national legislation in European countries does not even define the terms "car-pooling" and "HOV". Some countries consider that a change of the legal situation is necessary (e.g. The Czech Republic, Greece, The Netherlands,...) in order to support car-pooling measures such as HOV lanes. Authorities in other countries think that additional legislation would be sufficient to develop existing law (e.g. Belgium, Switzerland, Spain, France, Great Britain,...). However, a restrictive legal situation or indifferent legal framework complicates the implementation of car-pooling measures.

A particular situation might be the use of an existing bus lane by other HOVs. In most countries changes in the traffic laws would be necessary. An official definition by the authorities is needed and a traffic sign for HOV facilities, such as reserved lanes or reserved parking spaces, has to be created. In the Leeds demonstration (Great Britain) a traffic regulation order from the local authority (City Council) was sufficient. Measures associated with the scheme, such as the new road signs and markings did, however, require central government approval. As a similar step would be necessary for each new HOV lane, a change to the national regulations could ease and accelerate the implementation procedure significantly.

A good opportunity to introduce car-pool initiatives might be environmental legislation (e.g. air quality regulations), which was recently used in France. In many other European countries a slow trend towards the development of environmental legal criteria could be identified.

Further legal barriers against car-pooling include insurance coverage and fiscal treatment of compensation payments. The evaluation of the legal framework in European countries showed that the existing regulations and their applications made by the authorities do not hinder car-pool activities. In many countries the boundary between car-pooling and commercial activities has to be defined. This should avoid the (theoretical) possibility, as well as the consequences, that in a lawsuit, payment between car-poolers might be seen an indicator of car-pooling being something professional like a taxi-service.

In order to overcome prejudices of current car users against car-pooling, it would be helpful if official advice clearly stated at least the following issues:

- coverage of labour insurance in home-to-work trips, even if a detour is necessary to pick up car-pool partners;

- legal regulations to distinguish car-pooling and car-pool matching centres from commercial transport;
- limits on the money which can be paid to car-pool drivers so that this income can be non-taxable;
- legal requirements for large companies to implement mobility management plans.

4.2 Institutional issues

Local policies have a lot of autonomy in most countries. This may be a barrier to car-pooling and other innovative transport initiatives due to two reasons:

- A comprehensive vision for sustainable traffic developments in urban or metropolitan areas is lacking.
- Local approaches may tend to continue traditional solutions, so that it is difficult for innovative measures to escape the administrative / technical status-quo.

Increasing resistance to new road infrastructure in urban areas offers a valuable opportunity to try innovative approaches. The role of local authorities will be reinforced, so that the viability of innovative measures in the future will increasingly rely on an active attitude from the local administration. For instance, parking policy is primarily a local issue. This offers a unique opportunity for local authorities promoting car-pooling and other traffic management measures. This opportunity is however weakened by two related issues:

- lack of city-wide parking planning in most cases (positive examples have only been found in Austria, France and Denmark);
- limitations to influence private parking construction and management.

In a number of countries, traffic management is not the responsibility of the authority who own the road, as different authorities are responsible for the traffic management and for the road construction. However, this could also foster a more consensus-oriented attitude from the different agencies involved.

Traffic legislation is formulated and approved on a national basis, and the national police is usually involved in enforcement with a varied degree of co-operation with regional or local police. A broad consensus among all institutions is necessary for a successful implementation of car-pooling schemes. In this respect a local public authority's leadership would be needed, as currently an intermediate metropolitan transport authority is lacking.

A major barrier for the implementation of car-pool initiatives may be their perception as competition to public transport. This perception could come from the transport authorities, the public transport companies or even from public transport users. The current lack of co-operation among the public transport sector and the traffic and road authorities could strengthen this feeling. In this respect, public transport authorities have to be involved in the planning process for car pool strategies.

The lack of formal co-operation among institutions might be partially overcome through informal networks of transport technicians working in different agencies. However, extensive implementation will probably need support from the political level to foster institutional co-operation.

4.3 Financial issues

In many European countries there is a tendency towards private financing of public infrastructure, especially in the southern countries such as Portugal or Spain. This could give a good opportunity to introduce innovative measures in the financial framework of optimising the use of the infrastructure and creating an attractive scenario for the private investor. However, until now little is known, as preferential treatment of HOVs might be perceived by private investors as an additional source of risk and uncertainty for the project.

Car-pooling schemes are currently financed through road tolls or the general budget. Nevertheless, money from a variety of transport-related taxes is transferred to special funds in a number of countries. For instance in Switzerland, it is partially used for funding environmental-related research projects, in Austria for road traffic safety measures and for public transport funding and in Norway and Sweden money from toll roads is partially (indirectly) used for public transport improvements.

The role of the private sector in financing car-pool schemes seems to be modest at best, as there is little or no profit from these measures. This could be changed if the private sector, mainly large companies, were forced to implement mobility management measures by law or employers decide to use car-pooling to project an environmentally friendly image for their company.

4.4 Cultural issues

In spite of growing traffic problems, the implementation of restrictive measures is always difficult and not accepted by the public. A crucial issue is to build a more positive and modern image. The main aim is to link personal advantages, such as time or cost savings with social benefits, such as less energy consumption, less emissions, better use of existing infrastructure etc. This new image could overcome psychological barriers against sharing a ride.

5 CAR-POOLING MEASURES

Appropriate measures to encourage car-pooling can be found to some extent in literature, especially US literature. In the following chapter these measures are described and notable features are highlighted.

5.1 Information and marketing campaigns

An information and marketing campaign or a communication campaign can be defined as a way of informing the public or making the public aware of a certain issue/topic. In the case of car-pooling, a campaign can be organised to generate the awareness of the general public or decision makers for car-pooling in general or for a specific aspect of car-pooling.

A promotion campaign on car-pooling can be organised through four different channels either using them individually or in combination:

- directly to the target group of potential car-poolers;
- via employers to the employees;
- via intermediaries (such as NGO's or branch organisations);
- via the public media to the general public.

Information and marketing campaigns on car-pooling can make use of different media sources, such as articles or ads in the mass media, bill-boards along arterial roads, brochures and leaflets distributed at targeted locations or posters at company offices or in public places.

No proven direct effects of the impact of information and marketing campaigns on car-pooling have been identified. However, campaigns on these measures are very valuable to create a positive climate for car-pooling. It can enhance knowledge and awareness of car-pooling as a travel alternative. Information and marketing campaigns will have a higher impact if they are focused on special target groups, such as target groups with a high share of solo car commuting and with no objective reasons against car-pooling.

The arguments used in convincing people to pool cars should primarily point out personal benefits, such as time gained, money saved, etc.. It is important to position car-pooling as something smart, modern and associated with new lifestyles. Information is needed about the main issues which might concern car-poolers. Some examples could be insurance, costs, how to start a car-pool, how to find partners,...

It is advisable to involve some more readily accepted intermediate groups (e.g. automobile associations) to pass the message. Car-pool campaigns should start at the destination side (work places) to find people with the same work place. Campaigns along corridors and campaigns at the origin side can be an option.

A general information and marketing campaign on car-pooling can be considered as a goodwill operation for car-pooling. As such, it can be

considered in itself as a kind of accompanying measure for car-pooling. These campaigns should run alongside other actions. People should be encouraged to take action and to actively start looking for a car-pool partner.

Campaigning and marketing for car-pooling involves a lot of organisational work, for instance setting up the campaign, financing, contacting marketing agencies, etc.. It also requires a lot of contacts with intermediate groups in order to persuade them to get involved in the campaigns.

5.2 Matching services

"Non household car-pools" do not just happen, they need to be created. The potential partners must get in contact with each other. The bringing together of potential partners is usually done by means of matching services. These services can vary a great deal in scope, size and appearance. It can simply be newspaper ads in a regular or a dedicated newspaper. Computerised matching services are also available where contact is by phone, by post card or even by more sophisticated means.

Matching services only offer facilities to people who already have decided that car-pooling is something of interest for them. Matching services alone will not usually encourage people to start car-pooling.

Matching services should be offered as a continuous service, rather than as a short term project. Therefore, personnel and other resources have to be provided on a permanent basis.

Matching services are preferably targeting specific sites or areas (a large company, an industrial estate, a corridor, part of a region) and their work should be integrated in a package with other measures (preferential parking, company incentives etc.).

The data used by matching services should include:

- location of work place (destination);
- home address of the car-poolers (origin);
- working hours;
- car availability;
- other characteristics (smoking/non smoking and sex can be used as matching criteria or should at least figure on matching lists).

Potential car-poolers should have easy access to the matching service: a phone is a must, but other means can be considered as well. Matching can be carried out manually (map with indication of homes of car drivers) or by using computerised systems. There are a number of matching software systems on the market. The ICARO demonstration in Brussels made use of the car-pooling software "smart-pool".

Accompanying measures are necessary, e.g. marketing campaigns that give information on the extent of the service, point out the benefits of car-pooling, supplementary benefits for car-poolers, etc.. Better results can be expected if

potential car-poolers are permanently well looked after. The follow-up activities are preferably guided by the matching agency. This should be periodical informal letters sent to interested people who can not initially be matched or a car-pooling club magazine for practising car-poolers. In companies, however, this could be a car-pool (or transport) consultant - a dedicated member of staff - who is allowed to put some working time into car-pool (or transport) co-ordination.

The matching service is usually operated by a non governmental organisation or a private company. A car-pool matching service could also be part of a larger transport co-ordination centre, also catering for other transport needs. Public transport companies could also be involved in matching. The matching service could then be considered as a complementary offer to their bus services.

Co-operation is needed for the promotion of the matching service. Here authorities, socio-economic groups (e.g. employee representatives, trade unions, chamber of commerce, employers) and other interest groups can play an important role.

Authorities should often provide the starting funds for a matching centre. In the long run other parties can contribute to the costs of the operation (chambers of commerce, labour unions, employers, etc.). The costs involve staff, office, software and hardware for matching, telecommunication, postage and marketing/communication costs (phone, other access, internet, etc.). Costs can be reduced by using the existing infrastructure (e.g. offices, computers) of supporting organisations. Most of all, permanent financial support (whether private or public or a combination of both) is needed for the matching service.

Users should not have to pay for obtaining matching lists. If a charge is made, it is preferable to ask for a fee when a car-pool is formed. In order to make it more attractive for the car-poolers to pay the fee, an extra service can be provided such as extra insurance cover, guaranteed ride home service, etc..

5.3 Guaranteed ride home

A guaranteed ride home (GRH) service provides a ride home for employees in unforeseen situations. This service is specially set up for car-poolers within companies or administrations. Usually the service is organised within the company or administration employing the car-poolers, in special cases by the car-pool matching service.

Unforeseen situations can be:
- emergencies, e.g. illness of a child;
- unforeseen mismatches: when a person from a car-pool is not able to join the same car-pool for the journey home and finds out about this during the day, e.g. in case of irregular overtime.

Guaranteed ride home can be provided by:
- public transport: e.g. company year card and/or free tickets;
- bicycle: a company bicycle for short distances;

- taxi: a taxi is versatile and readily available, but is expensive;
- car-sharing: various companies use vehicles provided by a car-sharing organisation;
- other car-pools: finding a car-pool match is a relatively cheap solution, it is, however, less suitable in emergencies;
- company car: company owned cars can be used during the day for commercial transport and in the evening as a substitute means of transport.

It should be made very clear to whom and in which situations the guaranteed ride home programme applies. Fraud is possible, e.g. an employee claiming to have worked over because he/she prefers a taxi ride home. This can be overcome by setting some control measures, e.g. a guaranteed ride home because of working over should be approved by and/or be requested by superiors. Fraud can also be reduced by limiting the number of trips in the start up period of the guaranteed ride home service. The scheme has to be well promoted among employees, in terms of it's existence and the rules of application.

Guaranteed ride home schemes can increase the number of car-poolers in company car-pool schemes. This effect can be quite small in Europe due to the fact that here the public transport system is usually well developed. In cases of emergency, people in Europe are often able to travel by modes other than the car.
In general the system is not frequently used. The average use of the guaranteed ride home service for a company with 100 ride-shares (including walkers and cyclists) is probably between 8 and 20 trips per year (according to US figures). Experiences from the US estimate the costs per employee per year as 0.07 EURO up to 4.3 EURO.

The program itself (the guarantee) will not cost much, apart from the costs for negotiating and setting up the scheme. The highest costs result from the actual guaranteed rides home. GRH-trips in some companies in the Netherlands cost approx. 30 EURO per trip. A recommended maximum level of guaranteed rides home per person or a maximum number of kilometres per trip or per year can be defined. However, limitations are recommended only during the starting period of the scheme or if a large amount of fraud is detected.

Employers as well as employees consider a GRH-system as a useful and very cost effective tool within a total transport demand management system or a car-pool system. The implementation of a GRH-system increases the level of service, both in perceived and in real terms.

Some organisation, however, is required to set up the program and make agreements with transport providers (lease companies, taxi companies). A co-ordinator is required who can organise the guaranteed ride home in case of an emergency, but this work can also be delegated to the matching centre. He/she should be well aware of all existing alternatives (public transport, taxi providers, car-pools).

5.4 Financial benefits for car-poolers

Financial benefits for car-poolers are all direct or indirect benefits, which are provided in order to stimulate car-pooling.

Direct benefits could be:
- financial bonuses for car-poolers;
- tax benefits.

Indirect benefits could be:
- reduced parking rates, where there is paid parking;
- reduction on various car-related services (repair, maintenance, etc.);
- reimbursement of some specific costs (like environmental inspection costs).

Although the payment aspect in itself is not that complicated, the rules need to be fixed and a monitoring and control system has to be set up. The effect of financial benefits is usually correlated with the scale of the benefit. Also a careful balance needs to be made with benefits for public transport users or cyclists. If the benefits for car-poolers are higher than the benefits for public transport users or cyclists, then a considerable proportion of new car-poolers may well be former cyclists or public transport users.

Some control will be necessary to set minimum levels of car-pooling to qualify for a financial bonus. An example could be 8 out of 10 home to work trips. This allows for the fact that due to holidays or personal circumstances, people will not be able to car-pool every working day. In many companies social control is sufficient to enforce the scheme.

Employers need to be convinced of the merits in giving financial benefits. Once this has been achieved, other problems can occur. For instance, tax authorities might consider the payments as taxable income. The net benefit for the user might therefore be smaller than initially thought. This depends on the country, but most countries will tax the extra benefit. In some cases (e.g. reduction on parking costs, reimbursement of parking costs, reduction on various services, etc.) the benefit might not be taxable or not be recognised as such by the tax office. Trade unions might question the payment as not everybody is able to take part in car-pool schemes.

For instance, the city of Gent (Belgium) grants a benefit to employees not driving alone to work of 0.15 EURO per kilometre for a maximum of 6 kilometres. This benefit is embedded in a mobility plan including other items such as parking regulations, improvement of public transport services, infrastructure for cyclists etc..

More attention should therefore be paid to convincing companies to introduce financial benefits for car-poolers. One approach could be to review travel allowance payments.

5.5 Car-pool parking (park-and-pool areas)

Car-pool parking or "park-and-pool" areas should be situated preferably at intersections of major roads leading to a conurbation area. Commuters can meet, park their cars and collectively make the journey to the final destination. In many countries such areas exist on an informal basis.

The measure does not usually require the involvement of many actors. Generally, the authorities for road construction and maintenance can build and maintain the parking areas. Co-operation is still necessary with municipalities, for instance in the field of supervision or maintenance. Other actors could help in the promotion of the measure.

Usually, there are no rules for using these areas, so anybody can use them. High quality signing and road marking are essential for safe operation and public acceptance.

"Park-and-pool" areas as a stand alone measure are unlikely to have any significant effect on the formation of car-pools, as they are more likely to benefit existing car-pools. These areas can, however, convey the message that authorities take car-pooling seriously and are prepared to invest in infrastructure to promote car-pooling.

The costs involved are the investment costs for acquiring the land, together with additional costs to construct and equip the area. The cheapest way of providing a meeting point for car-poolers is to legalise wild parking facilities under bridges, along major roads or near major motorway junctions. The use of these parking areas, like most park and ride areas, should be free of charge.

Promotion for the areas is recommended. This can be done through intermediate groups such as automobile associations, but it is also possible to promote the areas at the destination through companies. A map of all park-and-pool areas in a region or country could be made available. It should also be possible to mark the areas on city maps and road maps.

Matching services could be provided on the park-and-pool areas, especially in the case of large staffed parking areas. In the Netherlands, larger "park-and-pool" areas are also equipped with further services such as coffee shops, telephone, Laundromats, notice boards etc..

5.6 Preferential parking at destinations

Preferential parking for car-poolers can mean:

- reserved parking places for car-poolers, usually at the best situated spaces;
- free parking or parking at a reduced rate where parking charges are levied;
- a combination of both.

Preferential parking is usually introduced on company grounds, but it could also be considered for public parking areas, especially off-street parking. It is more difficult to organise and control for on-street parking.

Preferential parking does not meet with opposition if parking is ample and free for non car-poolers. However, if non car-poolers have to pay substantial fees and/or walk long distances, there can be resistance. This is especially true for parking on company grounds and may deter companies from introducing such a measure. Preferential parking on public grounds will probably meet with less resistance, if it is part of the access rules of these public parking spaces. The users of these parking places do not generally know each other and are therefore unlikely to object as a group.

There are no institutional barriers/problems in European countries to implementing preferential parking at destination sites, since the sites are generally privately owned and operated by companies. However, planning procedures, failure to win public support, or lack of a positive cost benefit analysis could prove to be barriers to provision.

When introducing preferential parking, enforcement will be an issue. On company premises, enforcement can take place in various ways:

- The preferential parking areas can be protected by automatic barriers and/or cameras. Parking attendants can decide whether or not to accept the car.
- Each car-pool team can have its own badge which has to be on display. A parking attendant responsible for the area can carry out random checks.

On public parking grounds, the procedure is similar:

- access control;
- display of special badges.

In the latter fraud is still possible, as the numbers of occupants on arrival cannot be controlled.

When considering a preferential parking scheme on company grounds, it is recommended that consultation takes place with the trade unions or any other form of employee representation. Before introducing the measure, the reasons and rules have to be clearly explained to the employees (e.g. 2+ or 3+ get preferential parking, minimum distance required for the home to work journey etc..).

Preferential parking can be accompanied by a package of other incentives, especially when no real parking problems exist. Matching services should be set up, especially in larger firms, where people need to get to know each other or in the case of preferential parking on public parking grounds.

The costs involved for the provision of preferential parking are generally small. The largest cost is usually the equipment for the preferential parking places (special traffic signs, sometimes barriers, special badges, etc.). Other costs are associated with the personnel needed for issuing permits and enforcing the measure.

5.7 Parking Pricing

This measure consists of either instituting or raising the current prices of paid parking facilities for private vehicles. Such a restrictive measure can be accompanied by an incentive to either completely or partially waive the parking fee for car-pooling vehicles. The introduction of paid parking is usually instigated by companies in their own parking grounds. They could also stop paying parking subsidies for parking grounds which they rent elsewhere. Local authorities could also start collecting parking fees for on-street parking in areas which are overrun by commuter parking.

Even though the rationale behind parking pricing policies has become quite well understood by users nowadays, certain psychological barriers do still exist with respect to the application of a dissuasive price structure. Introducing either full or partial price discounts in the parking fees charged to car-poolers could help such a pricing policy gain the acceptance of the local population since motorists themselves benefit from such a policy (unchanged parking fees for SOVs and more parking space available).

Consultation is needed with the organisations representing the employees with respect to the scheme and it’s benefits. In the case of on-street parking, consultation is also needed with all external parties involved such as neighbourhood groups, shop keepers, etc..

The program itself does not have to be expensive. On the contrary, it could bring money in. The income can be used to improve other transport services or to continue to promote car-pooling.

5.8 High Occupancy Vehicle Lane (HOV lane)

HOV lanes are dedicated lanes which can only be used by High Occupancy Vehicles, i.e. vehicles with more than a minimum number of occupants (usually two or three). HOV lanes allow users to gain time, when the general purpose lanes are congested. Time gains are highly appreciated by commuters. HOV lanes can be a part of motorways or major arterial roads. They may be "tidal flow", i.e. reversible, to serve the traffic in the busiest direction (usually inbound during morning peak, outbound during evening peak). The motivations for the introduction of an HOV lane may differ from one case to another. Among the most cited reasons are congestion, energy efficiency, air pollution and the objective to transport more people on the existing infrastructure in fewer cars.

Concerning construction, HOV lanes can be physically separated from the all purpose lanes or they can be separated by purely non physical means (lane markings, special traffic signs, etc.). In the latter case, solo drivers are not allowed in these lanes, but they can enter and leave them anywhere.

There are three possibilities for the implementation of an HOV lane:

- an existing general purpose lane can be converted into an HOV lane;
- an additional lane can be added;
- a bus-only lane can be converted into an HOV lane.

HOV lanes require a lot of effort. In the planning procedure, co-operation is needed between the operator (usually the roads agency) and local and regional authorities. Public support is an essential factor for building successful HOV facilities. The marketing of any scheme must be included in the development process to create awareness and acceptance of the positive attributes in reducing traffic congestion and pollution. Equally important is the need to raise the profile of car-pooling.

Local and regional actors have to be involved, especially at the destination side, but perhaps also at the origin side. Lobby groups, which could oppose the scheme should be convinced: automobile associations, chambers of commerce, etc.. In any case companies (destination side) should be involved.

HOV lanes can provoke substantial resistance, so not all politicians will be keen on this measure. This is especially so in the case of a "convert a lane" HOV lane. Converting an existing lane into an HOV lane will most probably worsen the conditions for non-HOVs, but a conversion is more environmentally friendly and costs less.

If HOV lanes are apparently underused, a lot of resistance can be expected from drivers in the other lanes (the so-called "empty lane syndrome"). This can also occur in the case of added HOV lanes. Opposition can be expected when the rules are set too strictly. It is psychologically easier to upgrade from 2+ to 3+ than to downgrade the admission standard. The general public are more likely to accept the need for an upgrade to 3+ if a 2+ lane becomes overcrowded.

Time gains can be very tempting, so enforcement is necessary for HOV lanes. If the HOV lane is physically separated from other lanes, random police controls at the exit of the HOV lane can be cost-effective. If there is no physical separation, enforcement is more complicated. Random checks by the police over the whole length of the lane are necessary. Camera technology could also be considered. Unmanned cameras could register the licence plate of a car and the number of occupants. This would require legislative changes in some countries. In the case where the outer (in the UK the inner) lane of a motorway is a non-separated HOV lane, enforcement can be very difficult, since solo users will need to use the lane anyway for entering and leaving the motorway.

Whenever possible, bus routes should be concentrated on the HOV lane. This will significantly raise the numbers of people benefiting from the lane.

The costs for introducing HOV lanes can be relatively low. They can be high when new lanes need to be constructed, especially when physical barriers are needed. Accompanying measures, such as campaigning in companies, public relation schemes, information campaigns, etc. can be costly. Also enforcing the measure can involve substantial costs.

Usually, there are no sources of income associated with the HOV lanes. A possible source of income could be the introduction of a combined HOV lane / pay lane (High Occupancy Toll lane, HOT lane), where solo drivers are

also accepted upon payment of a toll, which could vary according to the time of day and the congestion level.

Each HOV lane scheme should be carefully prepared, not only technically, but also legally and in terms of support. HOV lanes should not be introduced just anywhere. The importance of accompanying measures has clearly been demonstrated in the USA and Canada, where some HOV lanes failed due to insufficient marketing or insufficient perception of need. Among transportation professionals in America it has been established that transportation infrastructure cannot be optimised without mobility management that controls car occupancy.

For the construction of or conversion to HOV lanes, various aspects need to be considered. They can be summarised as follows:

- Avoid an empty looking lane, because this might lead to negative public opinion reactions.
- It is better to start with a 2+ HOV lane and to convert it to a 3+ facility if necessary than to start with a 3+ which has to be downgraded because of a lack of success.
- Buses on an HOV lane can increase the public acceptance of an HOV lane, through a significant increase of the numbers of people transported along it.
- Allowing HOVs to use existing bus only lanes can be considered but it is necessary to avoid congestion in that lane. This measure has sometimes led to improved car occupancy levels.
- Should an existing motorway-lane be converted to an HOV lane or is constructing an additional lane as an HOV lane better? A conversion is environment friendlier and costs less. But it is more difficult to obtain public acceptance for a conversion because for the solo drivers, the situation can get worse: less capacity, slower traffic.
- Important time savings should result from the use of an HOV lane. This is crucial to encourage ridesharing.
- Arterial HOV lanes on main streets in cities, instead of ‘bus only’ lanes, can improve the acceptability of such dedicated lanes, especially if the frequency of the bus services is not very high.
- The capacity of inner city roads and parking has to be taken into account. Creating additional capacity by constructing HOV lanes does not make sense if the city can not absorb the additional flow of cars.

5.9 Ramp metering

Ramp metering is an instrument preventing congestion on motorways by stopping traffic entering the motorway when the motorway is reaching the capacity limit. Vehicles entering have to wait at a traffic light and can pass one by one according to the free capacity. In this way the traffic on the motorway remains fluid. An exemption can be given to high occupancy vehicles. They can pass by without waiting, or get priority to enter the motorway as soon as there is some free capacity. Ramp metering can be introduced as a part of an HOV lane program, or as a separate measure. Examples of ramp metering with by-passes for HOVs are known from the United States (San Francisco, Portland etc.).

5.10 Possible measures to be implemented by employers

Employers are very important partners when considering measures to increase car occupancy. Many measures can be implemented within the framework of company transport plans (mobility management). Below is a list of measures which can be implemented as part of company transport plans.

Employers wanting to implement these plans, have to take into account the same preconditions as mentioned under the description of the indicated measures in this report. Components of company mobility management plans:

- preferential parking space for car-poolers at destinations (in the company parking lot);
- matching services for employees in home to work traffic;
- financial benefits for car-poolers, public transport users, cyclists, walkers;
- guaranteed ride home schemes;
- awareness and information campaigns;
- paid parking.

The effects of car-pool measures implemented by companies are usually substantial. Employees have a common destination and often also more or less comparable travel hours, and are therefore more likely to car-pool together. Employees also know each other which means they should find it easier to consider car-pooling. Awareness raising and information provision on the measures is easily done through company channels such as company newspapers.

Involvement of and consultation with all parties is very important to avoid negative reactions from the employees. The employees themselves, represented or not by trade unions, should be involved from the start of the process and their points of view should be taken seriously.

6 CAR-POOLING DEMONSTRATIONS IN ICARO

The ICARO project has involved the analysis and evaluation of demonstrations in nine urban sites throughout Europe, covering a wide range of cities in seven European countries, and is subdivided into real life demonstrations and modelling demonstrations (feasibility sites), as follows:

6.1 Description of the real life demonstrations

6.1.1 Leeds (Great Britain)

Leeds has an outer ring road and an inner ring road, neither of which are complete. Schemes proposed over the next few years will effectively complete the ring road systems, subject to obtaining the necessary funding.

A number of radial routes run to the City Centre between the outer ring road and the inner ring road. The HOV demonstration was introduced on one of these radial routes on the west side of Leeds. The route chosen for the demonstration HOV lane was the A647 Stanningley Road. The length of A647 where the Leeds bound HOV lane has been introduced is a dual two lane carriageway, changing from a grade-separated section with a speed limit of 60mph to an at-grade section with a speed limit of 40mph and a number of side road and frontage accesses.

A combined bus, cycle and high occupancy vehicle (HOV) lane was introduced along sections of the existing nearside lane of the A647 route into Leeds. The introduction of an HOV lane is one measure which could result in a more efficient use of the cars on the route and allow more people to access the city, without necessarily resulting in an increase in the number of vehicles.

The main objectives of the HOV lane are to:

- encourage more HOVs leading to a general increase in car occupancy;
- provide time savings and more consistent journey times for existing HOVs;
- provide time savings and more consistent journey times for buses.

The length of the HOV lane is 1.5 km. The scheme is in operation from Monday to Friday from 07.00 to 10.00 in the morning and from 16.00 to 19.00 in the afternoon. The minimum occupancy level is 2 or more people per car. Buses, coaches, motorcycles, pedal cycles, cars/vans and other vehicles less than 7.5T with 2 or more people and wide loads on a short section of the lane are allowed to use the HOV lane.

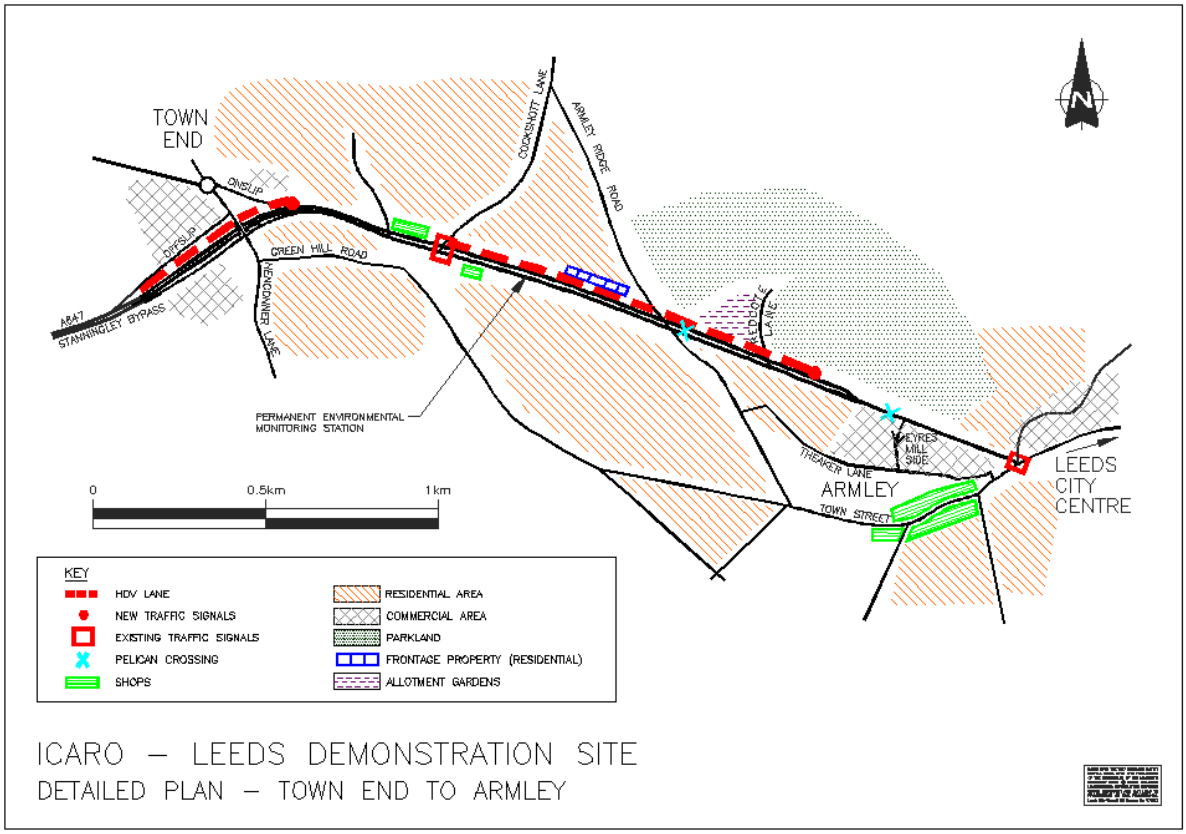

Figure 6-1: Map of the HOV lane in Leeds

The width of the HOV lane is 4.5 m with a 1.3 m cycle lane separately marked within the overall HOV lane. A special logo has been designed and is used on road-signs. "2+ LANE" is used on the carriageway within the HOV lane. New, specially designed HOV signs and advanced warning signs have been installed (Figure 6-2 and Figure 7-1). Half lay-bys have been provided at bus stops along the length of the HOV lane to permit vehicles to pass stationary buses. A special police enforcement layby has been provided at each end of the HOV lane route. The end of the HOV lane is controlled by traffic signals at the busiest times, giving priority to HOVs.

Police enforcement is used and a service level agreement between the police and Leeds City Council (LCC) has been signed.

Figure 6-2: Leeds' HOV- sign

Besides the infrastructure measure of an HOV lane, an information campaign was launched to promote the proposed HOV lane and to specify who is permitted to use it:

- Information signs were erected at two separate locations along the A647 route.
- An A4 size leaflet and poster were produced to provide information on the HOV lane. This covered who could use the lane and the benefits of car-pooling. The leaflets were handed out to drivers using the A647 HOV route and were made available at public buildings and used in presentations.
- A large amount of press coverage was received for the preliminary proposals. This was followed by significant press interest in the actual scheme on opening.
- A large number of radio and TV interviews took place which served to inform the public of the forthcoming HOV lane scheme and keep them informed about the latest position up to opening date. The benefits of car-pooling were also discussed.

The HOV lane was opened in May 1998 and became a permanent scheme on the 8th November 1999.

Figure 6-3: HOV lane in Leeds

6.1.2 Salzburg (Austria)

The region of Salzburg (i.e. the Federal Province of Salzburg and its capital - the City of Salzburg) is a very prosperous area. It offers a wide range of opportunities for trade and industry as well as cultural and recreational facilities. This will result in an increase in population and housing in the surrounding areas of the city as well as an increase in car traffic up to 60 % from 1994 to the year 2010. A major part of this traffic will be commuter traffic to and from the City of Salzburg.

Therefore one main objective of the Salzburg City Council is to operate the existing road network efficiently. Other more attractive modes and parking restrictions should discourage motorists from driving into the city. Motorised traffic should be reduced to "necessary" traffic, which will be calmed and will be organised to be environmentally friendly as and where possible. As car occupancy is still quite low, it seems logical to increase car occupancy and to investigate how this can be achieved in the most effective way and at minimum cost.

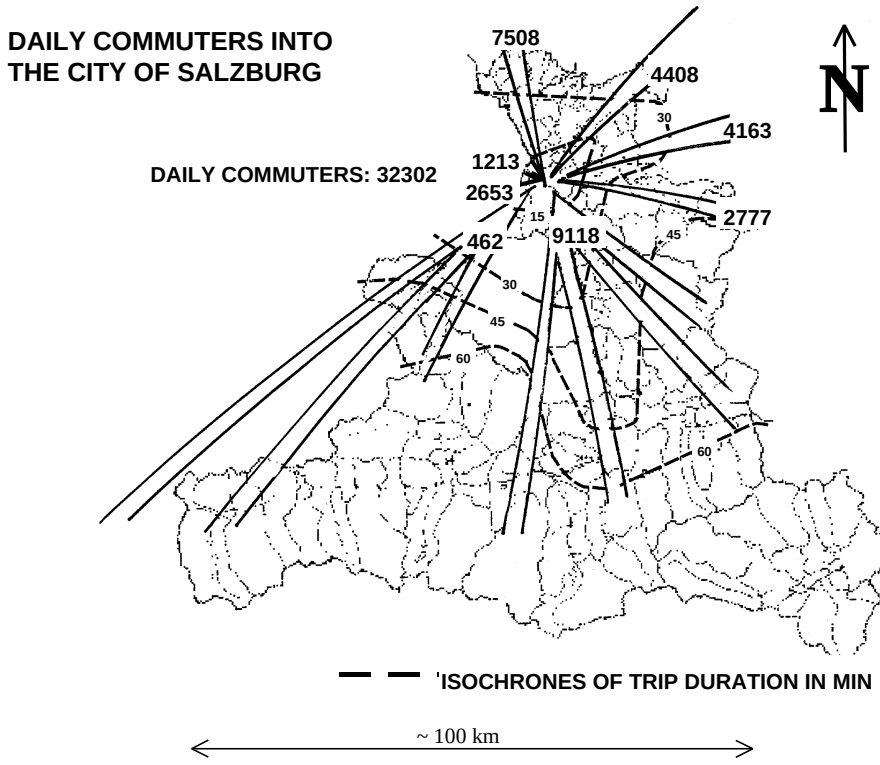

Figure 6-4: Daily commuter traffic towards the city of Salzburg

The measures in Salzburg can be described as supportive and stimulating. No additional restrictive measures were put in place, because inner-city parking is already restricted. Commuters from areas around the City of Salzburg should leave their cars at home or at special car parks and use only one car (e.g. "car-pooling car") to continue their journey.

In order to encourage them to do this certain benefits were made available for car-poolers: Long-term on-street parking for car-poolers in the short - term parking areas of the city and cheaper rates in garages, half-price tickets for the return journey (ride-home) on public transport if the car-pool does not work in the homebound direction.

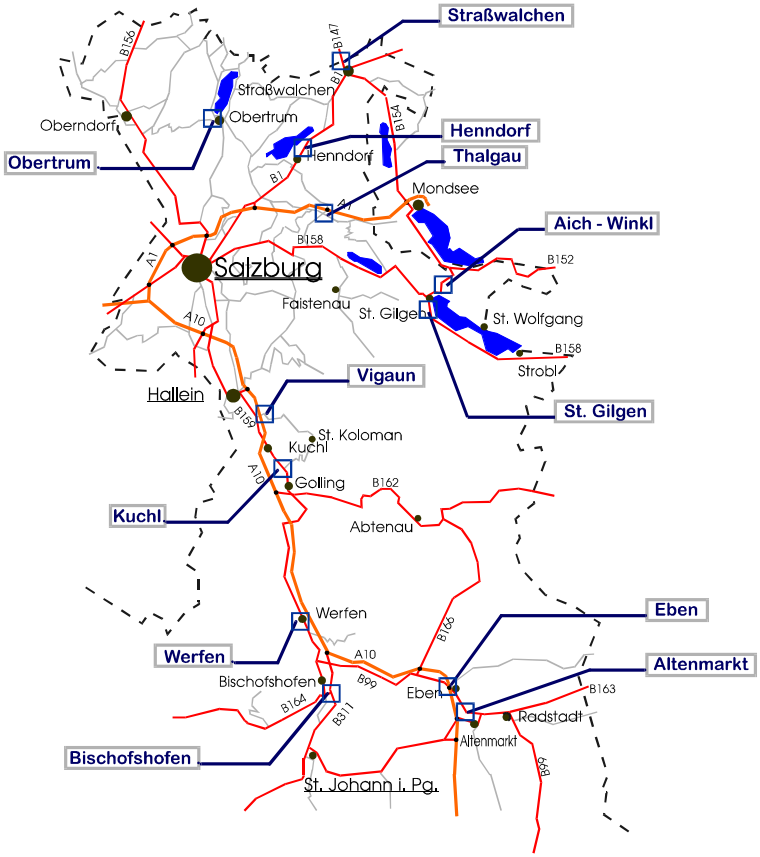

Figure 6-5: Car parks in Salzburg

A telephone hot-line provides information and a ride-matching service. For that reason a specific software program was introduced, which is able to register potential car-poolers and to combine the collected data in order to supply matching lists for car-pools in the region of Salzburg. The data is collected and co-ordinated using this software. The outputs are several matching offers for the interested persons, which are evaluated according to the percentage of fulfilling requested points. From these offers, the potential car-poolers can contact the most suitable partner and establish a car-pool arrangement themselves.

An additional passenger insurance was arranged in co-operation with the Wiener Staedtische Versicherung and the Wuestenrot company (insurance company).

Participants in this car-pooling scheme receive a membership card. To get the membership card, people have to be officially part of a car-pool consisting of at least two people (2+).

An information campaign based on leaflets, folders, information brochures, posters and information boards was intended to ensure a sufficient public awareness of the initiative. All larger employers in the city area – both public and private - were invited to participate and motivate their employees accordingly. A local newspaper and the Austrian broadcasting company, as well as regular publications distributed by the Provincial Government and the City Council of Salzburg, supported the project.

Figure 6-6: Information billboard

The start of the Salzburg real life demonstration was October 97, with the end originally planned for April 98. However, it was possible to prolong the scheme in a first instance until the end of 1998, and more recently until the end of 1999. It may possibly become a permanent scheme.

6.1.3 Brussels (Belgium)

Some 375,000 people commute to Brussels on an ordinary working day with 62 % by car and 38 % by public transport. Departing from an optimistic estimate of an average seat occupancy of 1.3 persons/car, this would mean that in commuting traffic alone 178,846 cars are entering Brussels every day. This situation, which is still worsening, causes a lot of traffic problems in the city, mainly at peak hours. The incoming traffic, originating in the surrounding regions Flanders and Wallonie, is more problematic than the traffic inside the Brussels Capital Region, where public transport is more important in the modal split.

The main aim of the project was to demonstrate that an increase of car occupancy can be obtained through a series of "soft" measures, essentially in the field of information and communication. The long-term aim is to demonstrate that car-pooling can have an important effect on the traffic situation in some parts of the city of Brussels. The Brussels Ministry of Transport is currently developing solutions to reduce the number of cars that enter the city daily.

A car-pool centre was established to campaign for car-pooling, and to offer incentives to encourage employees of individual companies to put car-pooling into practice. The aim of the car-pool co-ordination centre is to add an extra dimension to the existing practice of promoting car-pooling. The centre is responsible not only for answering questions and offering matching services to the public, but also for the acquisition of potential car-poolers (by a constant marketing effort) and the active follow-up of the interested part of the public.

All the participating companies and institutions received a specific manual describing the possible ways to stimulate the practice of car-pooling: the installation of a car-pooling co-ordinator in the company, internal promotion of car-pooling, preferential parking for car-poolers, the guaranteed ride home, van-pooling with company cars, flexible working hours, extra home-work and compensation fees to car-poolers. The car-pool co-ordination centre advises them on how to put these incentives into practice.

The centre promoted the car-pool matching system using posters and a first newsletter, announcing the existence of the car-pooling centre. These posters and newsletters were distributed in the participating companies and other organisations. The newsletter contained a survey among the employees, which gave them the opportunity to declare their interest in car-pooling.

The car-pool co-ordination centre is equipped with a car-pool matching software. After the launch campaign, the first series of matching lists was distributed to employees who declared their interest in car-pooling in the general survey. After this, companies themselves can produce matchings for any request, using a direct link with the database, or simply by contacting the centre. Employees are also able to register through the second and third newsletters as well as by contacting the centre (phone, e-mail, letter).

The centre has to make sure that the car-pooling list does not remain a piece of paper. The car-pooling co-ordinator contacts people who have received a matching list to help them contact the possible partners, to answer all the questions and eliminate all the objections people may have when facing the possibility of joining a car-pool.

This includes:

- contacting people by telephone;
- distributing guidelines to interested commuters/parents in the form of a second newsletter, which is attached to every matching list but also distributed among all the employees of the companies as a second campaign to obtain registrations;

- to organise information sessions with interested people on the work floor, to bring them together, and to respond to any objections (organisational, fiscal, insurance problems, ...);
- to keep in contact with groups of car-poolers and to create a "car-pooling culture": through the newsletters, by organising a car-pooling club, by organising a contest.

Car-pools often fall apart because of changes in the individual situation of the car-pooling participants. The centre must be ready to offer solutions. The possibility of finding new partners must be well communicated. The centre must be well informed about the evolution of the use of car-pooling. It therefore remains in contact with groups of car-poolers and companies.

The demonstration focused on home-work traffic, and on the companies and institutions located in Brussels that generate this traffic. On the other hand, a general campaign announced the existence of the car-pool centre to the general public, mainly inhabitants of Brussels. Three possible types of car-pooling were promoted:

- direct from home to work;
- car-pooling in the last part of the home-work route: from a specific place (car-park, station, ...) along the road outside Brussels where the candidates can meet their car-pooling partners, to the company;
- car-pooling in the first part of the home-work route: from home to a park-and-ride facility in the suburbs of Brussels. Here, car-pooling is used as a feeder to the Brussels public transport system.

The target groups were all the car drivers (solo drivers and car-poolers) among the employees in the selected companies. The car-pooling campaign and the activity of the matching centre were launched in October 97. The matching centre is still in operation.

Figure 6-7: Car-pooling centre in Brussels

6.1.4 Pilsen (Czech Republic)

Since the beginning of the nineties the Czech Republic has been experiencing a rapid increase of private cars including their increasing use for commuting. Simultaneously the demand for mass or public transport dropped with unfavourable shifts in the modal split. On some roads, especially in larger urban conurbation and on access roads, the traffic intensity has already reached capacity limits with negative environmental, economic, social and health consequences. Privatisation of formerly state owned and subsidised bus transport companies brought about problems with financing of unprofitable regional or interregional connections. Some of these lines were cancelled or at least restricted in frequency. Increasing use of private cars for commuting and other purposes then inevitably followed.

The territory of the Pilsen region covers up 3,100 km^2 and includes the districts Pilsen - City, Pilsen - North, Pilsen - South and Rokycany. The total number of inhabitants living in 260 municipalities is about 360,000. Dominant centres in the whole territory are the cities of Pilsen and Rokycany.

As the concept of formal car-pooling is virtually unknown, the main aim of this demonstration was to introduce and market the concept to the public and relevant interest groups. The measures included providing the matching and information service and guaranteed ride home for participants and, working with local employers, to explain how to operate and promote such a programme within their organisations.

In Pilsen only non - infrastructure measures were planned for implementation. These included:

- establishing and operating a car-pooling centre ("*Centrum sdílené dopravy"*); An important part of the services of the Centre was to provide information to potential car-poolers and all people interested in learning more about the system and its underlying philosophy. Information was given either personally or by phone.
- creating a registry to log participants and providing a matching service for them; (lists of potential partners were prepared and made easily accessible to the participants). Keeping contacts with potential car-poolers over the period when no suitable partners could be found for them. Following up successful car-pooling teams.
- working with employers to support the matching programme; in case of a need to help with developing a guaranteed ride home scheme (offering a free ticket for public transport);
- implementing an information campaign targeted both at the general public and individual groups;
- maintaining a marketing program throughout the demonstration, that was adjusted as needed, to provide targeted information based on employer and user feedback.

Prior to starting the ICARO project, the City of Pilsen had already introduced some restrictive measures for parking in the town centre. The City is currently considering enlarging this paid parking zone.

The publicity and marketing campaign has progressed in several stages to date. It began with information for Pilsen Town Hall authorities and other important Pilsen organisations. The second stage was an awareness campaign targeted at general public. Campaigning included the distribution of information leaflets, placement of coloured advertising posters and strategically placed newsletter articles. The third stage campaign was more individually targeted.

A comprehensive information leaflet, including an application form was prepared and subsequently approved by the Pilsen Project's Advisory Board to be distributed on a large scale over the Pilsen region. Dissemination of this material started at the end of October 97. The information leaflet with the application form was published in the official Pilsen Newsletter, Town Hall Papers (Radnicni listy) distributed free to every Pilsen household (number of copies 65.000). Another 18,000 copies of this leaflet were distributed over the region.

Several five minute clips on the project were broadcast by the local radio station and two five minute slots outlining the project were presented by a regional branch of one national TV station during evening prime time in October and December 1997.

The press conference to further promote the project was held in March 1998. About 20 journalists attended and many articles were published in local papers, including information in the Prague Town Hall journal METRO. The press conference was complemented by a radio release with an entry by the PANASONIC representative, who spoke about the benefits of the car-pooling project to their enterprise. A total of 1,000 coloured posters in A2 format were printed and strategically placed in Pilsen and suitable sites in the region.

6.1.5 Graz (Austria)

The city of Graz is the capital of the Federal Province of Styria located in the south- east of Austria. About 240,000 people live in the city, which covers about 130 km^2. It is the regional centre of the conurbation of Graz with a total of 350,000 inhabitants. About 156,000 people are employed in Graz, with around 102,000 of them are living in Graz, the rest being commuters. More than half of them (55.4 %) use their own car for this purpose. About 30 % are working in the field of production, 3.5 % in the field of tourism and 65 % in other service trades (1991). Whereas the inner city car traffic is only predicted to increase slightly, an overall increase of over 50 % car traffic is expected for the next 20 years (in 1991 about 100,000 vehicles were registered in Graz with a estimated increase of 23% up to 2011. More than 111,000 cars were registered in 1997).

The "Shake & Ride" concept, which was implemented in Graz, offers a viable alternative to this problem. The system encourages neighbours and people driving in a certain geographic area to give other people a spontaneous lift to

the next public transport stop. In this way the long walks to the stops can be avoided and special feeder trips become unnecessary. Due to the short distances, the lift is offered for free, no payment is necessary.

The objective of the demonstration was to test the suitability of Shake & Ride, an inexpensive and uncomplicated feeder system for public transport. A main concern for the Shake & Ride project was to find a suitable testing-area. The ideal areas should have a treelike road structure with the smaller roads leading towards only one main road that leads out of the area. A public transport stop providing high frequencies and good connections to the main part of the city should be situated on this road. No public transport should operate within the area. It is important that the areas are small enough so that people at least know each other by sight but are big enough for the car frequency to be sufficient. The two areas chosen were Mariagrün, which is an outer part of the city of Graz and Gedersberg, which belongs to the community of Seiersberg and is situated south of Graz.

Every participant was registered to improve the quality and to increase the safety of this "offering a ride" system. People who were willing to give someone a ride in their car marked it with a sticker and people who wanted to obtain a ride received an identification card.

Figure 6-8: S&R car sticker and ID-card

Registration was possible in Mobil Zentral, which is an information office for all public transportation affairs. The registration could be made personally or by phone. Mobil Zentral also had the task of processing the registrations - namely sending the stickers and identification cards to the people. A telephone hot-line for continuous service to the users at Mobil Zentral was installed. It served as an address to get information and to turn to for all experiences and problems concerning the Shake & Ride project.

Shake & Ride signs were erected, which are shaped like the ordinary bus stop signs in Austria coloured in the Shake & Ride colours blue and yellow with the logo and the inscription ”Halt”. Seven signposts were placed on important crossings in Mariagrün, with a further six in Gedersberg. The station-signs were intended as a marketing measure for the project since they were highly visible signs.

Figure 6-9: Shake & Ride station sign

The Shake & Ride project was based on non-infrastructure measures. The principle task was to motivate people to join the scheme. The first announcement of Shake & Ride was placed in the district-newspaper in Seiersberg and with a folder distributed to all households in Mariagrün during the beginning of July 1997, followed by a second information-folder in October 1997. A detailed system description was given and the future locations of the Shake and Ride Station posts were shown. This folder was sent out along with an invitation to the start-up workshop for potential participants and combined with information on future negative traffic developments.

These start-up workshops were held in both areas described above. It was used to provide better information about the project. First contacts between car drivers and future passengers were intended to help minimise the fear of giving a lift to a stranger. Interested people were registered and the car-stickers and ID-cards were handed out.

So called "multipliers" or opinion leaders were addressed personally during the implementation of the project. People such as local politicians, owners of restaurants, bank offices or simply people of interest were informed about the project.

During the implementation and the running phase of the project the publicity campaign and several press announcements led to press coverage in local district newspapers, ordinary papers and TV and radio reports. In addition, several information folders were sent to households in both demonstration areas.

6.1.6 Swiss demonstration sites

The goal of the Swiss project was to find out more about the possibilities of encouraging car-pooling through preferential parking and, at the beginning of the ICARO project, to improve the efficiency of Park & Rail transport. In addition, it was hoped that the project would help to create awareness of the economic and ecological public interest in increased occupancy of private vehicles.

The main aims of the Swiss demonstration projects were to find out:
- if reserved parking areas would be attractive for new car-poolers;
- whether reserved space or cheaper costs were more important to the public;
- the practical problems of implementation.

With the help of the Swiss Federal Railways (SBB), three railway stations with parking facilities, which are being used up to their capacity, were identified and

the possibilities of giving preference to car-pools were discussed and developed (Lyss, Yverdon-les-Bains and Oberglatt). The latter failed, because of some organisational problems.

The demonstration project at the railway station of Lyss started in January 1998 with a press conference and the distribution of an information leaflet together with a mailback questionnaire. The press conference was organised together with railway officials. The response in the press was fairly good and a radio interview was broadcast by a local station. However, the response from the users of the parking area to the mailback questionnaire was disappointing. Only 14 of 100 questionnaires were mailed back. The initially planned marking of car-pool parking spaces had to be dropped due to lack of interest by the railway company.

The City of Yverdon was in favour of the ICARO project and organised the markings and the signs for the separate reserved parking spaces. A press conference was organised in February 1998 jointly with the police, the officer for urban planning and a representative from the railway company. Nine parking spaces were reserved for car-poolers at the beginning of 1998. The preferential parking spaces have been marked as "ICARO"-spaces, but the nature of the reservation has not been indicated.

Figure 6-10: Preferential parking sign in Yverdon

In addition to the parking facilities at railway stations, a parking project was launched at the Berne administration building. Car-poolers were given a reserved parking space in the garage, but no incentive on the parking price was given.

Furthermore, a kind of event pooling was tested in Zurich. This demonstration was planned as follows. Together with the flyers for the Street parade (some 100,000 visitors) mailed to 2000 people, the possibility of forming car-pools to the party was described. An existing automatic Internet-matching service, which had been established by the ETH student union, was offered for the matching. This way the visitors to the parade could offer or seek rides on this Internet site and match themselves. A voucher worth 10 CHF for drinks was offered for each successful Internet-match.

6.1.7 Rotterdam (The Netherlands)

Rotterdam is the second largest city in the Netherlands, the largest port in the world, the economic, social and cultural centre of the Rijnmond region, the industrial heart of the Netherlands and the largest urban area in the country. Over one million people live in the region and almost 590,000 within the city boundaries. Rotterdam covers 27,000 hectares, 10,540 of which are occupied by the port.

The demonstration site is situated in the Rijnmond region. This region is heavily congested, especially during peak-hours. To reduce the growth of private car usage, the City of Rotterdam and the Ministry of Transport have joined forces to fight against congestion. The result is the congestion-plan Rotterdam. In this plan a large number of activities are identified to reduce the number and length of the traffic jams.

Car-pooling is considered as one of the most important alternatives in the battle against congestion and is promoted by the Transport Management Association (TMA) Rijnmond. Apart from matching car-pool teams, providing information and other activities linked to car-pooling, the TMA Rijnmond has expanded its service package by introducing *Guaranteed Ride Home* (GRH) systems.

Such a system helps people to overcome the fear that travelling by public transport or car-pooling results in reduced flexibility and increased dependence on other people's time schedules. By giving the assurance that in case of an emergency back-up transportation will be arranged, GRH should help to overcome that fear and attract more car-poolers.

When it comes to introducing such a system it has to be tailor-made. Therefore it is impossible for a single Guaranteed Ride Home system to suit all companies in the Rijnmond region. For that reason a manual was developed. This manual enables each company to start and implement its own Guaranteed Ride Home system. The main objectives of guaranteed ride home are:

- to improve the overall level of services offered by the TMA Rijnmond;
- to encourage car-pooling.

The ICARO demonstration focused on home to work traffic generated by companies located in the Rotterdam area. The main target groups were companies with over 50 employees at several locations in the city, varying from companies near to an important public transport interchange point, to companies that lack any kind of public transport and are easy accessible by car. The target group within the companies can be divided into two main groups. Firstly there are the car drivers who could potentially car-pool after the introduction of the GRH system and secondly the existing car-poolers and bus passengers.

The guide to a GRH system can easily be used in other countries of Europe. The handbook helps companies and TMA’s to develop and provide a tailor-made scheme. All aspects that play a role in the decision taking process are dealt with while preparing a short and concise step by step plan. The

companies' own situation is important for the decision making process. After the company has followed all the steps in preparing the plan, the employer will have designed his own GRH system and will be able to launch the system.

Figure 6-11: Guaranteed Ride Home manual

The TMA Rijnmond, who already have a strong relationship with many companies in Rotterdam, distributed the guide. Companies can become a member of the TMA. They pay a certain fee per year (ƒ 1,- per employee per year) and in return obtain numerous mobility management based services.

In total, a guaranteed ride home system was implemented within 4 companies. Two of those companies (Econosto and Nedloyd) made only the preparations for implementation and because of delays in the planning were not able to implement in time. Two other companies (RWS (Ministry of Transport, regional division South-Holland) and Europoint Bedrijven) did implement a guaranteed ride home scheme within their companies during the period of the pilot.

6.2 Results of the real life demonstrations

6.2.1 Car-occupancy rate

As car occupancy is the key indicator in the ICARO project, this indicator was surveyed in all demonstration sites (Figure 6-12). The car occupancy rate corresponds, to a certain degree, with the car ownership rate. Higher ownership rates result in lower car occupancy rates. It can be seen that the car occupancy rates in Leeds, Graz, Gedersberg and Pilsen are higher than in the other demonstration sites. One reason for this fact could be the pre-existence of a substantial amount of informal car-pooling at these sites. The reason for the low car occupancy rate in Brussels and Switzerland could be the good public transport system, which leads people to use their car only when necessary. The car occupancy rate is presently decreasing in all countries.

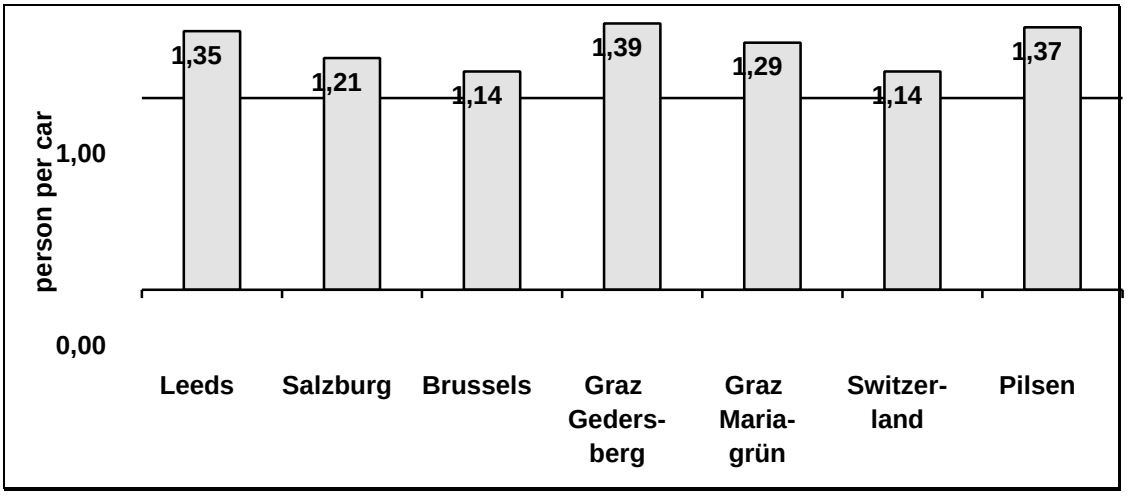

Figure 6-12: Car occupancy rates at different demonstration sites (peak period)

6.2.2 Information and awareness campaign

All demonstrations were accompanied by information and awareness campaigns. The effects of the campaigns were evaluated with surveys. Figure 6-13 shows a high level of public awareness, except in Pilsen.

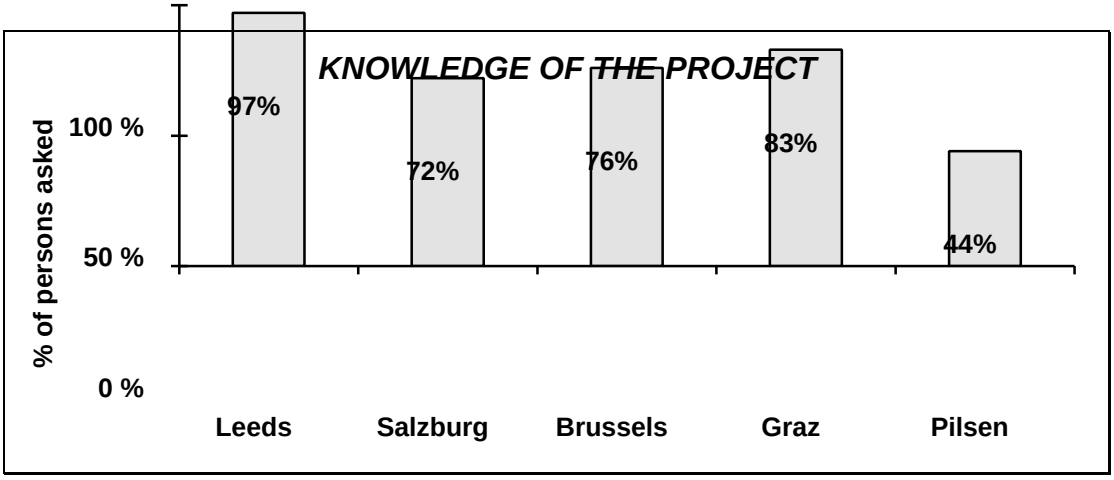

Figure 6-13: Public awareness of the projects achieved by information campaigns

Table 6-1 below gives an overview on people who were "registered" as participants in the different demonstration sites. As each demonstration site had different target groups, registered or even potential car-poolers were defined in different ways. Distinctions of the different real life demonstration are shown. It can be seen that not all demonstrations were successful.

Location	"registered" car-pools	Description
Leeds	no registration intended	
Salzburg	425 133	contacted the matching centre were registered as car-poolers
Brussels	1486 1348 229	registered as potential car-poolers received a matching list formed a car-pool after receiving a matching list (estimation based upon a representative survey among 665 registered persons)
Pilsen	15	contacted the matching centre for a mediation of a car-pooling partner
Graz	72	registered as S&R participants
CH-Lyss	1	project cancelled after start
CH-Yverdon	3	
CH-Oberglatt	-	project cancelled in early stage
CH-Berne	2	five parking spaces used but misuse was possible
CH-event-pool	0	

Table 6-1: Overview of the registered persons

6.2.3 Overview on the implemented investigations and surveys

The following tables give an overview of the different surveys that were completed at the different sites. For the results see the following chapters.

before surveys

Leeds	Salzburg	Brussels	Graz	Switzerland	Pilsen	Rotterdam
• postcard among car drivers • traffic counts incl. car occupancy rate • queue measure-ment • environment. monitoring • journey times	• household trip diary 1995	• companies and employees survey	• traffic survey 1991 • traffic counts incl. car occupancy rate • trip diaries of potential participants	• census 1991 • evaluation of the car-park use • common ICARO survey (Berne Administr.: employees survey)	• household survey 1996 • traffic counts incl. car occupancy rate	• employer survey • general survey in Rotterdam

Table 6-2: Overview of the implemented surveys before starting the demonstration

after surveys

Leeds	Salzburg	Brussels	Graz	Switzerland	Pilsen	Rotterdam
• common ICARO survey • traffic counts incl. car occupancy rate • survey among users (1) • queue measure-ment • environment. monitoring • journey times	• common ICARO survey • traffic counts incl. car occupancy rate • evaluation of the car-park use • trip diaries of participants • survey among participants • in depth survey (2) • evaluation of matching data	• common ICARO survey • survey among participants • evaluation of matching data	• survey among participants • in depth survey • evaluation of matching data	• evaluation of the car-park use • survey among participants • evaluation of matching data	• common ICARO survey • evaluation of the car-park use • survey among participants	

(1) roadside interviews
(2) including modal shift

Table 6-3: Overview of the implemented surveys after starting the demonstration

6.2.4 General attitudes towards car-pooling

A common ICARO telephone survey was designed and used in the following demonstration sites:

common ICARO survey	Leeds	Salzburg	Brussels	Graz	Switzer-land	Pilsen	Rotter-dam
sample size	300	250	178	-	250	392	-(1)

(1) In the Netherlands car-pooling is very well known (98% of the people understand car-pooling). Therefore a telephone survey was not carried out, but a lot of material and surveys which have been carried out in the past were used in the Rotterdam pilot.

Table 6-4: Overview of the sample size of the common ICARO survey

People were asked whether they understood the meaning of the term "car-pooling" (in Great Britain known as "car-sharing") and what they thought about the idea of car-pooling. Most of the people in Salzburg know the meaning of car-pooling, because in German the term "Fahrgemeinschaft" is self explanatory, whereas the Czech language does not even have an expression for it. The system of organised car-pooling has been practically unknown. In Leeds 21 % of the people knew exactly what car-pooling involved and a further 64 % had a good idea of car-pooling, but did not give a detailed response (Figure 6-14).

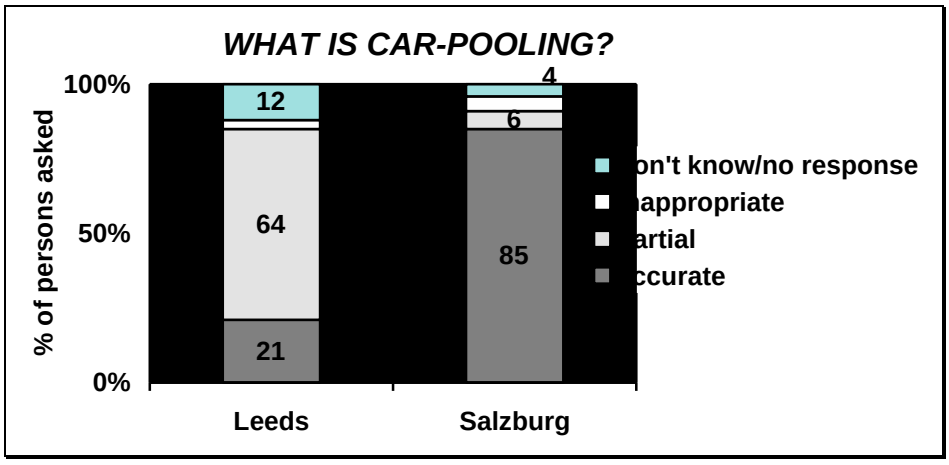

Figure 6-14: Knowledge of the term "car-pooling"

In all demonstration sites car-pooling was seen as a useful tool for increasing car occupancy and the attitudes towards car-pooling were mainly positive. Only 6 % of the respondents in Leeds felt that car-pooling should not be promoted.

It is interesting that the percentage of people who are experienced in car-pooling is nearly double in Pilsen compared to the other demonstration sites (Figure 6-15). One reason can be seen in the low car ownership rate, which is more than 100 cars per 1,000 inhabitants less in Pilsen than in the other countries. As a consequence the car occupancy rate is higher in Pilsen. Another reason might be that until recently private car ownership was not an option for a large proportion of the general public and people were therefore forced to pool.

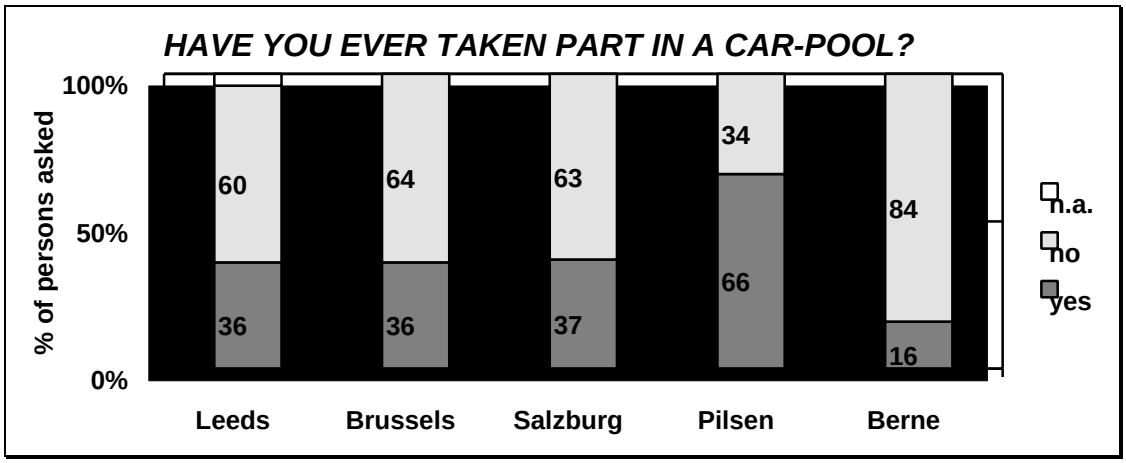

Figure 6-15: Experiences in car-pooling at different demonstration sites

Most of the people experienced in car-pooling stated that they have positive experiences, e.g. 81 % of the people asked in Leeds and 84 % of people asked in Brussels said that car-pooling works well.

Most of the car-pool trips are home to work trips and take place on a regular basis. 64 % of the participants in Salzburg frequent the car-pool 5 days a week and 87 % of the potential car-poolers in Brussels want to pool their car on a normal working week. Surveys among users of the HOV lane in Leeds indicated a high percentage of the drivers travelling with their passengers on a regular basis every working day (51 %). It can be said that the average car-pooler is also an average working person who works five days a week. People with different or unusual working schedules (part time workers etc.) have difficulties in finding a matching partner. 80 % of the commuters have to arrive in the city of Salzburg between 6.30 and 8.30 in the morning, thereby indicating the potential time for car-pooling.

The main target group, in promoting car-pooling, are employees who commute a longer distance by car every day. The willingness to pool a car increases with the distance between home and work. (Figure 6-16).

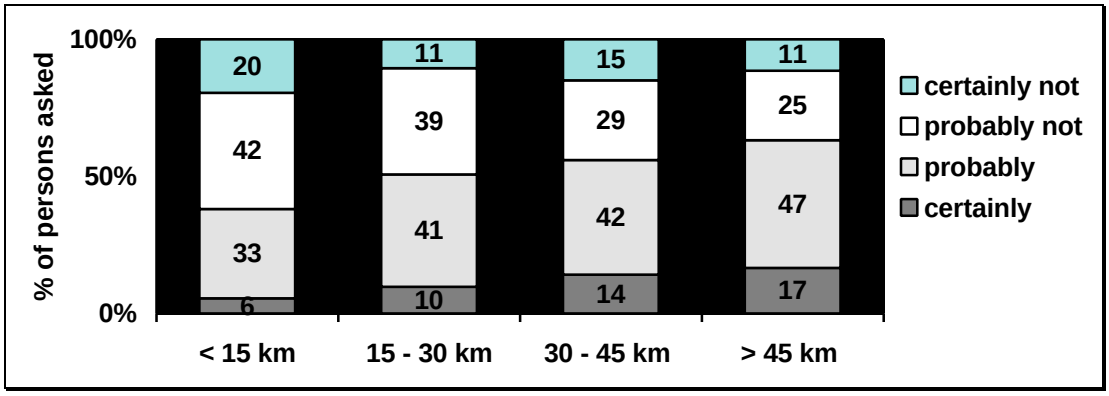

Figure 6-16: Willingness to pool a car according to trip distance (Brussels)

The analysis of the trip lengths of the participants in Salzburg shows that more than 50 % of the car-pool trips are longer than 25 km. The further people live

away from the city of Salzburg, the more willing they are to pool their cars, which results in an increase in the car occupancy rate (Figure 6-17).

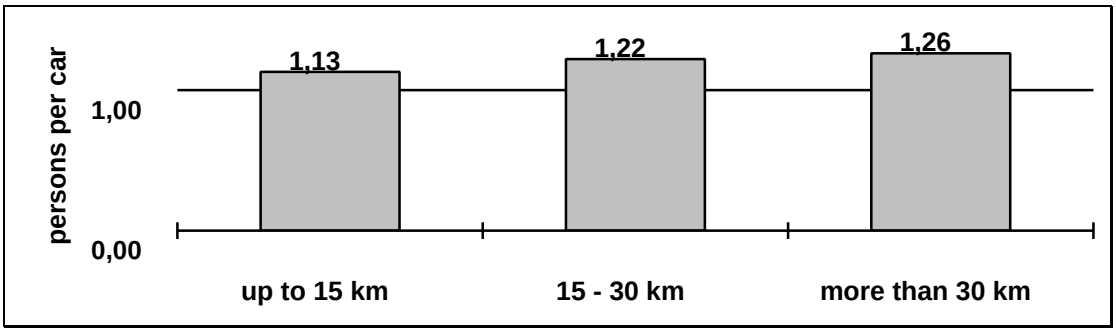

Figure 6-17: Car occupancy rate according to trip distance (Salzburg)

Normally, when different modes of transport are available, the choice of the vehicle depends on the generally accepted parameters such as travel time, followed by trip distance and costs. With respect to car-pooling, there are strong hints that once the decision to use the car is made, the costs per kilometre and thus the trip distance are the major impacts.

People were asked, which measures could support car-pooling. The responses indicated that restrictions like banning SOVs from the city centre or reserving lanes for HOVs are not accepted at the moment. Benefits and incentive measures such as preferential / cheaper parking or matching services (when people know what this means) are appreciated (Figure 6-18).

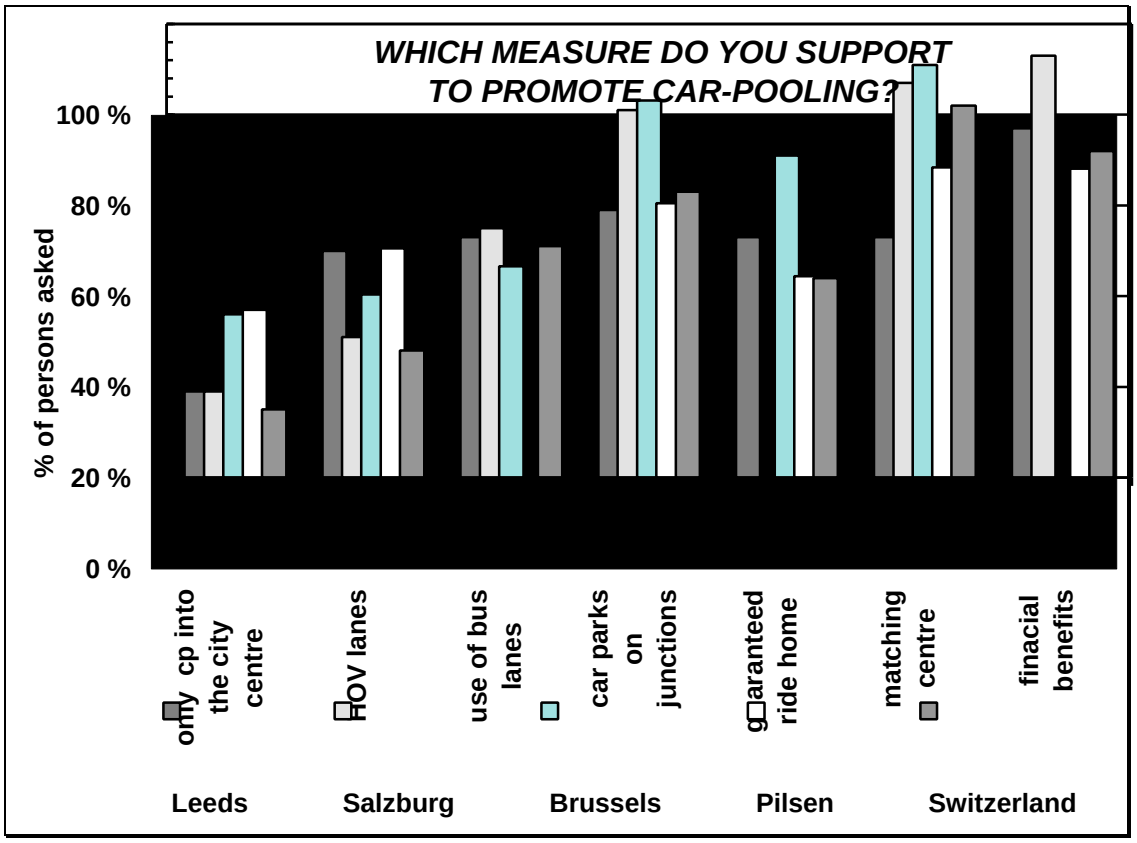

Figure 6-18: Acceptance rate of measures to promote car-pooling

6.2.5 Co-operation with companies

In nearly all demonstration sites, employees, and especially long distance commuters by car, were selected as a major target group for the car-pooling project. For that reason, most of the promotion and awareness work was focused on this specific part of the working population. It turned out that working with companies is one of the most efficient and effective ways to promote car-pooling. It is imperative that employers are convinced of the benefits of a car-pooling scheme.

Analysing the types of car-pools formed by participants of the car-pooling project in Salzburg, it emerged that the locations of the enterprises where people work have much more influence on the formation of car-pools than the location of housing. 62 % of the participants found their car-pool partner at work. Therefore, initiatives at the workplace seem to be more effective than indifferently spread campaigns. The advantages are obvious. Every participant is travelling to his/her workplace and most start their work at around the same time in the morning. The timing of the trip home can usually more easily be arranged.

Car-pools are mainly formed by commuters and therefore generally used at the same time every day. It is clear that the willingness to pool is higher among employees with regular working hours. Flexible working hours are hindering organised car-pooling. In Switzerland the employees of the administration participating in the demonstration have completely flexible working hours (no fixed hours) and are therefore very difficult to match. More than 66 % of the employees in the Brussels' demonstration stated that they would rather not participate in a car-pool, because they were concerned about less flexibility on their homeward trip. However, once an arrangement has been made it usually works out very well. It can also be seen in Figure 6-19 that the willingness to pool is highest among commuters with fixed working hours ("shifts" 62 %) and decreases with increasing flexibility of the working time ("irregular" 32 %).

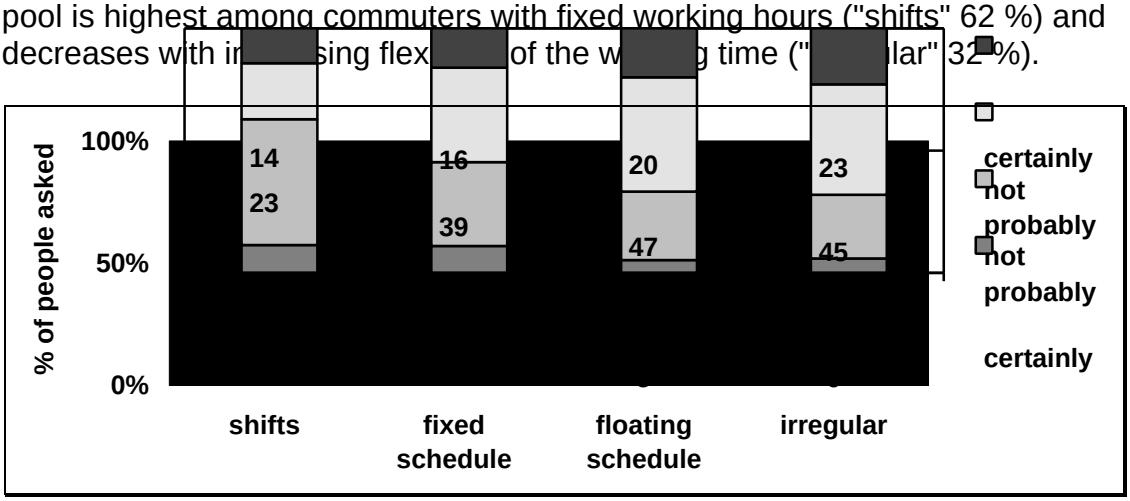

Figure 6-19: Willingness to car-pool among employees who are commuting alone by car according to the working schedule (Brussels)

6.2.6 HOV lane

Leeds was the only real life demonstration where a new HOV lane was introduced. HOV as a potential measure was included in some surveys, e.g. in the Salzburg in depth-survey and in the general telephone survey in Pilsen. A detailed comparison is made in the modelling cross comparison.

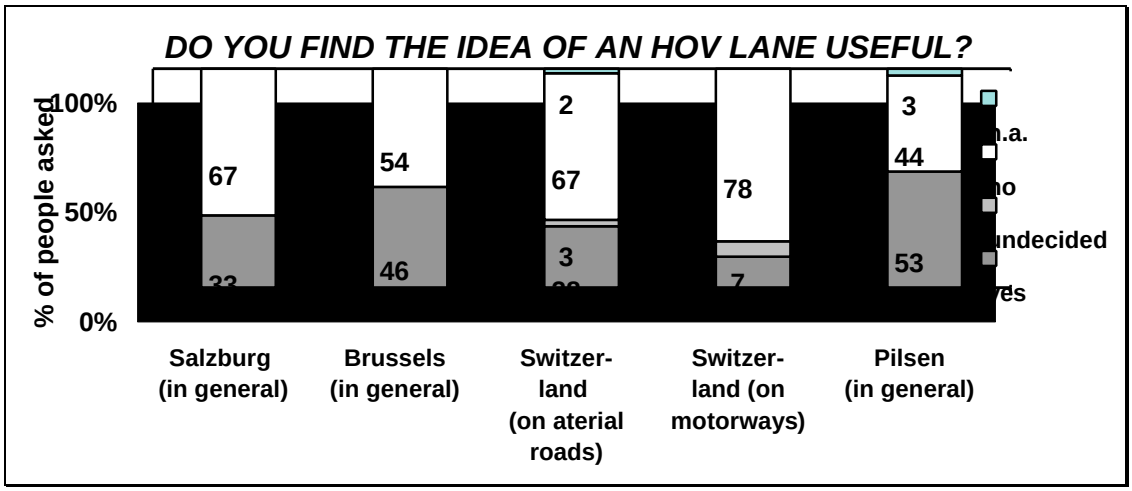

Figure 6-20: Acceptance of the idea of an HOV lane

The evaluation of the real journey times for HOVs in Leeds shows that journey times were reduced from 11 to 7.5 minutes on average for a 5 km journey in the morning peak due to the possibility of using the HOV lane which is 1.5 km long. The non HOV time remained unchanged.

On the A647 HOV route in Leeds, HOVs now account for 32 % of the city bound traffic flow and carry 35 % of the total number of people travelling into the City on the A647 between 07.00 and 10.00. Non-HOVs account for 65 % of the traffic flow but only carry 36 % of the people. However, buses account for only 3 % of the traffic flow and carry 29 % of the people (Figure 6-21).

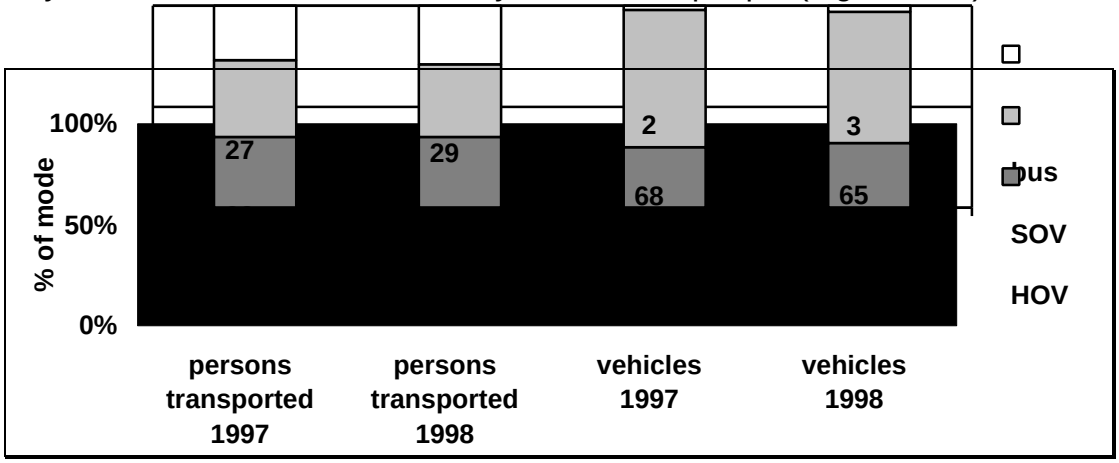

Figure 6-21: Percentage of people travelling on the A647 in Leeds compared to the vehicles counted on the screenline, before the introduction of the HOV lane (1997) and after the introduction of the HOV lane (1998)

In the morning peak (7.00 until 10.00) the absolute number of single occupant-cars has decreased on the A647 (2515 in May to 2115 in September), so too has the number of cars with 2 occupants. However, there are more cars carrying 3, 4 and 5+ occupants. Overall, there has been little change in the total numbers of high occupancy cars on the A647 in the morning, 1040 (May 1997) compared with 1030 (September 1998). Surveys showed that the average car occupancy along the corridor has increased from 1.35 to 1.41 although this is more a reflection of reduced numbers of SOVs rather than increased HOVs.

To put this in perspective, for Leeds as a whole the average car occupancy rate is 1.30 persons per car. These figures can be broken down further to give an occupancy rate by lane. Within the HOV or "2+" lane, the September car occupancy rate is an average of 2.19 persons per car (Figure 6-22). This figure is 1.04 in the all-purpose lane and reflects some multi-occupancy use of this lane, either in error or because drivers are turning right shortly after the count site.

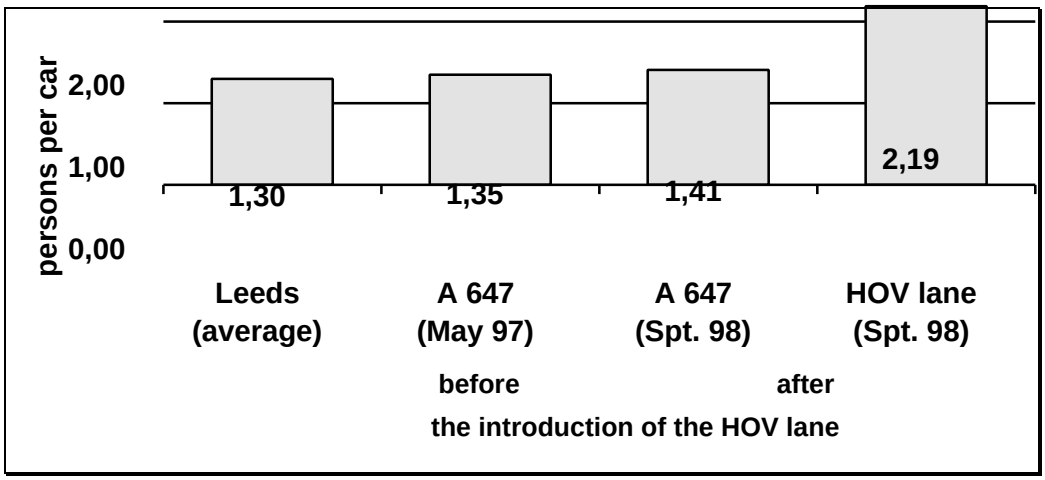

Figure 6-22: Car occupancy rate in Leeds

In determining the transferability of the Leeds experience, the main question concerns the compatibility of this measure within national legislative contexts. This particular aspect must be clarified at the very beginning of any implementation strategy. This issue is one that cannot be easily handled since, from a general standpoint, current legislation usually does not make explicit reference to the possibility of creating reserved lanes for car-pools.

The legal aspects could be a significant obstacle to the development of reserved lanes for car-pools. Creating appropriate signing at the European level could serve to strengthen the confidence of potential backers of such measures.

In principle the transferability of the HOV lane to other countries is possible, but it is necessary to understand the importance and the relationship between a number of influential factors. Among these are:

- Transport policies, which influence the provision of new and/or adapted infrastructure. These may differ significantly between countries or between states within countries. Examples are: Transport legislation on

environmental issues (e.g. pollution from exhaust fumes); Road pricing, and private motorway/arterial road ownership (e.g. in the UK).

- Institutional framework, such as National Government, Regional & Local Government, Public Transport Authorities, and Business Enterprises may have a legal involvement demanding consultation. Their interactions will differ between countries influencing the adoption of HOV lanes.

- Legal framework of the national legislative systems have to be considered prior to the decision to create road infrastructure reserved solely for vehicles with 2 or more occupants.

- Financial issues including private financing in transport management and dedicated toll revenues (from road-pricing) to finance HOV provision, costs of transport infrastructure construction and maintenance.

6.2.7 Matching centres

The quality of the matching lists offered to people interested in ride sharing improves by the number of registered potential car-pool trips as the data base increases. Table 6-5 shows an overview of the matches requested in relation to the number of matching lists which were sent to interested people. The number of interested people in the demonstration sites in Pilsen and Switzerland was not large enough to form any car-pool.

	Salzburg	Brussels	Pilsen	CH - Zurich
Number of contacts	425	n. a.	n. a.	1
Matches requested	175	1486	15	-
Matching list received	82	1348	0	-

Table 6-5: Requested matching in relation to the matching lists received

The main reasons for contacting the matching centres were matching requests of would-be car-poolers. More than half of the people who contacted the matching centre in Salzburg were in search for a partner for their daily trip to work. The modal split of the people who want a match shows a high proportion of car-drivers. Most of them are driving alone at the moment and are willing to pool their cars (Figure 6-23).

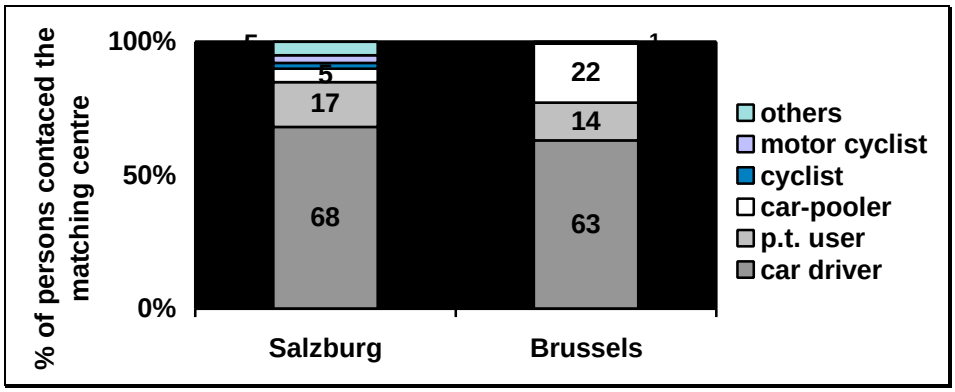

Figure 6-23: Modal split of the daily trip to work of people who requested a match.

The percentage of people who received a good matching list increased with the increasing numbers of registrations. It is noteworthy that the percentage of people who formed a car-pool, from those receiving a matching list, is equal in Salzburg and Brussels, regardless of the fact that in Brussels, the total number of people who received a matching list is nearly 10 times higher than in Salzburg (Figure 6-24). About 15 % of people who received matching lists formed a car-pool based on the recommended list. However, a further 37 % of people receiving a matching list in Brussels stated that they intended to form a car-pool in the future.

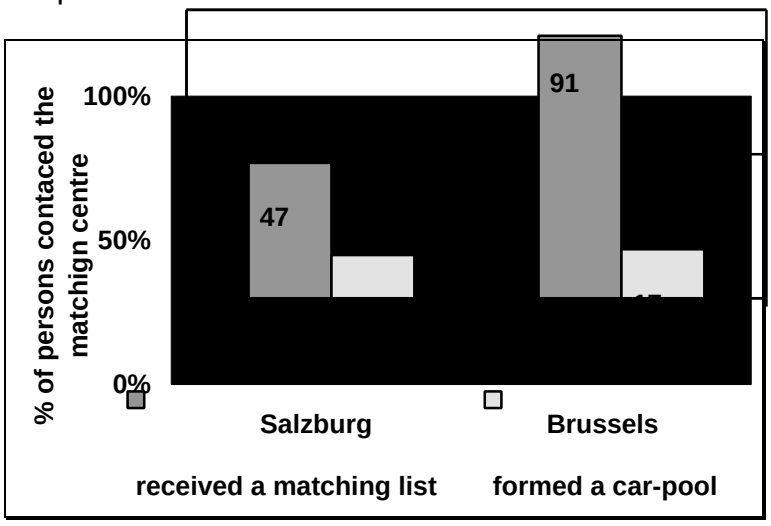

Figure 6-24: Percentage of people requesting a match who received a matching list (left bar) and the percentage of these who formed a car-pool (right bar)

The conditioning elements, in determining transferability of a matching centre to other European countries, are not technical, but rather institutional, legal, fiscal and cultural. Legal considerations have to address the statutes governing the collection and use of personal data within countries. Penalties and consequences for misuse may preclude its use for car-pooling or the creation of car-pooling co-ordination centres. The legal ownership of data and responsibility for maintaining its accuracy may differ between countries. Financial consequences may arise should a subscriber to the database suffer adversely through participating in a scheme.

6.2.8 Preferential parking

Several solutions of preferential parking for car-poolers were implemented.

- At public garages

In the city of Salzburg 4 public garages offered reduced fees for car-poolers. The reduction was about 20 % of the normal tariffs but this did not result in any additional car-pools, perhaps even the reduced prices were still too high.

- On street

As most of the areas in the city of Salzburg are marked as short time parking areas, commuters can get all day parking permits under special conditions (e.g. bad PT connections) granted by the Salzburg City Council. These conditions were also applied to car-poolers for the duration of the ICARO project. The conditions were very restrictive: 3+ car-pool with 2+ members working in the same district, total travel time in one direction with public transport exceeding 90 min. This was later reduced to 45 min. Nevertheless 7 % of the registered car-poolers in Salzburg managed to obtain a permanent parking permit.

- At the working place

Commuters were the main target group in most of the demonstration areas. For this reason, preferential parking spaces were implemented on a trial basis at the car park of the Provincial Government office of the Province of Salzburg and in the garage of the administration building in Berne. As the reserved parking spaces were on a trial basis, the control of the measure was very difficult. In Salzburg it turned out that the reserved parking spaces for car-poolers were ignored, as the employees realised that misuse would have no financial consequences. In Berne, three out of five users of the reserved parking spaces might not be car-poolers, within the meaning of the definition. Only one new car-pool could be identified as a result of the new parking management favouring car-poolers.

In the preparatory phase of the Salzburg project, many companies argued that there was no need for reserved parking facilities. The analysis of the parking habits and costs of commuters in Salzburg shows that 86 % of all car-commuters can park their car free of charge and only 14 % have to pay. 83 % of all car commuters park their car directly at the work place. Even in Brussels, 67 % of the employees have parking places for their cars at work.

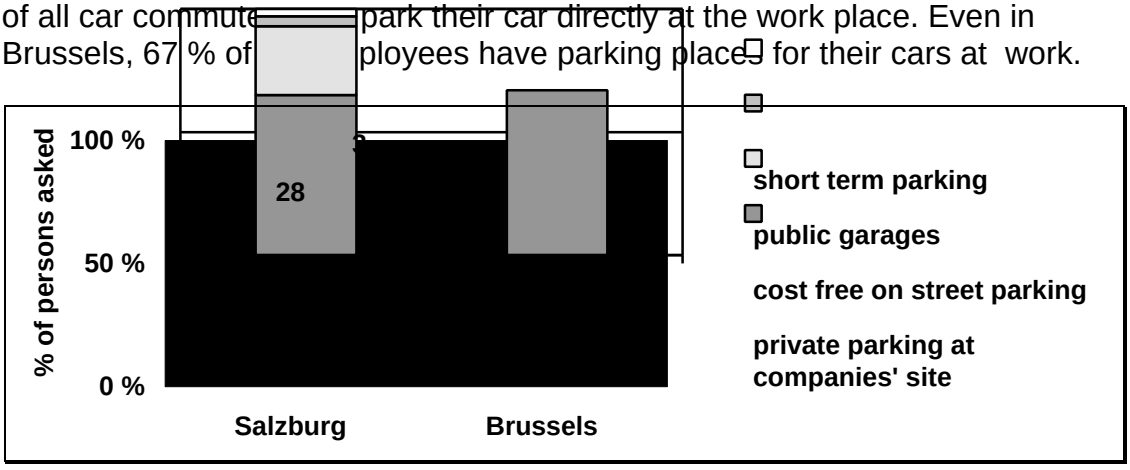

Figure 6-25: Parking habits (Salzburg, Brussels)

However, experiences from Pilsen show that there are advantages for the company itself when car-pooling is promoted. The Panasonic company has currently a total of 650 employees, 250 of them commuting by car. 100 parking spaces are available within the company's grounds. Since the car-pooling campaign was launched, 40 car-pooling teams with over 80 participants have been formed. The actual plan of reserving special spaces for car-poolers was abandoned as employees had no problems finding an empty parking space after they started to pool. As people work in shifts at Panasonic, up to 21 parking places could be saved (21 in the morning-, 16 in the afternoon-, 3 in the night-shift).

Table 6-6 gives an overview of the offered parking facilities at working places.

site	parking spaces reserved for car-poolers	Remarks
Salzburg	2 out of 20	at Provincial Government
Brussels	n. a.	at companies
Pilsen	0[1]	at Panasonic
CH-Berne	5 out of 80	Berne Administration office

[1] due to the successful car-pooling initiative at the company no reserved spaces were needed

Table 6-6: Number of parking spaces at the work place that were reserved for car-poolers

- At railway stations

The attempt to form new car-pools among railway customers in Switzerland failed for several reasons:

- The villages scattered around the railway stations each have only a very low number of riders per hour to the station and the hours for their homeward trips are rarely the same.
- Free parking spaces are available within 5-6 minutes walk of the stations.
- The incentives offered in the scheme were not important enough for people to accept the inconvenience of being obliged to form a car-pool.
- Lausanne, which is the city the commuters from Yverdon-les-Bains mostly want to reach, has recently improved the parking situation for commuters.
- Public transport is quite well developed, even at the level of the connections between the villages and the stations.

6.2.9 Car parks for car-poolers

At 12 locations around the city of Salzburg, special car parks for car-poolers were introduced. These parking facilities were situated at interchanges of major roads leading to the city. The total number of available parking spaces is about 340. The main trip purposes of the users is work (79 %), followed by education, leisure and other purposes. The car parks are mainly used for park & ride (35 %) and park & pool (33 %). In Brussels, 26 % of the interrogated car-poolers use the park & pool system. In the Flanders Region many park & pool areas have been developed.

As car-poolers can park their cars wherever it is legal to do so, special car parks for car-poolers (park & pool areas) do not necessarily attract overwhelming numbers of users, but they are important landmarks of sustainable car-use and useful for the purposes of awareness campaigns.

The transferability of car parks for car-poolers to other countries causes no problem, but the responsibilities for financing as well as for the maintenance have to be defined clearly.

6.2.10 Pick up points for car-poolers

In Graz, lift-giving pick up points similar to Bus Stops were designed for Shake and Ride participants. As none of the registered S&R participants in Graz made use of the system, the effectiveness of such a system could not be derived. For that reason no transferability can be recommended.

6.2.11 Guaranteed ride home / reduced transport fares

The demonstration site in Rotterdam was focused on providing a manual for developing a guaranteed ride home scheme for companies. The implementation of the manual within companies failed for several reasons. Many companies were asked to participate, but only two companies were willing to implement the scheme during the period of the pilot project. However, none of the employees were using the system during the testing period. Both companies have a mobility plan and transport manager and as such the commuter trips are well organised and there was no reason therefore for using the system. The existing car-pool teams are long standing and have developed their own safety net, for instance using another car-pool within the company or riding home by public transport. Emergency cases have not occurred during the running phase of the ICARO project. Despite the results of the real life demonstration in the Netherlands, further experiences outside the ICARO project show that the system can work as a useful element of an internal mobility plan of a company.

In Salzburg a half price ride home was offered to registered car-poolers in order to prevent difficulties on the homeward trip, if the car-pooling driver was not available. This benefit achieved a high acceptance rating and is an excellent incentive for car-poolers. The half price ride home ticket was used once a week by 44 participants (40 %).

The scheme can be transferred to other countries without any problems. The financial responsibility has to be well defined beforehand.

6.2.12 Event pooling

Some important conclusions can be drawn from the Swiss experiences. It is difficult to persuade private organisers to manage the mobility and parking behaviour of people attending an event, because these organisations want to make a profit and are not concerned with transport policy. There are plenty of parking spaces which prevents restrictive measures being introduced against SOVs. Current restrictions are only promoting the use of public transport and do

not take car-pooling into account. In addition, some practical problems can occur, for instance the Berne fair ground parking has many entrances and cannot be easily controlled.

Car-pooling at events can be effective, only if parking permissions are sold together with or integrated in group entrance tickets. Car-poolers need to obtain advantages compared to single car users, including integrated information. Therefore successful car-pooling has to be integrated in the official permission procedure for events.

6.2.13 Other specific aspects

Sizes of car-pools at the different demonstration sites
As it is one of the main goals of ICARO to increase the car occupancy rate, this section deals with the influence of the different measures on the car occupancy rate. For this assessment, only the demonstrations in Leeds, Salzburg and Brussels offered results which can be evaluated, as the number of participants was significant. All other demonstrations did not reach a representative number of participants, because people were interested in the scheme in general, but did not actively join in. For example more than 70 people were registered as Shake & Ride participants in Graz, but no use of the system was observed. In Pilsen only 15 people contacted the matching centre in order to find a car-pooling partner.

The following figure shows the car occupancy rate of car-poolers which was measured at the demonstration sites in Leeds, Salzburg and Brussels after implementing the measures. The car occupancy rate in Leeds was measured on the HOV lane. In Salzburg and Brussels, the average number of people per car was calculated according to the feedback from the registered car-poolers.

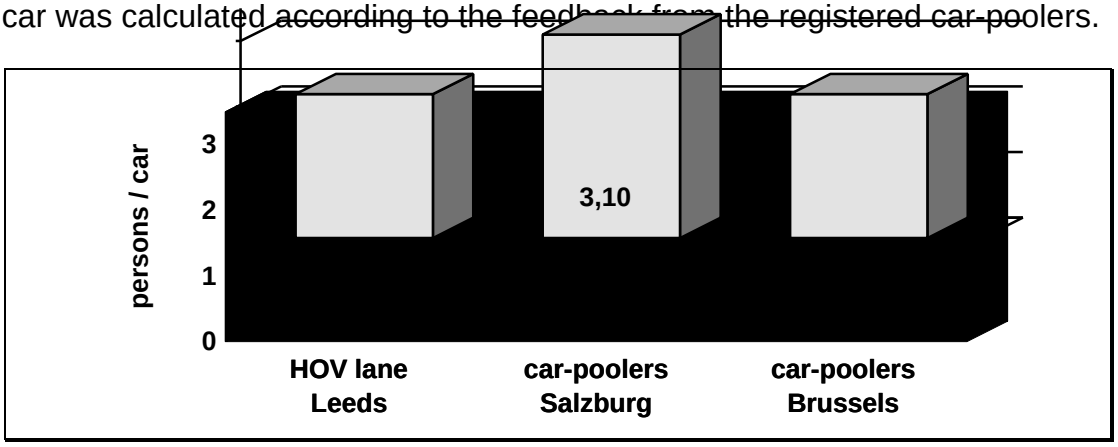

Figure 6-26: Car occupancy rate of car-poolers as a consequence of the measures implemented

Size and duration of the measure
Each activity must exceed a certain "minimal threshold" of participants or users in order to be successful (critical mass). The different demonstrations have shown that car-pooling has a somewhat limited potential. As such, the population number and the density of a region must reach a certain value, if the implementation of a general matching centre for the public is to be successful. Also, activities should be focused on the destinations of commuter trips, for

instance a centre with offices or businesses. Measures which are focused only on small living areas will not generate enough public interest and thus the number of potential participants will be too small.

This required minimum threshold depends on the accompanying measures, i.e. if car-pooling is introduced in combination with incentive or restrictive measures. To achieve a satisfactory matching service, a database at a minimum of about 500 to 800 people is estimated for a region. This number can be lower if the car-pooling campaign is focused on a very specific target group like employees of one company or a group of companies in a limited area. In this case some 100 people can be enough for a successful matching service. In addition, the awareness of a car-pooling campaign among the public, politicians and companies is absolutely necessary. Without a public awareness campaign even the best car-pooling measure will not be successful.

A car-pool project has to be sustainable which means that a permanent organisation has to be established. Short-term projects are not favoured by participating organisations. The railway authorities in Lyss for example did not want to repaint reserved parking spaces for a short-term project.

Legal aspects
At the different real life demonstrations of the ICARO project, various legal aspects and barriers emerged in the implementation phase. Most of these aspects can be of importance for other similar projects in the future.

- The terms "car-pooling" and "HOV" are not defined in the legislation of the countries where the demonstrations were launched.
- In many countries, the boundary between car-pooling and commercial activities has to be defined. Payments between car-poolers may lead to a lawsuit from professional transport businesses. As a consequence any person benefiting from car-pool payments may have to pay taxes for this extra income and, worse still, could be responsible for his/her passengers, e.g. like a taxi-service.
- The insurance situation regarding car-pooling is not yet clear as car-pooling is not mentioned explicitly in insurance policies. In the Czech Republic as well as in Austria, insurance companies stated that claims for accidents caused by the driver of a car-pool are covered by the third party insurance by default.
  In Salzburg, free additional passenger insurance was offered to cope with possible prejudices against car-pooling which might be brought forward by arguments of insecurity. Although it was not strictly necessary, it was another benefit encouraging people to car-pool.
- Opponents tried in some cases to use the argument of "data protection" to inhibit the implementation of the demonstrations.
- A particular situation was the implementation of a combined bus / HOV lane. In the Leeds demonstration, a traffic regulation order from the local authority (City Council) was sufficient to realise this scheme. However, in most countries changes in the traffic law would be necessary. An official definition by the authorities is needed and a traffic sign for HOV lanes has to be created.

Abuse of the benefits

Preferential parking or the half price ride home on public transport could be a reason to form "bogus" car-pools. Means of control should be developed to avoid benefits for car-poolers being misused. Both the Berne and the Salzburg demonstrations were implemented on a trial basis. As a consequence the reserved parking spaces in Berne were often misused. The reserved parking places for car-poolers in Salzburg were not complied with. (see chapter 6.2.8). Strict regulations are required, for example how often per week a car-pool should operate, whenever the "social control" by colleagues does not work.

Potential for car-pooling

The existing modal split shows a car occupancy rate in Europe of between 1.14 and 1.2 for home-to-work traffic. On average about 28 % of all trips are made by solo-car-drivers and around 12 % by HOV-drivers.

567 households in the Province of Salzburg were evaluated and were identified as commuter households with daily trips to the city of Salzburg. Four different traffic scenarios were offered to 196 people from these respondents and the reactions of the interviewees were collected.

Scenario A (base scenario) was the demonstration scenario. A matching centre was set up to arrange for car-pool partners based on individual's requirements. The benefits for car-poolers are already available (car-parks for car-poolers, half price ride home on PT, additional passenger insurance, preferential on street parking in the city centre and preferential parking at public garages).

Scenario B: The reaction of the interviewees on sensible higher costs for car driving was researched. The price for a solo-driver on his/her commuting trip was calculated considering a higher petrol price of 50 % and considered in relation to the costs of commuting with a car-pool.

Scenario C: Interviewees were asked how they would react if the duration of the commuter trips into the city of Salzburg increased due to the continued growth of traffic. In this scenario a combined bus / HOV lane was installed on all major inbound streets so that car-poolers could save up to 10 minutes on each trip. People were asked if they would car-pool to gain the time benefit.

Scenario D: To be permitted to enter the city by car, a city-toll had to be paid, according to the occupancy of the car. Solo drivers had to pay 3.0 ECU, for 2 or more occupants entering the city cordon was cost-free.

The following conclusions of this in-depth survey can be shown:

- Measures which raise the attractiveness of car-pooling reduce the number of solo drivers in the modal split and help to increase the car occupancy level on one hand, but also cause people to leave public transport on the other hand. But measures which are intended to enforce car-pooling through restrictions also increase the car occupancy level but simultaneously lead to an increase in the number of people travelling by public transport.
- The level of car-occupancy of all car-users can be increased from 1.19 up to 1.57 by restrictive measures, such as raising fuel prices or imposing a city toll on SOVs.
- The percentage of SOV-drivers can be reduced from 57 % down to 41 % (fuel pricing) or to the minimum of 30 % (city toll for SOVs).
- The number of HOVs can be increased from 15 % up to a maximum of 33 %.
- Restrictive measures combined with incentives are more effective in increasing the car-occupancy rate than incentives only.

Figure 6-26 shows the different car occupancy rates according to the scenarios. In Figure 6-27 the different modal splits of the scenarios can be seen.

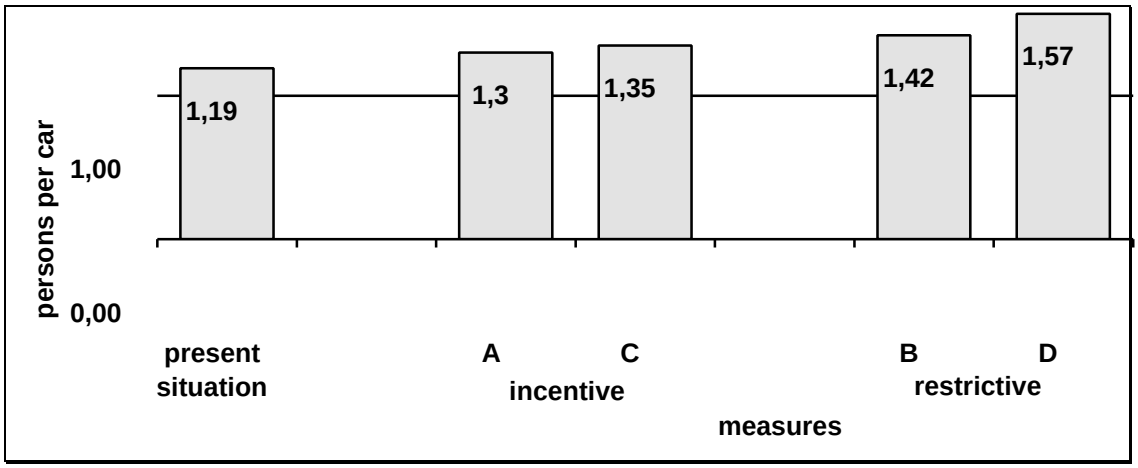

Figure 6-27: Car occupancy level according to different scenarios

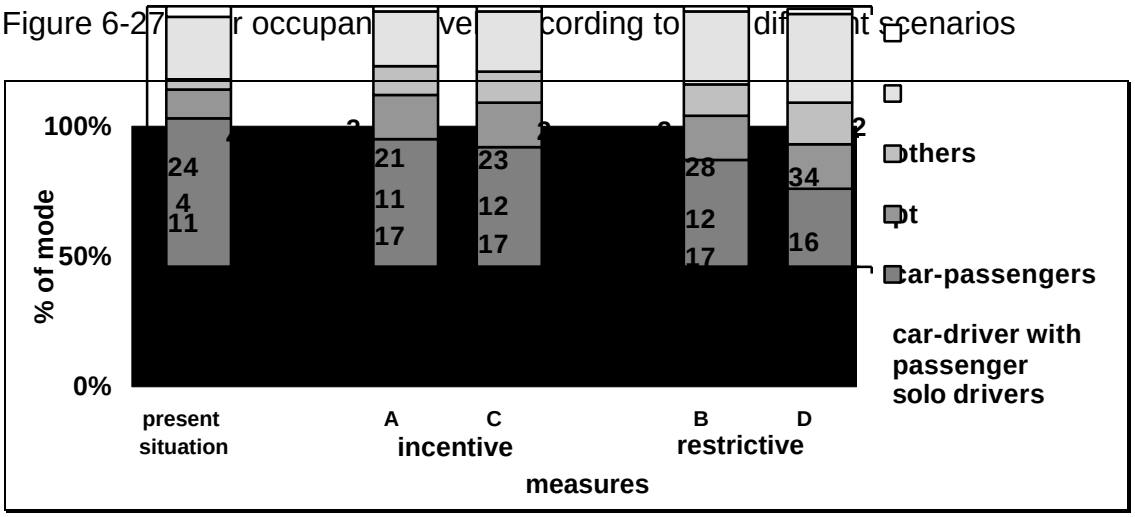

Figure 6-28: Potential shifts in the modal split according to different scenarios

6.3 Description of the modelling demonstrations

6.3.1 Leeds (Great Britain)

The objective of the Leeds modelling demonstration was to support the real life demonstration by providing answers to a series of "What if?" questions considering the future development of the Leeds HOV lane scheme. The objectives for the modelling scenarios were therefore similar to those stated for the real life demonstration.

Seven separate modelling scenarios for future development of the real life scheme were specified as given below:

Scenario 0	Do-Nothing reference scenarios for A647 with no HOV provision for 2000 and resulting trend for 2010
Scenario 1	Test the real life scheme based on a 2+ occupancy rate with around 30 % HOVs and 70 % general traffic in 2000 and in 2010
Scenario 2	Test additional inbound HOV provision at Henconner Lane with 30:70 split in 2000 and in 2010
Scenario 3	Test a 3+ occupancy scenario for current scheme with 7.5:92.5 split in 2000 and in 2010
Scenario 4	Redefinition of the current HOV lane as a bus-only lane in 2000 and 2010
Scenario 5	Introduction of non-infrastructure measures (e.g. Salzburg "park-and-pool" car parks on the outskirts of the A647 corridor and a Brussels "car-pool co-ordination centre" for Leeds) to compliment the existing HOV scheme, a **demand change** to 40 % 2+ and 60 % SOV with constant passenger trips in 2000 (i.e. 8.6 % reduction in vehicle trips) and in 2010 combined with a reduction in network demand
Scenario 6	Introduction of a Madrid-like "segregated" HOV lane on the **M1** into Leeds.

Table 6-7: Modelling scenarios in Leeds

All model tests in Leeds were carried out with respect to a reference scenario (2000) and a trend scenario (2010). Both scenarios were built up by factoring the existing 1993 matrix by a growth factor of 2.2 % increase p.a.. For all the tests, assumptions have been made about the occupancies across the network:

- an average occupancy over the network of 1.4 persons per vehicle;
- the empirical split between SOV and 2+ is 70:30;
- this split gives a 2+ occupancy of 2.33 persons per vehicle.

- If 7.5 % of vehicles are assumed to be 3+, then their average occupancy will be 3.3.
- The above assumptions lead to a combined average occupancy for vehicles with either 1 or 2 occupants of 1.25.
- An average occupancy of 50 is assumed for buses.

For the demand scenario 5, the number of vehicles in the network were reduced but the number of person trips were held constant. This was achieved by altering the SOV:HOV split from 70:30 to 60:40. At the assumed occupancy of 2+ vehicles of 2.33, this resulted in an 8.6 % reduction in vehicle trips and an increase in the average network occupancy to 1.53.

Note that Scenario 6 was tested on a separate network to the south of Leeds surrounding the M1 motorway. For these tests, demand was held constant and average occupancy was set at 1.20.

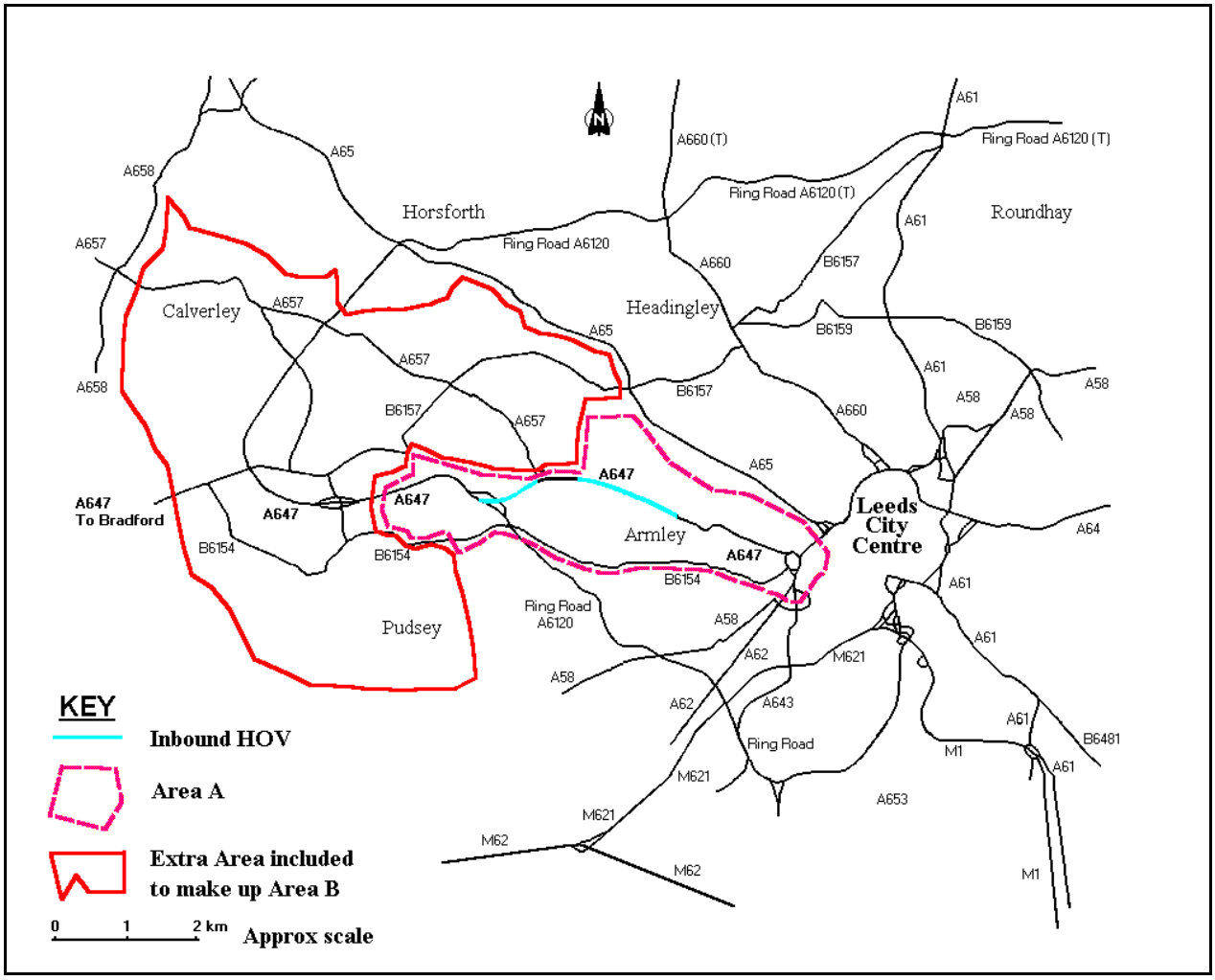

Figure 6-29: Leeds HOV demonstration site

6.3.2 Salzburg (Austria)

The real-life demonstration for Salzburg was based upon incentive measures and a public awareness campaign. In addition the Salzburg modelling included the effects of two long HOV lanes (36 km) running along corridors (A1 Westautobahn and A10 Tauernautobahn). One major reason for considering car-pooling in the corridor was that the population is sparse (concentrated in outlying villages) and hence the alternative public transport option is relatively poor. Improving the public transport service was not considered an option.

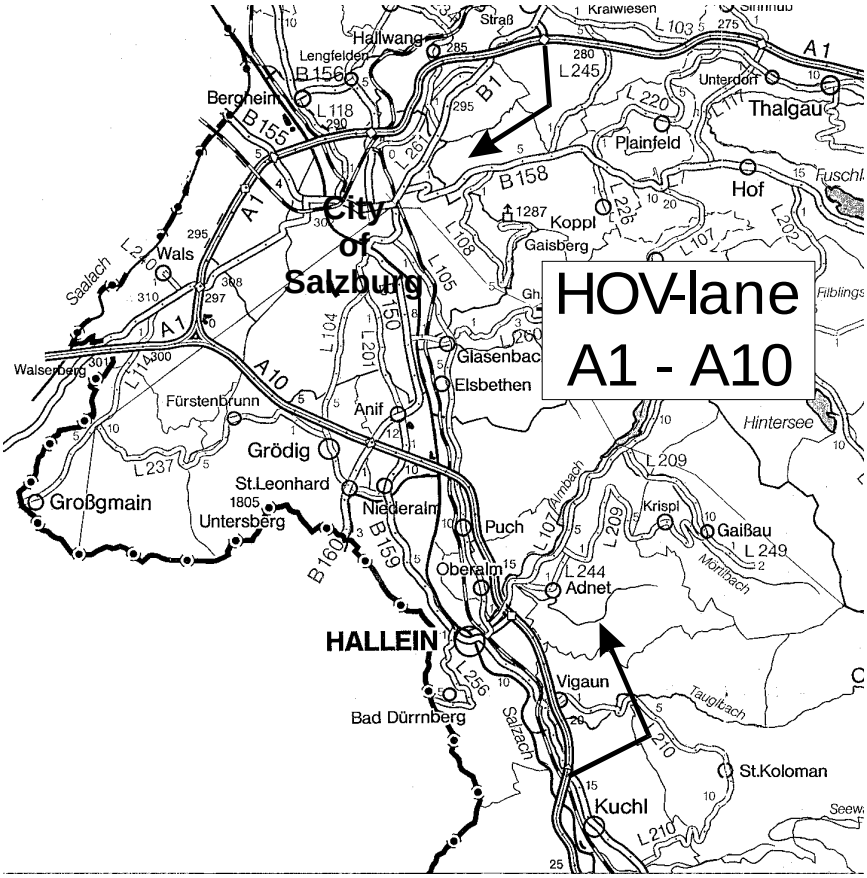

Figure 6-30: Salzburg HOV modelling demonstration site

The traffic conditions are at present not so congested that an additional HOV lane in these corridors is a realistic alternative. It does not seem possible to convert an existing lane to a HOV lane as most parts of the motorways included in the modelling scheme consist of two carriageways with two lanes each and it does not make sense to convert one of two lanes to an HOV lane.

However the prognosis for 2011 shows a tremendous increase in traffic around the City of Salzburg. The scenarios for 2011 include an analysis of the effects of a HOV lane at that time. It is of great interest to predict what the effects would be if a HOV lane measure similar to that in Madrid were to be implemented in Salzburg.

Shifts in modal split and "substitute behaviour" effects of the schemes, particularly the possibility of drivers returning to the peak in response to greatly

improved conditions have been assessed. This was important as it is possible on a wider scale than is feasible in the current real life demonstration.

The choice of traffic models for the modelling demonstration was based on:
- the need for the models to represent the impact of the demonstration-site-specific measures;
- the transferability of the Madrid scheme (existing HOV lane) to the Salzburg modelling scheme (scenarios);
- availability of appropriate software;
- availability of an existing data base for traffic modelling.

Two existing models were selected as suitable for Salzburg: SATURN and FREQ11.

The modelled scenarios can be summarised as either variations on the present situation and real-life demonstration represented by data from 1995 and variations on the future or trend scenarios based on additional capacity represented by the forecast year 2010. The scenarios were defined as follows:

Present (1995)	Future (2010)
Scenario 0A: Reference Scenario: Do-nothing	Scenario 0B: Trend Scenario: Do nothing
Scenario CPD: Car-pool demonstration Sensitivity Tests on effects of car-pooling measures on the A10	Scenario 1: Extra GP Lane Add a general purpose lane from Kuchl to Wallersee (2010)
	Scenario 2: Extra HOV lane (2+) Add an HOV lane (2+) from Kuchl to Wallersee
	Scenario 3: Extra HOV lane (3+) Add an HOV lane (3+) from Kuchl to Wallersee

Table 6-8: Modelling scenarios in Salzburg

6.3.3 Madrid (Spain)

Madrid has a surface area of 8028 km^2 with a population of 5.2 million inhabitants (12.7 % of the Spanish population). It is the administrative and the geographical centre of Spain, as well as the financial capital. Three areas can be distinguished as showing different trends with respect to population location, employment and mobility:
- the centre of Madrid (60 % of the population and 75 % of jobs);
- the metropolitan area (the towns surrounding Madrid with 1,650,000 inhabitants);
- the regional area (rest of the districts in the Community of Madrid).

Radial access from suburban areas in the Madrid Region into the centre suffer from recurrent cyclical problems. One of the most affected accesses is the west N-VI motorway. In 1995, the flow on the motorway reached 150,000 vehicles. Owing to the unbalanced relationship between supply and demand along with the peculiar characteristics of this corridor, the administration tried to find new solutions including a combination of the public transport services and new demand management measures.

An HOV / bus lane comprising of 12.3 km lanes, supplemented by an additional 3.8 km bus-only lane has been provided and is connected to a transport intermodal centre to channel the traffic flow of most buses using the N-VI. These two facilities are reversible. The core of the HOV-Bus lane is located right in the central section of the N-VI corridor. This lane is separated from the general traffic lanes by an uninterrupted barrier.

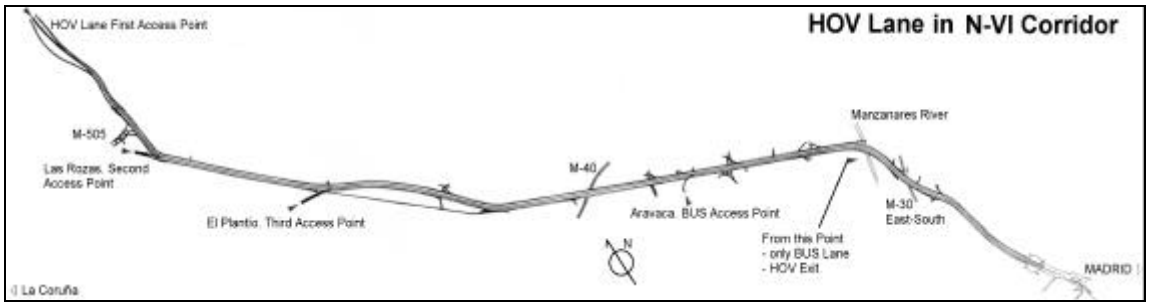

Figure 6-31: map of the HOV lane in Madrid

The modelling exercise had the following objectives:

- to test the willingness of current 2 occupant vehicles to accept a third occupant to continue using the HOV lane (otherwise having to use the more congested conventional lanes);
- to analyse the effects on N-VI corridor traffic conditions -where Madrid's HOV lane is located- of the 3+ limit for three different scenarios: short-term (1997), medium (2005) and long-term (2010).

	Short term (1997)	Intermediate (2005)	Long term (2010)
Scenario 0	Existing HOV lane with 2+		
Scenario 1	Existing HOV lane with 3+		

Table 6-9: Modelling scenarios in Madrid

The goals of the scenarios were as follows :

- to increase the average car occupancy along the N-VI corridor;
- to reduce overall passenger travel time;
- to reduce overall vehicle-km, travel time and emissions;

compared to the do nothing scenario.

In order to accomplish the objectives mentioned above, the following methodology was developed:

- computer aided telephone interview (CATI) to 1707 residents in the corridor that travel to Madrid at least once a week between 7 and 10 A.M;
- face to face stated preference survey to current HOV users with 2 occupants;
- modelling of the transport supply in the corridor, especially the HOV lane;
- modelling of the transport demand: O-D matrix and its distribution among levels of occupancy;
- estimation of discrete choice models to quantify willingness to accept a third occupant;
- traffic assignment with emme/2 with interaction with discrete choice model estimated;
- microsimulation analysis with FREQ11;
- analysis of the results and conclusions.

Figure 6-32: HOV lane in Madrid

6.3.4 Thessaloniki (Greece)

Thessaloniki is the second largest city in Greece after the capital Athens. The geographic location makes it very important in terms of commercial, cultural and political interest. Following development, Thessaloniki was expanded along the coast line. It is an oblong shaped town with approximately 500,000 inhabitants. The Greater Area of Thessaloniki includes 15 municipalities with 900,000 inhabitants in total. The central part of the city is built on the ruins of the old city and is a rather narrow stretch between the coast line (south) and the mountains (north).

The high density in combination with the lack of parking spaces results in population and housing increase in the surroundings and especially at the eastern part of the city. It is estimated that the daily trips from that part of the city to the centre will increase up to 50 % by the year 2005. Therefore,

investment in major infrastructure, such as the construction of an HOV lane in this part of the city, as well as the enforcement of traffic calming and restraint measures in the city centre, could relieve the already congested streets.

The modelling study of Thessaloniki examined the likely impacts of an HOV lane with or without a car-pooling facility. The modelled HOV lane starts from an open area at the south-eastern part of the Municipality of Thessaloniki beside the coastline and runs towards the city centre. This open area at the beginning of the HOV lane might be used as a park and ride facility and / or as a car pooling facility. One lane of the existing main arterial coastal road was reserved, which serves the outward traffic and connects the city centre to the eastern Thessaloniki and to the airport.

The HOV lane would be differentiated from the other traffic through physical measures and would terminate at the fringe of the city centre area. Beyond the White Tower, the HOV lane would be connected to the main one-way arterial road of Tsimiski St. which crosses the city centre and consists today of three lanes plus an exclusive bus lane. At the same time the creation of a new parking space next to the White Tower is being discussed.

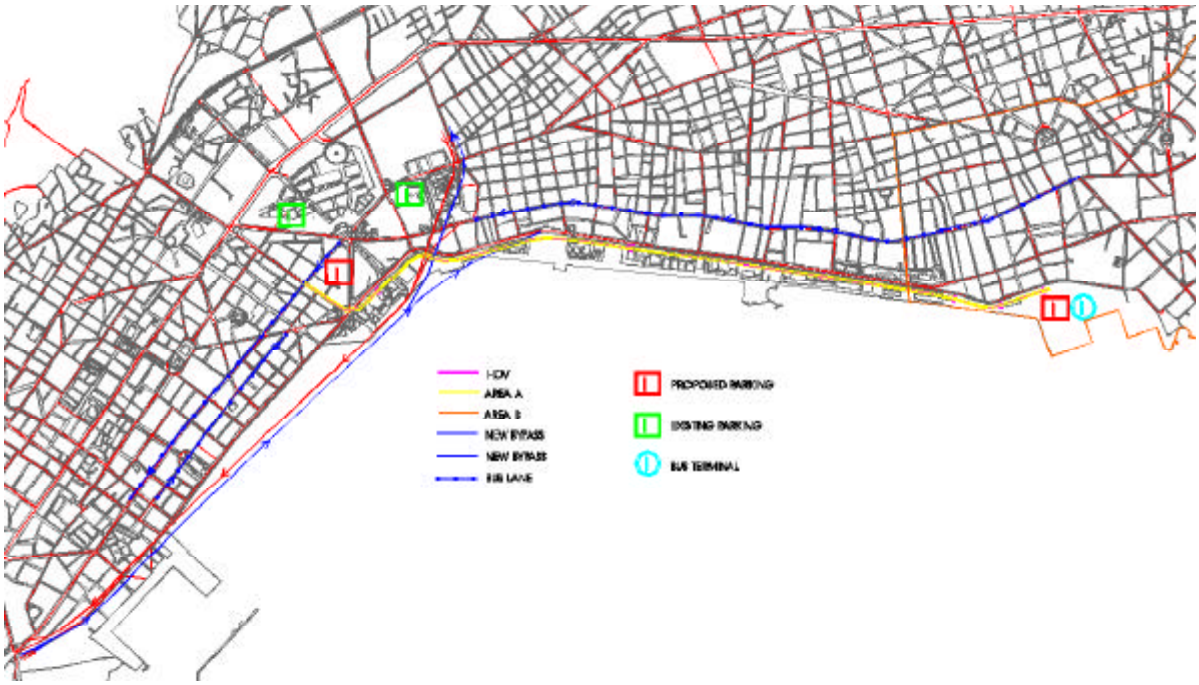

Figure 6-33 Thessaloniki modelling demonstration site

The total length of the HOV lane in the modelling demonstration was about 3,500 metres. It was open to taxis and private cars with 2 or more passengers. Alternatively, the HOV lane was open to all private cars regardless of passenger occupancy during all time periods except for the peak periods. No parking was allowed along the HOV lane. The HOV lane was defined as a closed road with limited points of access. No crossing points existed at all, except for the service of a big hotel on the coast.

The main goals of the Thessaloniki modelling demonstration are summarised as follows:

- to provide an alternative route and better traffic conditions to trip makers towards the city centre;
- to help Public Transport to improve the level of service provided;
- to increase car occupancy and reduce car trips.

Two additional goals, mainly based on the scenarios tested, are the following:

- to divert traffic to the car pooling facility;
- to reduce car park demand in the city centre by encouraging the use of the park and ride or park and pool facilities at the start point of the HOV lane.

Modelling was carried out using the SATURN software. The base scenario assumed current traffic trends and inelastic demand.

Three different scenarios were tested. Changes to the network modelling compared to the current situation were required for each scenario. The updated Demand Matrix (prepared recently with 1996 traffic count data) was used for the reference scenario and for all scenarios. The future-year models were based on the matrices and the models that were developed for the base year. An average travel growth factor of approximately 2.2 % was applied for the period up to 2005 thus resulting in an overall growth of 20 %. The above figure was based mainly on demographic information as well as local knowledge and experience about the traffic developments during the last 10 years. This factor was applied to all origins of the base-year matrix.

	Present (1997)	Future scenario (2005)
Scenario 0	reference scenario (do-nothing)	trend scenario (do–nothing)
Scenario 1	HOV lane	
Scenario 2	HOV lane + car-pool facilities	
Scenario 3	HOV lane + park and ride facilities	

Table 6-10: Modelling scenarios in Thessaloniki

6.4 Results of the modelling demonstrations

In order to allow the comparison of the results from the four case-studies, a summary table has been drawn up showing the main impacts and the results of each scenario (Table 6-7 to Table 6-10). Some efficiency indicators of the measures to be taken have been calculated, namely economic benefits, environmental assessments, travel time savings and changes in the average car occupancy rate.

	Scenario 1: 2+ Scheme		Scenario 2: Henconner		Scenario 3: 3+ scheme		Scenario 4: Only-Bus		Scenario 5: Modal Shift+HOV lane		Scenario 6: Madrid in Leeds on M1	
Demand change	**Constant over network**		**Constant over network**		**Constant over network**		**Constant over network**		**8.6% reduction in vehicle trips**		**Constant over network**	
Major impacts 2000	1.7 min saving for HOVs on A647, extra 1.7 mins for SOVs HOVs travelling further to use lane Shorter SOV trips diverted away from A647 more than longer ones. A647 traffic down 9.7% For study area: Marginal increase in pollutants Marginal change in veh kms, person hrs and fuel		Results similar to Scen1-2000 Slightly larger time saving for HOVs on lane. Against Scen1-2000		2.5 min saving for 3+ & an extra 1.5 min for others (over Scen0-2000) 16.5% loss in traffic from A647 *For study area results are not significantly worse than for Scen1-2000*		Loss of 28.3% of vehicles from A647 1.5 min increase on A647 for cars		2.2 min time saving for HOVs on A647 A647 average speed for HOVs up 22% 14.2 % loss in traffic from A647 Major network savings in kms, hrs, fuel and pollution of between 10 to 15%. *Network benefits mainly due to 8.6% reductions in cars on network rather than HOV lane*		NOTE: Different network used for this test Over the network CBA (excluding scheme costs) is negative Assessment on just M1 links gives benefit in terms of person time. Only minor route choice diversions Recommend micro-simulation modelling	
Trend scenario 2010	Improved savings for HOVs over Scen1-2000 Increase in network person hrs over Scen0-2010		Similar to Scen2-2000 HOVs drawn to A647 Increase in network pass hrs over Scen0-2010		Saving for 3+ up to 6.5 min on A647 Further attraction of HOVs to A647 over Scen3-2000		Travel time increase for cars of 3.6 min on A647 Reduction of person hrs over network		Level of benefits similar to 2000 Improved network time savings		Increased traffic flow increases CBA loss. Loss on M1 as well 2% reduction in pollutants	
	2000	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
Car Occupancy on A647 (Scen0=1.4)*	1.71	1.76	1.70	1.77	1.62	1.77	1.40 by definition	1.40 by definition	1.75	1.79	1.23 (base=1.2)	1.24 (base=1.2)
Benefits*												
Per peak (EURO)	-529	-1459	+1024	-666	+1821	+2955	-1341	+1563	+20217	+35685	-69.21	-3476.82
Per year (MEURO)	-0.238	-0.667	+0.461	-0.300	+0.819	+1.330	-0.604	+0.703	+9.098	+16.058	-0.03	-1.56

· **EVA values at 1998 prices - Not including cost of scheme** *** Network aggregate occupancy fixed at 1.4 in all schemes except for scenario 4 and 6**

Table 6-11: Leeds modelling results (compared with scenario 0)

Scenario CPD: Car-pool demonstration (1995)	Scenario 1: Extra GP lane (2010) (24km extra lane, 83 km corridor)	Scenario 2: Extra HOV lane (2+) (2010) (24km extra lane, 83 km corridor)	Scenario 3: Extra HOV lane (3+) (2010) (24km extra lane, 83 km corridor)
Considerable benefits from small applications, better part of benefits go to car-poolers through vehicle operating benefits. Therefore, target longer trips. Secondary benefits of time, fuel and emissions are less important but fuel and emission benefits should be used to market car-pooling image. Use on corridors with low PT service levels.	Used as a comparison frame for additional HOV lane. Congestion reduced significantly in 2010, but it has no influence on mode choice or occupancy levels.	Very successful. Even with no mode shift to HOVs, the HOV lane restrictions could produce time benefits over the extra GP lane due to initial proportion of HOV users. However, delay to vehicles generally increased, and so did fuel consumption and emissions. Therefore, a mode shift is essential to produce environmental and fuel benefits. This is achieved if initial delay is over 30 minutes, and benefits are increased substantially for a moderate mode shift to HOVs.	Not Successful compared to the scen1-2010: Extra GP lane. This is due to lower use of the HOV lane. Therefore use a 2+ restriction for Salzburg.
For 100 new car-pools veh-km (-6,800 /hr) -3.9% veh-hours (-104 /hr) -4.8% person-hours (-32 /hr) -1.2% fuel consumption -4.0% Hydro-carbons -4.2% Carbon-monoxide -3.8% Nitrous Oxides -4.0% Compared to scen0-1995: do-nothing	The effect of additional capacity : vehicle-hours (-1,006 /hr) -25% passenger hours (-1,267 /hr) -25% compared to do-nothing in 2010.	Resulted in 1545 new car-pools veh-km (-18,000 /hr) -10% veh-hours (- 652 /hr) -22% person-hours (-526 /hr) -14% fuel consumption -14% Hydro-carbons -22% Carbon-monoxide -18% Nitrous Oxides -19% Compared to scen1-2010: Extra GP lane	Resulted in 496 new car-pools Only a 5% reduction in veh-km (-9,000 /hr) and an increase in person-hours of 4% (+ 150 /hr) compared to scen1-2010: Extra GP lane. Still better than scen0-2010: Do-nothing, but only due to extra capacity
Occupancy from 1.26 to 1.28	N/A	Occupancy from 1.26 to 1.41	Not calculated
CBA : EVA values 15 EURO/peak period per new car-pool or 6,600 EURO per new car-pool p.a. compared to scen0-1995:do-nothing	CBA : EVA values 17.25 million EURO per annum compared to 10-0 : do-nothing (costs of additional lane assumed to be covered by these benefits) 0.72 million EURO p.a. / km extra lane	CBA : EVA values 13.8 million EURO per annum compared to scen1-2010: Extra GP lane 0.58 Million EURO p.a. /km of HOV lane 8,900 EURO per new car-pool p.a. (additional costs are related to converting the GP lane to HOV lane only)	CBA : Negative Benefits compared to scen1-2010: extra GP lane therefore use 2+ restriction.

Table 6-12: Salzburg modelling results (compared with scenario 0)

Measure evaluated: increase cut-off limit from 2+ (scenario 0) to 3+ (scenario 1)												
Emme/2 analysis											FREQ11 analysis	
Short-term 1997:			**Intermediate scenario 2005**			**Long-term 2010**			**Short-term 1997**			
Significant benefits of operating costs and fuel consumption, and considerable benefits of trip time. Benefits for HOV lanes users are bigger than benefits for non priority lanes users. Important decrease in pollutant emissions and therefore enviromental benefits.			Benefits of operating costs and fuel consumption are reduced compared to the 1997 scenario, due to a larger demand. However, benefits of trip time are increased if compared to the 1997 scenario. Important decrease increase in pollutant emissions and, therefore, environmental benefits.			Considerable benefits of operating costs, significant benefits of fuel consumption and very important benefits of trip time. Significant decrease in pollutant emissions. Benefits for HOV lanes users are greater than benefits for non priority –lanes users.			FREQ11 has problems when applied to the Madrid case-study. Some assumptions were to be made to handle the fact that problems and results were not consistent with Emme/2 Increasing cut-off limit from 2+ to 3+ is not a succesfull measure. Considerable benefits from operating costs but negative benefits from trip time and fuel consumption. Significant increase in pollutants. Significant rise in time saving using the HOV lanes between 2+ cut-off limit and 3+ cut-off limit.		
Veh-km	-11,541	-14.37%	Veh-km	-7,307	-7.52%	Veh-km	-3,583	-3.2%	Veh-km	-6,117	-5.9%
Person-hour	-68	-3.54%	Person-hour	-546	-11.75%	Person-hour	-1,548	-16.53%	Person-hour	+3,090	+22.9%
Fuel consumption	-626 l.	-11.96%	Fuel consumption	-404 l.	-5.62%	Fuel consumption	-614 l.	-6.45%	Fuel consumption	+928 l.	+2.6%
Hydro-carbons		-6.75%	Hydro-carbons		-15.57%	Hydro-carbons		-25.01%	Hydro-carbons		+21.7%
Carbon-monoxide		-9.59%	Carbon-monoxide		-13.47%	Carbon-monoxide		-24.94%	Carbon-monoxide		+21.9%
Nitrous oxides		-17.35%	Nitrous oxides		-18.70%	Nitrous oxides		-21.7%	Nitrous oxides		-0.4%
All values related to 7:45 A.M.- 8:45 A.M. period.			All values related to 7:45 A.M.- 8:45 A.M. period.			All values related to 7:45 A.M.- 8:45 A.M. period.			All values related to 7:00 A.M.- 10:00 A.M. period.		
Compared to do-nothing (2+)			Compared to do-nothing (2+)			Compared to do-nothing (2+)			Compared to do-nothing (2+)		
Occupancy from 1.50 to 1.55 (excluding public transport buses)			Occupancy from 1.50 to 1.70 (excluding public transport buses)			Occupancy from 1.50 to 1.78 (excluding public transport buses)			Occupancy from 2.55 to 2.67 (including public transport buses)		
Economic analysis (EVA values) Benefits 1,828 EURO/ peak hour. 148.61 EURO/peak hour /km extra lane. 31,159 EURO/year /km extra lane.			Economic analysis (EVA values) Benefits 3,872 EURO/ peak hour. 314.80 EURO/peak hour /km extra lane. 76,905 EURO/year /km extra lane.			Economic analysis (EVA values) Benefits 9,260 EURO/ peak hour. 752.8 EURO/peak hour /km extra lane. 169,380 EURO/year /km extra lane.			Economic analysis (EVA values) Benefits -28,225.38 EURO/ peak hour period. -1,927.96 EURO/peak hourperiod /km extra lane. -433,791 EURO/year /km extra lane		

Table 6-13: Madrid modelling results (compared with scenario 0)

	Scenario 1	Scenario 2 (1997)	Scenario 3 (1997)	Scenario 1-1 (2005)	Scenario 2-1 (2005)
Major impacts	A 3.5 km contra-flow HOV lane is modelled. Significant reduction in overall time travelled (1.4%) and fuel consumed (0.9%). Reduction in travel time for each user along B.Olgas & HOV lane is 1 min and 2.9 min respectively, on a current total trip time of 16 min along B.Olgas.	A car-pool facility is modelled in the beginning of the HOV lane. SOV users park to car-pool facility and become HOV users. Even more benefits to SOV and HOV users. Both travel time and fuel consumed were reduced overall by 2.7% & 2% respectively. Reduction in travel time for each user along B.Olgas & HOV lane is even more (1 and 2.7 min respectively).	An existing bus lane form B. Olgas to the HOV lane is diverted. It is the most benefitial scenario. A total reduction of 2735 travelled hours and 3121 was calculated. On microscopic level, the travel time along B.Olgas & HOV lane was reduced 1.5 and 2.9 min for each user.	Same as in scenario 1. A matrix growth of 20% is applied using elastic assignment. The predicted increase of traffic movements deteriorates the overall situation. The HOV lane must be combined with supplementary and restraint measures. Benefits are expected on microscopic level. The travel time along B.Olgas & HOV lane will be reduced in 0.1 and 3.2 min for each user respectively.	Same as in scenario 2. A matrix growth of 20% is applied using elastic assignment. The modelling of a car-pool facility in combination with the HOV lane seems to be globally benefitial. On microscopic level, the travel time along B.Olgas & HOV lane will be reduced in 1.8 min (11.2%) and in 4.2 min (25.1%) respectively for each user.
Global network	Person-hrs: -885 (-1.4%) Vh-kms: +3,325.9 (+0.9%) Lt. Cons.: -984 (-0.9%) CO_2 (kg): +229.2 (+0.9%) HC (kg): +4.6 (+0.9%)	Person-hrs: -1,735 (-2.7%) Vh-kms: +2,742 (+0.7%) Lt. Cons.: -2,106.3 (-2%) CO_2 (kg): +118.5 (+0.5%) HC (kg): +4.97 (+0.4%)	Person-hrs: -2,644 (-4.1%) Vh-kms: +3,090.1 (+0.8%) Lt. Cons.: -3,121.4 (-3%) CO_2 (kg): +189.4 (+0.9%) HC (kg): +4.41 (+0.9%)	Person-hrs: +2,273 (+3.4%) Vh-kms: +12,948 (+3.8%) Lt. Cons: +3,538(+3.3%) CO_2 (kg): +2,496 (+12%) HC (kg): +63.6 (+15.1%)	Person-hrs: -37 (-0.1%) Vh-kms: +806 (+0.2%) Lt. Cons: -142.7 (-0.1%) CO_2 (kg): +1,655 (+7.9%) HC (kg): +45 (+10.7%)
Average car **Occupancy rate**	1.204 (overall network) 1.32 (corridor specific)	1.205 (overall network) 1.28 (corridor specific)	1.205 (overall network) 1.29 (corridor specific)	1.205 (overall network) 1.25 (corridor specific)	1.205 (overall network) 1.26 (corridor specific)
	morning peak (7.30-9.30)	morning peak (7.30-9.30)	morning peak (7.30-9.30)	morning peak (7.30-9.30)	morning peak (7.30-9.30)
	compared to present base	compared to present base	compared to present base	compared to future base	compared to future base
Overall Benefits*					
Per peak (EURO)	2,678.3	4,732.7	9,282.6	-12,948.6	9,313.8
Per trip (EURO)	0.0291	0.0514	0.1009	-0.1451	0.1084
Per year (MEURO)	1,339	2,366	4,641	-6,474	4,657

Table 6-14: Thessaloniki modelling results (compared with scenario 0)

From the analysis of the above results tables, the following conclusions can be highlighted.

- **Leeds**

Significant time-savings have been recorded for vehicles making use of the HOV lane in all cases. The biggest time saving was found in the 3+ scheme (scenario 3). By contrast, the SOVs experienced an increase in travel-time. They tended to divert away from the A647, but only for short distance trips. This in combination with the increasing car-occupancy rates led to a decrease in traffic volumes on the A647 between 9.7 and 16.5 %.

In each scenario a substantial increase in the occupancy rate (up to 20 %) of HOVs could be evaluated proportionally associated with the increase in the demand. This relation shows that the implementation of HOV lanes can be effective even in the very short-term. In this case, scenario 4 (Only-Bus) did not yield negative results stemming from the high congestion levels that were provoked when all car traffic flow was forcibly diverted to the remaining lanes.

The excellent results obtained in the demand-scenario 5 are to be attributed to a change in the modal split, rather than be regarded as a consequence of the HOV lane efficiency.

The M1 tests of the short section of motorway HOV showed marginal benefits on the motorway itself and only caused minor route choice diversion.

- **Salzburg**

The car-pooling scheme for Salzburg gave reasonably high benefits per new car-pooler based on freeway associated benefits alone (i.e. not taking into account external factors such as car-pool formation time, inconvenience, destination measures etc.). However 72% of the benefits were due to vehicle operating benefits with benefits to other road users being less important. Obviously the longer the average distance travelled by the car-pooler the greater were the direct benefits of car-pooling and the more likely these benefits were to offset the inconveniences associated with forming a car-pool.

It follows that the Salzburg scheme would transfer well to corridors with similar features of poor public transport services coupled with sparse pockets of population.

The HOV lane (based on Madrid) implemented for the year 2010 in the A10 Salzburg corridor showed benefits even with no modal response when compared to an additional all purpose lane. However, these results were for one scenario which was assumed to have high initial delays due to growth in traffic until 2010 and was assumed to have a reasonable initial proportion of high occupancy vehicles (20% of the cars with 2 or more passengers).

It can be inferred that the expected upgrade in traffic conditions takes place with the incorporation of an extra general purpose lane, since it increases the capacity in the corridor. The HOV lane, in turn, prompts a rise in average occupancy. Thus, the implementation of an extra HOV lane produces obvious

improvements in traffic conditions, which are over and above those derived from setting up an extra general purpose lane.

The study by Dahlgren (1998) showed that additional HOV lanes can only provide benefits over adding an additional GP lane if the initial maximum delay was greater than 30 minutes and the initial proportion of HOV users was between 15% and 33%. The Salzburg transferability study confirmed these results in that the initial conditions were within this range and so the HOV lane was shown to be successful.

Sensitivity tests for Salzburg also showed that a high response rate or mode shift is critical when the initial proportion of HOVs is low, but less important when the proportion is high (approaching 20-30%).

- **Madrid**

An increase in the occupancy rate to 3+ does not have a big impact on the demand, but a consistent reduction in demand can be brought about by the application of car-pooling measures. Therefore benefits can be obtained with no infrastructure costs. The prospects of successfully applying a scheme 3+ are increased as the level of demand rises.

The analysis with Emme/2 indicated that a clear increase in the average occupancy rate was observed in all scenarios, even with the knowledge that the onset occupancy rate is already high (1.50). The economic analysis yielded positive values for all time scopes.

The incorporation of FREQ11 in the modelling of the N-VI corridor had two main restrictions. Firstly, it is not possible to test future situations, since FREQ11 requires the simulation of the actual situation in the corridor before the implementation of an HOV lane. In Madrid this data was not available, as the HOV has already been constructed and is operating. Secondly, the road network of the corridor was not suitable for the requirements of FREQ11. This imposed the need for some simplifications leading to a lack of consistency between the results from FREQ11 and those from Emme/2. This inconsistency in the results was shown clearly in the economic analysis, the environmental assessment, and in travel-times. In spite of it all, there was a common result, namely, both models predicted a rise in the average occupancy rate.

- **Thessaloniki**

The implementation of an HOV lane in the current time period resulted in a reduction in the travel time for people travelling from the eastern part of the city towards the city centre. On the other hand, a slight rise in pollutant emissions resulted from higher speed rates in all cases. There was a drop in bus travellers, which was viewed as a non-desirable outcome of the measure. A rise in the average occupancy of HOV's was observed, but this increase was not as remarkable as in the case of Leeds (10 % vs. 20 % in Leeds).

The most beneficial scenario was a combined bus / HOV lane with park and pool/park and ride areas, where people can leave their cars and use either an HOV or the bus.

In the future scenarios the implementation of an HOV lane without accompanying measures showed a negative impact on the overall road network. Therefore the implementation has to be combined with supplementary traffic management and restraint measures.

The HOV scheme showed benefits based on an implementation cost of 1 million ECU. The benefits were even higher by diverting the bus services to the HOV lane. In all cases there was a significant cost benefit ratio which indicates the scheme would be beneficial.

7 RECOMMENDATIONS

7.1 Lessons from the real life demonstrations

The following recommendations can be drawn from the real life demonstrations:

Awareness and information campaigns
Extensive awareness and publicity campaigns were launched at those demonstration sites which achieved better results. General campaigning, not focused on a specific target group, does not seem to be very effective. In order to optimise the value for money, it is strongly recommended to identify target groups and to focus intensive campaigning and individual marketing activities on them. Visible measures, such as infrastructure measures are awareness raising activities by themselves. An important lesson about promoting car-pooling is that campaigns should be focused as much as possible on the following target group: home to work traffic, car drivers, employees with regular working shifts, co-operative companies, commuters with long home to work distances, etc.

Matching centres
Research has shown that people wanting to obtain a match to form a car-pool are usually car drivers (Salzburg, Brussels). The majority of people contacting matching centres are interested in "five days a week nine to five" arrangements. Occasional car-pooling generates little interest, which has been confirmed by the results of the demonstrations carried out in Switzerland. As a rule-of thumb, it has been estimated that any matching database should contain at least 500 - 800 records (depending on the region) in order to be able to offer attractive matching arrangements. This figure is lower when the matching list belongs to one single company or working location (employees have the same destination address), then the minimum number of registrations could be about 100 according to experiences in Belgium.

Preferential parking at the destination
The interest of this incentive to car-poolers seems to be limited, especially if no severe parking shortages exist at the destination. Most people enjoy free parking at their workplace, even in big cities where parking places are expensive, e.g. Brussels. Preferential parking for HOVs should therefore be considered only in terms of convenience (reserve the better places to car-poolers), or within the framework of a revision of the current parking policies carried out by employers.

Preferential parking at the origin (park and pool)
This seems to be a measure easy to implement and with little cost. Two categories of park and pool areas are possible: informal and formal. The cheapest way of providing a meeting point for car-poolers is to legalise "wild" parking under bridges or along major roads. Generally speaking, it simply consists in improving the conditions of existing places where people are parking their cars in order to form a car-pool, close to public transport stops, to road

interchanges, etc. On the other hand, local authorities looking to promote car-pooling can provide special formal car parks, mostly as a combined park and pool respectively park and ride area which is connected to the public transport system. Usually the use of the park and pool areas need not be subject to strict rules, because anybody is allowed to park.

High quality signing and road markings are essential for safe operation and public acceptance, regardless of whether a scheme is informal or formal. However, park and pool areas as a "stand alone measure" will not increase the car occupancy on the road significantly, but can be seen as an additional service for existing car-poolers. Moreover the car parks can serve to promote the idea of car-pooling. The location of the car parks has to be selected carefully covering the aspects of current modal split, car occupancy rate, origin destination of commuters along a corridor etc..

Guaranteed Ride Home (GRH)
No convincing proof of their usefulness has been found in the ICARO project. A GRH scheme did not prove to be influential on the decision of people to car-pool. Employers, who are probably the key agent for the implementation of schemes seem to have little interest in them. They are concerned about abuse of the facility. The number of people making use of the GRH scheme has been proved to be limited. Public transport seems to be able to offer an adequate alternative to car-pool at most locations. It is not strange, therefore, that the measure in Salzburg (half-price PT tickets valid after 1 p.m. for car-poolers participating in the project) was the most successful. It should be borne in mind, however, that people are not necessarily familiar with public transport (fares, transfers, schedules), and that adequate support through a mobility management scheme will often be necessary. Misuse of these privileges is tempting and should be prevented by controlling instruments, such as limited numbers and times of trips, signature of superiors etc..

Car-pool as a feeder of PT lines
The value of car-pooling as a feeder of high-frequency public transport lines, seems to be very limited, as can be seen from the Graz and Brussels experiences, where this idea was promoted. Once in the car, people tend to continue the ride to the final destination of the driver or, at least, to the central area. This means that radial (periphery to centre) public transport services are not likely to benefit from car-pooling unless parking is restricted at the destination.

HOV lanes
The practical development of an HOV lane showed beneficial impacts on HOVs. In Leeds, real journey times for HOVs were reduced from 11 to 7.5 minutes on average for a 5 km journey in the morning peak due to the implementation of a 1.5 km long HOV lane in the corridor. The time on the other lanes remained relatively unchanged. Car occupancy of HOVs increased from 1.35 to 1.41 and was accompanied by a reduction in the total number of vehicles on the road. Similar trends were identified at the opening of the HOV lane in Madrid before the ICARO project. However, polls carried out in Salzburg, Graz and Pilsen suggest that people perceive HOV lanes as a

restrictive measure so that sufficient campaigning is needed to ensure public acceptance of the development of an HOV lane.

It is important to distinguish between three different forms of the development of an HOV lane:

- conversion of an existing general purpose lane; here it is recommended to start with a minimum car occupancy rate of 2+.
- addition of an HOV lane to existing general purpose lanes; here it is also recommended to start with a minimum car occupancy rate of 2+.
- conversion of a bus-only lane into an HOV lane; here it is recommended to start with a minimum car occupancy rate of 3+.

However, the minimum level of the car occupancy rate (2+ or 3+) has to be defined on the basis of site specific traffic surveys or modelling work. A certain congestion level plus an existing relatively high number of 2+ or 3+ vehicles in the present traffic situation favours the successful introduction of an HOV lane.

7.2 Lessons from the modelling demonstrations

The limits of existing models

A specific model, taking care of public transport and HOV inter-relationships and of European commuters' attitudes towards car-pooling is lacking. The sole exception is the model FREQ11PL, which was designed at San Francisco's Metropolitan Area for a very specific situation, namely suburban corridors where HOV lanes are to be implemented by adding a lane.

HOV lanes are usually proposed in areas with severe traffic congestion. It is difficult for models to achieve reliable results in these extreme situations. Macroscopic analysis (as made by SATURN and Emme/2) should be complemented by microscopic analysis (as performed by FREQ11PL).

General considerations for HOV lanes

As traffic conditions change due to the introduction of an HOV lane, it is clear that the whole network may be affected, and not only the route concerned. A number of effects have to be considered:

- Concentration/extension of peak traffic
  As traffic conditions improve, there is a trend to concentrate journeys within shorter time periods which are more convenient to users (e.g. people do not need to get up as early in the morning to avoid congestion…). The opposite also occurs: as traffic conditions become more congested, peak traffic period extends, following the combined effects of longer travel times and the distribution of demand over a longer period.
- Geographic conditions
  Geographic conditions have to be taken into consideration. HOV lanes can be planned in two different urban contexts:
  Firstly, urban schemes are characterised by dense networks and frequent junctions. Multiple routes can be chosen between two points. Secondly suburban schemes, which offer only a few (if any) alternative routes.

- Attraction/diversion of traffic from/to parallel routes
  This effect may result in traffic volumes different from those expected on both general purpose lanes and HOV lanes, as well as on parallel routes and therefore different travel times and timesaving for HOVs. It is therefore necessary to consider whether the whole network should be modelled.

Time savings are important when trying to induce a user to change mode, but they need to be significant. This can only be achieved if the HOV lane is long enough and / or the congestion is significant. One or two minutes saved will probably not attract any additional users.

Considerations for HOV lanes in urban areas
Urban areas are characterised by the existence of a dense road network, numerous junctions and frequent entry/exit points. The implementation of HOV lanes is usually limited to short sections. Up-stream traffic conditions are frequently influenced by down-stream congestion.

Add-a-lane schemes are extremely difficult to implement in built-up areas, and when feasible, environmental impacts will more often than not discourage such an approach. An urban HOV lane will most likely have to be based on a convert a lane approach. Traffic conditions on general purpose lanes could further deteriorate, making it difficult for the reserved lane to attain overall positive global results. This would suggest that the number of initial HOVs should be high enough to minimise this negative effect, and that very attractive timesaving should be attained.

Traffic regulations at junctions are also significant for the total time saving. They should be carefully analysed to avoid undesirable traffic diversions and to ensure full advantage of timesaving for HOVs.

In dense urban networks with multiple alternative routes, it is more likely that the implementation of an HOV lane will simply result in a reassignment of traffic. HOVs would be attracted by the new facility, while SOVs would distribute among the parallel routes, thus increasing total vehicle-km and passenger-km without achieving any significant modal change.

The urban schemes analysed within the ICARO project seem to confirm the complexity of urban HOV lanes. In Thessaloniki and Leeds the benefits attained by HOVs and the increased car occupancy rate were only in some scenarios big enough to balance the deterioration of the overall traffic conditions in the whole network.

The Leeds modelling indicated time benefits for HOVs between 1.7 and 6.5 minutes. The most favourable scenario under constant demand network conditions would require a minimum car-occupancy rate of 3+. The attractiveness of the time benefit led to an increase in the average car occupancy rate in the corridor from 1.4 up to 1.77. But overall benefits can only be achieved when in accordance with the rise of the car occupancy rate also the absolute number of cars on the road network decreases significantly (see scenario 5, chapter 6.4). A certain congestion level and a minimum proportion

of HOVs are therefore necessary as a pre-condition for the successful development of an HOV lane.

The modelling scenarios in Thessaloniki showed that additional incentive measures, as well as restrictive measures, can be crucial for the success of an HOV lane. Incentives can be an improved public transport schedule as well as an acceleration of buses, decentralised park and pool / ride facilities at the city's perimeter etc.. The intended effect is that public transport users are not attracted towards car mobility. Restrictive measures include mainly inner-city parking-restrictions. These measures aim at relieving inner-city road traffic conditions, so that the traffic on the road network in conjunction with the HOV lane operates with an overall benefit.

Considerations for 3+ HOV lanes in agglomeration areas (corridors)
As a general trend, the ICARO modelling exercises showed that as demand increases, the overall benefits in the whole road network are greater with a minimum occupancy requirement of 3 or more persons per car on the HOV lane (3+) compared to 2+ scenarios (see chapter 6.4). This is probably due to the fact that traffic on the HOV lane may reach levels close to its capacity, thus reducing time savings compared to users of general purpose lanes and discouraging further modal change. It should be kept in mind, however, that actual modal change from SOVs to 3+ is much more difficult to achieve, and that time-savings have to be much higher. In other words, usually 3+ HOV lanes cause high congestion levels on general purpose lanes.

Final considerations
From the analysis of the results obtained in the modelling exercises applied to the four case studies, some general considerations can be drawn that should be taken into account in the implementation of other future HOV lanes:

- In order to attain significant modal change, reserved lanes have to be long enough and/or congestion on general purpose lanes has to be high.
- Congestion has to be a real problem on the corridor even if road capacity is increased in the case of add-a-lane strategies.
- It is important to start from relatively high initial proportions of HOVs (at least 20% of the global number of car users) to ensure convincing levels of use from the beginning.
- The capacity made available to HOVs should easily absorb the expected increase of HOV vehicles.
- Both short-term and long-term responses are important for the assessment of the scheme.
- In order to enhance efficiency in the HOV lanes, it is important to supplement their introduction with additional measures, such as promotion campaigns and park and ride / pool facilities. The HOV lane should be designed in such a way so that it does not attract users from public transport. Buses should benefit from the HOV facility and take priority over the rest of HOVs where possible. This could involve making part of the HOV scheme bus only as in Madrid. Buses could also be given preferential access/exit points or additional priority at some traffic lights. The most beneficial scenario in Thessaloniki was a combined bus / HOV lane (see chapter 6.4).

- In any modelling effort, barrier-segregated HOV lanes are not able to attract as many vehicles as lanes without physical barriers. However, multiple entry/exit points may result in poorer traffic conditions on all lanes. Furthermore, the enforcement effort is much greater when there is no physical segregation. Both possibilities have to be assessed in order to identify the best solution.
- Add-a-lane schemes lead to increased road capacity. This initially reduces the attractiveness of modal change, and may induce new car traffic.(This reinforces the importance of modelling alternative routes).

Recommendations for future modelling exercises

Short-term and long-term scenarios have been considered in ICARO and they have proved to be effective in understanding likely traffic trends. Both are important in order to assess the feasibility of the measure (short-term) and its usefulness (long-term).

Traffic reduction should occur as a consequence of modal change, thus giving substantial benefits to HOVs. When the traffic reduction is substantial, even SOVs will benefit. For this to occur, substantial time savings have to be perceived by HOVs, without relevant deterioration of traffic conditions on the general purpose lanes or the whole road network. These benefits are likely to attract traffic from alternative routes. This is particularly the case if the new lane attracts HOVs from parallel routes. Time savings may become smaller than expected and the growth in car occupancy in the corridor would be counterbalanced by a reverse effect on other routes. This would be the case if, for instance the number of new HOVs is not large enough to compensate losses in time by SOVs.

Key issues to be assessed in short-term scenarios include the total number of HOV lane users, time savings, and the total travel time. Short-term analysis should be able to establish whether the public will accept the measure and whether significant modal change can be attained shortly after opening. Short-term congestion conditions will probably be more critical in convert-a-lane schemes, while in add-a-lane schemes concerns will initially focus on the additional capacity and lack of substantial time-savings to foster modal change.

Long-term scenarios show if the benefits will be preserved in the future due to additional modal changes or whether an unfavourable trend will follow. Reliability of long-term forecasts is always limited, but they are useful to check if short-term benefits can be maintained, even after some years of operation. Of course, the effectiveness of an HOV lane scheme cannot rely only on long-term benefits, as it would be impossible for the public authorities to justify the scheme during its first years of operation. But the merits of a successful scheme rely on being able to offer good mobility standards in the long-term, because future additional traffic may erode time savings. Benefits for HOV lane users must be preserved in the long-term, while traffic conditions on general purpose lanes should stay at reasonable levels. Otherwise, alternative or additional measures should probably be considered, such as improvements to the public transport service, traffic restrictions (road pricing, parking management etc.).

7.3 Key agents

The typical car-pooler
Though no specific effort has been made to identify the characteristics of those people more willing to car-pool, a trend is evident. Car-pools mainly consist of two people and car-poolers usually have fixed working schedules and commute longer distances on a daily basis. Car-pool arrangements can involve either alternating cars or use of a fixed car. No monetary exchanges are necessary.

Public support for car pooling policies
Evidence in this regard is somewhat contradictory. People in general have positive attitudes towards car-pooling as an environmentally friendly mode of travel. Negative aspects seem to be linked to legal uncertainties and the lack of information, rather than to actual barriers. However, support for "restrictive measures", that could give advantages to car-poolers at the expense of solo drivers, seems to be quite limited at the moment. It could be concluded that most of the people interviewed do not consider themselves as potential car-poolers and they therefore consider incentives to car-poolers as benefits for others. Negative experiences reported by car-poolers during the ICARO demonstrations are few. Following these *a priori* statements, it is likely that car-pooling has potential for development in the future. Positive experiences of initial users will probably be communicated to friends and colleagues, provided the efforts on awareness and information are maintained beyond the short-term.

The relevance of large working centres to promote car-pooling and the role of employers
As expected, real life demonstrations show that car-pooling is much easier to organise within large working centres. In Salzburg, 62% of the car-poolers had found their partners at their workplace. However, it has been difficult to obtain active support from employers, beyond publicity. As benefits from car-pool policies primarily concern the social fabric as a whole, it could be argued that carrot-and-stick policies should be developed in order to interest employers in mobility issues in general and promoting car-pooling in particular among their employees. Otherwise, it would be extremely naïve to expect that they will undertake changes in their policies on issues such as availability of parking places, work schedules, etc. Therefore, the obligatory introduction of company mobility management schemes (“green commuter plans”) in big enterprises could be a successful legal measure to promote car-pooling.

Public awareness and official support
In addition to an adequate campaign effort, obtaining the support of the public, politicians and companies is absolutely necessary, as most measures can only be implemented if these agents are actively supporting them. As it is the case for any innovative activity, car-pool incentives are not legally regulated, organisations responsible for the implementation are not clearly defined, and the results are uncertain. Sufficient time and effort must be devoted to clarifying the issue to key actors, to explain the benefits they can attain and to obtain positive support and not only passive acceptance. In this regard, the

identification, in each case, of a public leader for the initiative would probably be a decisive step forward.

Enforcement
Positive incentives have been found to be important to promote car-pooling. However, there is an obvious risk of misuse of these incentives. Strict control and regulation are expensive, usually criticised by those who feel to be the losers in the new situation, and may be counterproductive (e.g. "social control" within a working centre may backfire in the form of deteriorated inter-personal relationships). Benefits should be carefully balanced to these negative outputs before implementing such measures, and the legal basis for them should be beyond question.

Financial issues
The private sector could be involved in mobility management, especially in the implementation and management of car-pool policies. Authorities can provide incentives and subsidies, or devote toll revenues (from road-pricing) to finance car-pooling-related measures.

Planning instruments and education
Planning instruments and the education of transport planners is a very important issue if a new planning instrument is to be introduced and used in the planning process. Two points have to be mentioned in the context of car-pooling:
Modal split surveys usually distinguish the modes walking, cycling, public transport and car-use, the latter normally being divided into car driver and car passenger. Transport planners should be aware that car-pooling needs an additional distinction. In terms of car-pooling, it is of interest whether the driver of a car is a solo-car-driver or ride sharing in an HOV. This distinction has to be considered in future traffic surveys. An additional important issue is the distinction between family passenger and non-family passenger (related to the driver).

Education is one of the most effective long-term measures. It is crucial that mobility management and car-pooling measures become better integrated in the transport curriculum of transport engineering studies.

7.4 Strategy for a successful car-pool policy

7.4.1 Reasons for success

Publicity campaign
Whenever implementing a new idea, an intensive awareness and information campaign is needed involving different types of media. A public awareness campaign was carried out in Leeds several months before the opening of the HOV lane culminating in extensive coverage of the scheme on the opening day in the press and media at both local and national level. The strategy followed in Salzburg was to distribute information folders to commuter households. In addition, information boards were placed alongside major roads. A personal information campaign carried out in several steps was successfully undertaken

in Graz. However, these types of campaigns have their economical limits if the target group is too big.

Defined target groups
It is therefore very important to focus all activities towards well defined target group(s). In Leeds a measure was implemented which was targeted at car drivers on selected corridor leading to the city.

"Minimum sizes"
A minimum number of potential participants and a minimum size of the catchment area are necessary. e.g. the database of a matching centre needs a minimum size to offer acceptable matching lists.

Co-operation
To achieve a successful implementation, the support of different opinion leaders and organisations (representing lobby groups, politicians, enterprises, (non) governmental organisations etc.) is helpful in achieving awareness. In Salzburg an information letter from a politician of the Federal Government of the Province of Salzburg was distributed with the information brochure.

Permanent measures
Permanent measures have a much higher impact than temporary ones. Most car-poolers get to know each other at their work place through "word of mouth". In addition, it is necessary to display and spread the information permanently to offer a continuous information flow in order to offer people who are initially undecided the possibility of joining the scheme later.

Incentive measures
Incentives such as preferential parking, half price ride home ticket for the public transport, financial benefits etc., can play an important role in a person's individual decision process, but they will not be the sole reason triggering the decision to car-pool. The demonstration in Brussels did not offer any incentive and only the advantages of car-pooling were promoted. More than half of the people who participated in the car-pooling project in Salzburg stated that they did not use any incentive.

Restrictive measures
The most efficient measures to promote car-pooling are restrictions targeted at SOVs (e.g. restricted on street parking or at work places, access control to inner city areas or motorways etc.) combined with incentives for car-poolers. One point needing attention is enforcement. The HOV lane in Leeds was controlled by the local police. It must be considered, however, that the more restrictive a measure is, the less it is likely to be accepted by the public.

7.4.2 Reasons for failure

No severe problems for SOVs
Congestion, parking problems, travel expenses etc. are not severe enough to make people aware of traffic problems and to ensure that a sufficient personal benefit can be achieved through car-pooling.

No regular fixed schedules
One of the biggest obstacles against organised car-pooling is flexible working schedules, because varying time schedules complicate the matching. Differences arise mostly on the homeward trip. To avoid such inconveniences, guaranteed ride home schemes or half price ride home tickets are useful.

Dispersed settlements
Although in Salzburg the widespread settlements caused no problems, as long-distance commuters organised the pickup along their routes accordingly, the Swiss demonstration showed problems in preparing acceptable matching lists for people living in rural areas.

Small catchment areas
A minimum "critical mass" for a car-pooling project has to be ensured.

Unsuccessful awareness and information campaign
General public awareness campaigns will not convince people to car-pool. As mentioned above, a focused awareness campaign aimed at well defined target groups is necessary. As the event pooling in Switzerland was only one single event, the publicity campaign did not reach the target group, as dissemination-channels towards the participants of the event could not be activated.

Good public transport service
One of the results of the Swiss demonstration was that a good public transport service (short intervals, high frequency, good connections etc.) sets a high threshold to form car-pools. However in Salzburg, car-poolers who were attracted by car-pooling originally had bad public transport connections.

No parking shortage
If there are plenty of free parking spaces within walking distance of the destination, then parking management is unlikely to be successful as part of any promotion of car-pooling. However, most of the European cities are expected to have shortages of parking spaces at destinations in the near future and this could be an additional incentive to car-pool.

"Hidden" parking facilities
If one provides a reserved parking facility for car-poolers it has to be attractive. Some employers were willing to promote specially marked car-pooling spaces near the main company entrance, whereas the parking spots at the railway station in Yverdon were not accepted by the users as they were too far away from the station building.

Parking Permits
Cars parked on dedicated car-pool places have to be identified as car-pooling cars. Car-poolers in Salzburg and Switzerland were given car-pooling stickers for their car, but the stickers were not flexible, as most of the car-poolers were driving alternately with different cars. For that reason, a parking card would be more beneficial.

Legal inflexibility
All legal issues addressed by car-pooling have to be identified beforehand and people have to be informed about their legal situation. One example is the insurance of passengers not belonging to the family in case of an accident. Of course this information is linked to the legal situation in each country.

Complicated co-ordination processes
Whenever a new solution is proposed people are reluctant to accept change. If too many people or organisations are responsible for the implementation, the process may become inefficient. Many authorities had to be consulted in Graz and Bern for their permission and support which delayed the start of the projects.

Private versus public interests
Private / individual companies that run a business such as a garage or a public transport service have to maximise their profit or minimise their losses. Thus all incentive measures for car-poolers that result in the loss of clients or reduced income are not attractive where the publicity gained does not outweigh the financial loss.

Car-pooling as competition to public transport
Public transport companies will only support a car-pooling scheme if they expect additional customers or revenues. Research in ICARO showed that this is difficult to achieve. However, public transport can benefit from the development of an addition combined bus / HOV lane. The demonstration in Leeds showed that the bus service was improved as the buses made time savings and reliability was improved.

Unknown measures
A large proportion of the population is not accustomed to innovative measures such as matching centres. Experience from the Swiss demonstration has shown that the use of the Internet for matchings at the beginning of a car-pooling project is not successful as users would have to search actively for the information which is only feasible if the Internet address is well known (compare with chapter 7.4.1, "publicity campaign").

Difficulties in getting acquainted
Drivers are reluctant to give a ride to someone they do not know (Salzburg, Brussels, Graz, CH). In Brussels, people tended to request matchings only within their company. In Graz more people were ready to give a lift rather than join someone as a passenger. People like to have some certainty that their driver is reliable. People in Pilsen wanted a contract, whereas in Salzburg the membership card helped to overcome this uncertainty.

Not enough incentives
In the Swiss demonstrations in Lyss and Yverdon, a bonus of 67 EURO per year for a parking space at the railway station was no incentive to promote car-pooling. In Salzburg participants were recruited regardless of whether it was financially beneficial to them or not. A good matching was considered far more important. In Graz ten single tickets for public transport were given to every

person who participated in the car-pooling project, but this incentive could not convince people to join a car-pool.

Car use is cheap
In most countries the individual marginal cost of a car-kilometre is much lower than a ticket for public transport. Surveys have shown that changes in car usage (reductions of vehicle-km) can only be achieved by a significant rise of the costs, such as doubled fuel prices or road tolls.

7.4.3 Recommended procedure

If car-pooling measures are to be successful, a well developed strategy at local level is necessary. The following steps are recommended:

Step 1: Analysis of the market
Firstly the existing car-pooling market has to be analysed. That includes an analysis of the information level and information lag of all involved target groups and their attitudes towards car-pooling etc.

Step 2: Institutional awareness raising
The awareness of the relevant institutions and people (opinion leaders, decision makers, transport experts etc.) for car-pooling measures has to be raised.

Step 3: Developing a car-pool programme
A tailor made mix of car-pooling measures has to be identified. They have to be planned in detail including an implementation concept. It is important that all relevant public and private organisations participate in this planning process of car-pooling.

Step 4: Implementation of car-pooling measures
The measures have to be implemented following a time schedule allowing the most effective use of the available resources. Obstacles must be identified beforehand and should be removed in due time where they could threaten the successful implementation.

Step 5: Public awareness and information campaign
A successful campaign has to be orientated towards different target groups. General information can enhance other initiatives, but as a single measure it is unlikely to change the travel behaviour. A successful instrument is an individual marketing procedure.

Step 6: Installation of a permanent information process as part of a comprehensive mobility management programme
This addresses the longevity of the scheme and is important for success.

7.5 Recommendations on the European and the national level

The existing legal frameworks of the Member States are not actively supporting car-pooling and some barriers have been identified. Therefore the following recommendations are made:

7.5.1 Legal framework

On EU-level

- A harmonised Europe-wide definition for car-pooling should be agreed on for legal insurance and policy use.
- A harmonised European car-pooling sign for HOV infrastructure should be developed and implemented.
- HOV lane regulations should be developed and included in the national traffic regulations
- A means to ensure that car-pooling is always covered by third party insurance should be explored.
- Possibilities for a harmonised tax treatment of a limited reimbursement of costs between car-poolers should be explored.
- Company mobility management (including car-pooling) should be recommended for companies over a specific size (e.g. 100 employees).

On national level

All recommendations mentioned above should be introduced at national level.

7.5.2 Harmonised traffic sign

This is an important issue. A specific traffic sign must be defined for car-pooling at an European level. This sign could also be used in information campaigns, at preferential parking areas, at pick-up points, at park and pool areas, in matching centre's logos, at HOV lanes, etc.

Work carried out as part of the ICARO demonstrations in both Leeds and Salzburg led to the development of signs to depict a car-pool lane and a car-pool car park. The signs used in Leeds and Salzburg were slightly different but both adopted the principle of a car logo viewed from the front with a number of heads visible in the windscreen.

The logo used for the Leeds HOV Lane (see below) should be recommended as a standard sign to adopt on future HOV lanes and car-pool measures adopted throughout Europe.

Figure 7-1: ICARO proposal for an HOV traffic sign, which should be recommended at the European level

Different occupancy rates can be depicted by changing the 2+ to 3+, 4+ etc., but the general principle of the car shape with two heads should be retained.

7.6 Concluding comments

One of the goals of the ICARO project was to identify further needs for research. Two important issues have been identified:

- What are the impacts of car-restrictive measures on car-pooling?
  Currently there is no satisfactory information concerning the impact of access-restriction for cars, road-pricing (e.g. cordon pricing in urban areas), parking-restrictions and parking-pricing in combination with car-pooling incentives.
- Improving modelling instruments for car-pooling measures in order to include the behavioural modelling parameters.
  There are many transport models on the market, but they do not offer specific solutions for car-pooling measures.

It could be said that the potential for car-pooling to dramatically change current mobility patterns and traffic conditions seems to be, at best, limited. However, it is worthwhile as a complementary and inexpensive measure, especially under certain specific conditions e.g. large affected areas with high numbers of daily commuters and a significant concentration of work places in the area. It is particularly interesting in those areas and conditions where public transport is inadequate to meet demand or is doing so at very high costs. Effort should be focused on well-identified target groups and work centres and should include extensive campaigning among the public and key actors. The effort should be maintained in the medium and long-term, thus avoiding the label of "provisional" or pilot measures. Incentives, and particularly restrictive measures such as HOV lanes have proved to be most efficient under specific traffic situations, though they have lower acceptance from the public at large. It was found that no severe problem exists for the transferability of each measure tested in the ICARO project to other European countries under the reported pre-conditions.

It would be pointless to conclude by repeating here all the car-pooling measures. Only the main points are therefore summarised:

- No single car-pooling measure is successful, only an integrated package of measures holds the promise of success.
- All measures must be focused on well identified target groups (employees of firms, commuters, etc.).
- Car-pooling should be included in the mobility management plans for companies
- The individual marketing approach as a permanent procedure is a very effective supporting measure.
- The implementation of matching and information centres is necessary.
- Supporting infrastructure is very important as an additional measure, but makes little sense as a single measure (HOV lane, park-and-pool sites, etc.).
- Restrictive measures for non-car-poolers seem to be very promising (restricted access, road pricing, parking restrictions, etc.). There is no research yet on the impact of these measures.

8 SUMMARY

The ICARO project investigated the possibilities of Increasing CAR Occupancy through innovative measures and technical instruments (Task 5.2/17 in the Transport RTD Programme of the European Commission DG VII). ICARO commenced in January 1997 with a 27 month programme to March 1999. ICARO undertook a combination of both research and demonstrations, concentrating on the latter. The inclusion of demonstrations in this research project is important, to show the impact of measures in real life situations and not only in theoretical modelling situations. Demonstrations are always more convincing.

International literature uses a variety of words and phrases to describe the process for increasing the occupancy of cars. For that reason a definition of car-pooling was developed.

A car-pool should not be confused with an HOV (High Occupancy Vehicle). The latter is a vehicle travelling on the road complying with an occupancy requirement of two or more people.

The existing modal split shows a car occupancy rate in Europe of between 1.14 and 1.2 for home-to-work traffic. On average about 28 % of all trips are solo-car-drivers, about 12 % are HOV-drivers.

Infrastructure as well as non infrastructure measures were carried out at seven demonstration sites throughout Europe. The ICARO project's main scientific approach was empirical rather than analytical in assessing the results of the real life demonstrations. Although they are, to some extent, different from each other, some features, including the main goal of increasing car occupancy, are common:

- Leeds (UK): HOV lane into the city centre of Leeds;
- Salzburg (AT): Incentives for car-poolers in combination with a matching centre;
- Brussels (BE): matching activities in co-operation with companies;
- Pilsen (CZ): widespread promotion campaign for car-pooling in combination with a matching centre;
- Graz (AT): car-pooling as feeder for public transport;
- Rotterdam (NL): guaranteed ride home scheme;
- Switzerland: preferential parking for car-poolers, event pooling.

A useful complementary area is the modelling studies where several scenarios were modelled on four demonstration sites:

- Leeds (UK): HOV lane in Leeds under different conditions;
- Salzburg (AT): HOV lane on the motorways around Salzburg;
- Madrid (ES): turning the minimum requirement of two or more persons per car (2+) into 3+ on the existing HOV lane towards the city centre;
- Thessaloniki (GR): HOV lane into the city centre.

The different demonstrations have shown that, as car-pooling has a somewhat limited potential as a transport mode, the population and density of a region, as well as the concentration of work place destinations, must reach a certain value for the implementation of a general matching centre for the public to be successful. This minimum value depends on the accompanying measures, i.e. if car-pooling is installed in combination with incentive or restrictive measures. To achieve a satisfactory matching service, a database of about 500 to 800 people is estimated as a minimum. This number can be lower if the car-pooling campaign is focused on a specific target group like employees of one company or a group of companies in a limited area. In this case some 100 people can be enough for a successful matching service.

Analysing the types of car-pooling trips confirmed that promoting the idea of car-pooling at the workplace is the most successful approach. Companies can support car-pooling in many ways (matching service within the company, promotion campaigns, setting up the working schedule, reserved parking facilities for car-poolers on companies' ground, financial benefits,...).

One of the most effective ways of increasing car occupancy is to provide a separate lane for buses and HOVs (high occupancy vehicles). In Leeds, the only demonstration site where an HOV lane was newly introduced, the car occupancy rate increased from 1.35 to 1.41 and the total number of cars decreased. In addition, car-poolers have gained a time benefit in excess of 3.5 minutes by using the 1.5 km long HOV lane.

Besides matching centres and HOV lanes, many other measures were implemented at the several demonstration sites of the ICARO project. None of these measures influenced car occupancy rates significantly during the running phase of the project, but were well recognised by the target groups. These incentive measures can be seen as an additional service for current car-poolers or as an important promotion factor to reach a higher level of awareness. Several conclusions and recommendations can be drawn from these experiences.

The evaluation shows that the following activities for a successful car-pooling scheme are essential:

- a well focused publicity campaign;
- co-operation with companies and local politicians;
- involvement of all public transport authorities;
- specification of target groups (i.e. commuters) and catchment area;
- initiation of permanent measures;
- implementation of restrictive measures rather than incentive measures;
- permanent enforcement.

There are a number of obstacles against organised car-pooling:

- flexible working hours;
- dispersed settlements in the origin of the journey;
- availability of parking spaces at the destination.

The real life experience has been supplemented by the four modelling exercises in respect of Leeds and three other cities: Thessaloniki, Madrid and Salzburg. All of them are related to HOV measures, including different management options and short and long-term scenarios. The cross-comparison analysis highlights the effectiveness of HOV lanes to foster public transport patronage and to increase car occupancy.

In all cases, the modelling-exercise was designed to analyse HOV schemes. The implementation of an HOV lane leads to an increase in average vehicle occupancy which varies depending on the type of HOV lane. Namely, HOV lanes replacing a general-purpose lane appear to yield better results as regards the rise in occupancy, whereas an additional HOV lane increases road capacity, accordingly improving the conditions of the SOVs (single occupancy vehicles) and thus reducing the tendency to change mode. Likewise, benefits from the implementation of an HOV lane are directly associated with the initial congestion level.

For car-pooling measures to be successful, a well developed strategy is necessary. The following steps are recommended:

- analysis of the market;
- institutional awareness raising;
- working out a car-pooling programme and plan;
- implementation of car-pooling measures;
- public awareness and information campaign;
- installation of a permanent marketing procedure as part of a comprehensive mobility management programme.

In all cases, it is important to ensure that the successful formation of new car-pools is not at the expense of a drop in the number of public transport users. In this respect, the Madrid scheme, with a bus only lane on the final stretch of the HOV lane, appears to afford a noteworthy solution aimed at preventing competition between car-pooling and public transport.

A legal supportive framework is essential in setting up a car-pool scheme. A standardised traffic sign at European level has been identified as one key to promote public awareness and political support. Positive incentives have been found to be important to boost car-pooling, but there is the risk of misusing them. Strict controls and regulations are expensive but always necessary for success.

European guidelines for car-pooling, for transfer into national law, would be most helpful in promoting car-pooling throughout Europe. These guidelines should include:

- regulations for third party insurance;
- clear regulations for reimbursements of costs for car-poolers;
- European car-pooling sign for HOV-infrastructures;
- obligatory mobility management for large enterprises;
- HOV lane regulations.

The ICARO project has raised the profile of car-pooling as a serious contributor in the field of traffic management. Nevertheless, the measures investigated indicate that they can only be regarded as an appropriate response in specific situations, where, for example, public transport is either not competitive or already overcrowded.

As a measure, car-pooling will always be a peripheral component of any strategic transport management policy, albeit an important contributor. Under the most favourable conditions, the impact is unlikely to be other than minimal in contributing to the solution of complex transport problems that beset European urban/interurban conurbations. The final outcome from ICARO suggests that by adopting an integrated approach with a toolkit of applications, given appropriate safeguards, car occupancy rates can be improved without adversely affecting public transport usage. In conclusion, from the ICARO experiences it can be said that car-pooling is a promising part of any transport policy in the urban/metropolitan framework. Nevertheless, it should take into account a number of site, mobility and potential user characteristics in order to achieve good and permanent results.

9 PUBLICATIONS OF ICARO

To achieve increases in car-occupancy it is essential to establish a beneficial attitude towards car-pooling among transport policy representatives. Therefore it is very important to disseminate the results of the ICARO project to all potential supporters, such as national, regional and local authorities, but also to individual citizens, companies and trade unions etc.

The following publications are available:

Best practice (on measures to increase car-pooling)
The first part of the ICARO program consisted of research activities on existing practices to increase car occupancy in Europe and North-America. The results of the research are presented in this report.

Institutional, Legal, Financial, Cultural and Legal Framework
Concerning the institutional, legal, financial and cultural issues in the European countries a number of key questions are raised as important to the future of car-pooling. Institutional, legal, financial and cultural issues are often merged. In this report their importance is identified and discussed.

Evaluation and Recommendations of ICARO
This is a report on the valuation and recommendations based on the results of the real life as well as the modelling demonstrations.

Implementation guidelines for increasing car occupancy
This manual is based on the research findings and demonstration experiences of the ICARO-project. However, it is not a theoretical study to be archived. It is intended as a practical guide to the transport professional with responsibility for devising and implementing traffic and transport policies in local, regional and national governments. The aim is to give an overview of measures and instruments to increase average car occupancy. It can be used as a tool for introducing such measures by providing the user with detailed guidelines on best practice. The manual was produced in English and translated into German, Spanish, French, Czech and Dutch.

Brochure on car occupancy increasing measures
The title of the brochure is *"Car-pooling, A better use of Transport Capacity".*
A number of measures and techniques as well as schemes to increase car occupancy merit wider publicity. The brochure is aimed at politicians and authorities who very often depend on the technical assistance of professionals and who are interested in the possibilities and advantages of car-pooling. As companies play an important role in successful car-pooling schemes, employers and trade unions as well as employees organisations should be involved. Therefore the brochure is especially aimed at decision makers. Basic data, facts and figures are included, together with photographs. The brochure is available in English, German, French, Dutch, Spanish, Greek.

Video on car occupancy increasing measures
Attending seminars and reading manuals or brochures does not suit everybody. A video often is a less time consuming educational medium. The target public for the video *"Use those empty seats! Recommendations for a car-pool policy"* are the decision-makers (politicians, senior administrators, company executives,...). The aim of the video is to present car-pooling, more specifically to state why car-pooling needs to be promoted and to give an insight into measures to promote car-pooling, with demonstrations of the ICARO project as examples. As such the video can be used by people such as transport professionals to convince the authorities. The duration of the video is about 12 minutes and it has been produced in English and translated into German, French, Spanish and Dutch.

CD-ROM
The CD-Rom includes all deliverables with public availability, the manual and the national reports.

Internet
The ICARO homepage has been on the world wide web since May 5th 1997. The web site gives an overview of the ICARO project and details about the demonstration sites. The ICARO homepage can be found at
http://www.boku.ac.at/verkehr/icaro.htm

An easily accessible main page was installed, which provides an overview on all distribution material of the ICARO project. The list consists of all deliverables which are available for the public as well as all dissemination material of the project. All materials can be ordered in several languages by e-mail.

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11 ABBREVIATIONS

CP	Car-Pool(ing)
CPD	Car-Pooling Demonstration
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CTR	Centre of Research of Transport
Emme/2	Equilibre Multimodal, Multimodal Equilibrium
EVA	EVA manual, Evaluation process for road transport information
FREQ11	Freeway simulation modal for HOV lane analysis
GRH	Guaranteed Ride Home
HC	Hydro-Carbons
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
GP	General Purpose
MEURO	Million Euro
NGO	Non Governmental Organisation
SATURN	Simulation and assignment of Traffic to Urban Road Networks
SOV	Single Occupancy Vehicle
S&R	Shake and Ride
PT	Public Transport

12 GLOSSARY ON HIGH OCCUPANCY TRANSPORT

add-a-lane:
A general implementation approach whereby an HOV facility is created by adding roadway capacity to an existing freeway facility, usually by widening the freeway or modifying the median or outside shoulder (see also convert-a-lane).

average vehicle occupancy:
The number of persons divided by the number of vehicles travelling past a selected point over a predetermined time period (i.e. 1,2 or 1,26).

barrier-separated facility:
An HOV lane that is physically separated by guard-rail or concrete median barriers from adjacent mixed-flow freeway lanes. The opposing directions within a barrier-separated facility may be separated by a barrier or buffer.

bi-directional facility:
A preferential facility in which two-way traffic flow is provided for during at least portions of the day.

buffer-separated facility:
An HOV lane that is separated from adjacent mixed-flow freeway lanes with a designated buffer width of one foot or more. Narrow buffers (1 to 4 feet) may either be transgressed or not (i.e., the buffer can be legally crossed at any point or cannot be legally crossed except at designated access points). If the buffer is sufficiently wide (12 to 15 feet), it may be considered a refuge for disabled vehicles or for enforcement (Neither of these uses is recommended).

bus and car-pool lanes preferential lanes, or HOV lanes:
A form of preferential treatment in which lanes on streets or highways are restricted for the exclusive use of high-occupancy vehicles during at least a portion of the day.

busway:
A preferential roadway designed for exclusive use by buses, constructed either at, below, or above grade, and located either in separate right-of-way or within freeway corridors (TRB, Urban Public Transportation Glossary, 1989).

capacity, design (or roadway capacity):
The maximum number of vehicles (vehicular capacity) or persons (person capacity) that can pass over a given section of roadway in one or both directions during a given period of time under prevailing environmental, roadway, and roadway user conditions, usually expressed as vehicles per hour or persons per hour (Operational capacity for an HOV lane should be less than this.).

capacity, operational:
The optimum number of vehicles (vehicular capacity) or persons (person capacity) which can pass over a given section of roadway in one or both

directions during a given period of time under a prevailing management strategy which assures an acceptable free-flow level of service, usually expressed as vehicles per hour or persons per hour (This should be the goal for operating HOV facilities).

car-pool, car-pooling / -pooler:
Car-pooling is at least two people riding in a car usually belonging to one of the occupants, whether one person always drives or the car-poolers alternate driving. Each member would have made the trip independently if the car-pool had not been there. Driver and passengers know before the trip that they will share the ride and at what time they will be leaving. Professional and/or commercial transport are not considered as car-pools. Both the driver and the passenger(s) are considered as car-poolers.

car-pool, instant:
A form of car-pool in which drivers pick up random passengers (usually commuters), often at predetermined locations along the route. The composition of the passengers typically varies from one day to another. Instant car-pool passengers sometimes use this commute mode in one direction and take public transit in the other.

change of mode:
The transfer from one type of transportation vehicle to another (i.e., car to bus or pedestrian to car).

car-sharing:
A number of drivers with part ownership of a vehicle. There may be a signing out system (see also ride-sharing and car-pool).

compliance rate:
The number of eligible HOVs on a HOV facility divided by the number of total vehicles on the HOV facility (eligible and ineligible), expressed as a percent.

contraflow lane:
See lane, contraflow.

convert-a-lane:
Implementation approach whereby an HOV facility is created by converting one or two existing lane(s) without adding additional road space.

delay:
The increased travel time experienced by a person or vehicle due to circumstances that impede the desirable movement of traffic. It is measured as the time difference between actual travel time and free-flow travel time.

emergency vehicle:
Any vehicle generally used in responding to an incident that has caused or may lead to life -or injury- threatening conditions or destruction of property. Examples are police, fire and ambulance vehicles as well as tow trucks and maintenance vehicles.

enforcement:
The function of maintaining the rules and regulations to preserve the integrity of a preferential facility.

enforcement area:
A space on which enforcement can be performed, such as the space where vehicles may be stopped for officers to issue citations. Enforcement areas can be delineated within an available shoulder or provided at specific locations such as entrances and exits.

general purpose lane:
See lane, mixed-flow.

guaranteed ride home (GRH):
Arrangement offering to car-poolers a free ride home by public transport or taxi in case of an emergency.

headway:
The time interval between the successive passing of vehicles (measured from bumper to bumper), moving along the same lane in the same direction on a roadway, expressed in seconds or minutes.

high-occupancy vehicle (HOV):
Motor vehicles carrying two or more persons, including the driver. An HOV could be a transit bus, vanpool, car-pool or any other vehicle that meets the minimum occupancy requirements, usually expressed as either two or more, three or more, or four or more passengers per vehicle. A taxi without passengers is a single occupancy vehicle (SOV).

- ***HOV facility (also priority treatment):*** *The collective application of physical improvements that support an HOV operation, including lanes, entrance/exit, park-and-ride areas, park-and-pool areas, etc.*

- ***HOV lane:*** *See lane, high occupancy vehicle.*

- ***HOV system:*** *The collective application of physical line-haul and support facilities, programs and policies that are effectively integrated to provide a comprehensive application of HOV incentives in a corridor or region.*

kiss-and-ride:
An access mode to transit whereby passengers (usually commuters) are driven to a transit stop and left to board the vehicle, then met after their return trip.

lane:
A portion of a street or highway, usually indicated by pavement markings. that is intended for one line of vehicles.

- ***bus lane (bus primary lane, preferential bus lane):*** *A highway or street lane reserved primarily for buses, at least during portions of the day.*

- ***bypass lane:*** *See queue bypass (HOV)*

- ***concurrent flow lane:*** *An HOV lane (commonly the inside lane), that is operated in the same direction as the adjacent mixed-flow lanes, and designated for use during at least a portion of the day. The lane is separated from the adjacent freeway by a standard lane stripe (termed non separated lane) or buffer.*

- ***contraflow lane:*** *An HOV lane operating in a direction opposite to the normal flow of traffic (commonly the inside lane in the off-peak direction of travel), designated for peak direction travel during at least portions of the day. For freeway applications the lane is separated by plastic pylons or movable barriers.*

- ***general purpose lane:*** *See mixed flow.*

- ***high occupancy vehicle (HOV) lane:*** *A preferential lane that is reserved for the use of HOV vehicles during at least a portion of the day.*

- ***high occupancy and toll (HOT) lane:*** *An HOV lane which can be used by SOVs paying a toll.*

- ***mixed flow lane:*** *See mixed-flow.*

- ***non-separated (HOV) lane:*** *An HOV lane that is not separated from adjacent mixed-flow freeway lanes (i.e., delineation via a standard pavement stripe).*

- ***queue bypass lane:*** *See queue bypass.*

- ***reversible flow lane:*** *An HOV facility in which the direction of traffic flow can be changed at different times of day so as to match the peak direction of travel during periods of peak demand. (Also called tidal flow lane.)*

- ***shoulder lane:*** *An HOV lane that is created on an existing median or outside shoulder of a freeway.*

- ***tidal flow lane:*** *see reversible flow lane.*

level of service:
A descriptive measure of the quality and quantity of transportation service provided the user that incorporates finite measures of quantifiable characteristics such as travel time, travel cost, number of transfers, etc. Operating characteristics of levels of service for motor vehicles are described in the Highway Capacity Manual (TRB, Highway Capacity Manual 1985).

line-haul:
That portion of a commute trip that is express (non-stop) between two points.

mixed flow (also general purpose) lane(s):
Lanes adjacent to or affected by an HOV facility that are available for use by all vehicles (i.e. single-occupancy vehicles, HOVs, transit, trucks, etc.).

mode:
A particular form of travel (i.e., walking, bicycling, travelling by bus, travelling by car-pool, travelling by train, etc.).

mode shift:
The shift of people from one mode to another (i.e., single-occupancy vehicles to HOVs or vice-versa).

non-separated HOV lane:
See lane, non-separated (HOV).

off-line station:
A mode transfer facility located off of the HOV lane, either adjacent to the freeway or some distance away. Mode transfers could involve bus, rail, auto, or pedestrian modes.

off-peak direction:
The direction of lower demand during a peak commuting period. In a radial corridor, the off-peak direction has traditionally been away from the central business district in the morning and toward the central business district in the evening.

online station:
A mode transfer facility located along the HOV lane. Mode transfers involve bus, auto and/or pedestrian modes.

paratransit:
Any form of demand-responsive transport services such as taxis, car-pools, vanpools buses-on-request etc., that are available to the public. They are distinct from conventional transit as they generally do not operate on a fixed schedule and/or on a fixed route.

park-and-pool area:
A parking facility where individuals rendezvous to use car-pools and vanpools as a transfer of mode, usually from their private automobiles. The facility is not served by public transportation.

park-and-ride area:
A parking facility where individuals access public transportation as a transfer of mode, usually from their private automobiles. Public transportation usually involves express bus from the parking area to a central business district or major activity centre. A park-and-ride car park can also be allowed to serve the dual function of a park-and-pool area.

peak direction:
The direction of higher demand during a peak commuting period. In a radial corridor, the peak direction has traditionally been toward the central business district in the morning and away from the central business district in the evening.

peak hour:
That hour during which the maximum demand occurs for a given transportation corridor or region, generally specified as the morning peak hour or the evening peak hour.

peak period:
A portion of the day in which the heaviest demand occurs for a given transportation corridor or region, usually defined as a morning or evening period of two or more hours.

preferential parking:
Car parks or spaces that are reserved for HOVs as a means to encourage ride-sharing.

preferential treatment:
In transportation, giving special privileges to a specific mode or modes of transportation (i.e., bus lanes or signal pre-emption at intersections).

public transit (US) or public transport (GB):
Passenger transportation service to the public on a regular basis using vehicles that transport more than one person for compensation, usually but not exclusively over a set route or routes from one point to another. Routes or schedules of this service may be predetermined by the operator or may be determined through a co-operative arrangement.

queue bypass (HOV):
An HOV facility that provides a bypass around a queue of vehicles delayed at a ramp or mainline traffic meter, toll plaza or other bottleneck location (i.e., bridges, tunnels, ferry landings, etc.).

ramp meter:
Traffic light control at the entrance of a facility (e.g. motorway / freeway) allowing access to the facility for a limited number of vehicles. Possibility of giving preferential treatment to HOVs.

ride-sharing:
The function of sharing a ride with other passengers in a common vehicle. The term is usually applied to car-pools and vanpools (see also car-sharing).

single occupancy vehicle:
Vehicles with one person only, including taxis without passengers.

support facility:
A physical improvement that enhances HOV operation, including park-and-ride areas, park-and-pool areas, transit centres or other physical improvements that are considered a supporting element of the operation.

support program:
Any of a number of services that enhance the public acceptance or usage of the HOV system, including ride-sharing, employer-sponsored programs, public information and marketing, etc.

surveillance and communication (S&C):
A remotely operated system for monitoring and managing operation of an HOV and/or freeway facility to improve traffic operation, responsiveness to incidents, and communication with motorists.

transit: see public transit

transit centre (or transit station):
A mode transfer facility serving transit buses and other modes such as automobiles and pedestrians. In the context of this document, transit centres are either on-line or off-line facilities with respect to the HOV lane.

transportation demand management (TDM):
The operation and co-ordination of various transportation system programs to provide the most efficient and effective use of existing transportation services and facilities. TDM is one Category of TSM actions.

transportation system management (TSM):
Actions aimed at the improvement of the operation and co-ordination of transportation services as well as facilities to reach the most efficient use of the existing transportation system. Actions include operational improvements to the existing transportation system, new facilities, and demand management strategies.

vanpool:
A prearranged ride-sharing function in which a number of people travel together on a regular basis in a van, usually designed to carry 7 or more persons.

violation:
An infraction of the rules and regulations for roadway use. In an HOV context, a violation can include vehicle and occupancy eligibility.

violation rate:
The percentage of traffic in the HOV facility that does not qualify to be in that facility.

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ANNER, R. (1992) *Effiziente Nutzung des Verkehrssystems, Höhere Fahrzeugauslastung durch elektronische Märkte, in: NZZ Nr. 265, 03-11-92*

APARICIO, Angel C., CRISTOBAL, Carlos and GARCIA, Antonio (1998) " La calzada Bus-Vao de Madrid: Tres años de seguimiento" in *X Congreso Panamericano de Ingeniería de Tránsito y Transporte*.

BART-1 (1973) : Traveller behaviour studies, part III, Institute of Urban and Regional Development, University of California, Berkeley, 1973.

BILLHEIMER, J. W., STAMM, H. (1994*) High Occupancy Vehicle (HOV) Lane Marketing Manual*, Systan, California.

BILLHEIMER, JOHN F. (1995) *Surveys of Park-and-Ride Lot users In the San Francisco Bay Area, Submitted to CALTRANS, district four, by Systan Inc., Los Altos, Calif*

BOENDER, JOHN AND DE WINTER, AAD (1995) *Opening Europe's First High Speed HOV Facility on Route A1 in Amsterdam* in Transportation Research Board (1995c) (ETH)

BONSALL, P. (1995) "Microsimulation: its application to car sharing", in *Transportation Research A*, vol. 16A, nº 5-6.

BÜHLER, STEFAN (1998) "Autos besser auslasten" *Der Bund* , Bern.

CALIFORNIA DEPARTMENT OF TRANSPORTATION, DISTRICT 4 (1995) *Annual HOVL Report,* Office of Highway Operations, Oakland, Calif.

CHRISTIANSEN D.L. (1989) *Implications of Increasing Carpool Occupancy Requirements on the Katy Freeway High-Occupancy-Vehicle-Lane in Houston, Texas,* Transportation Research Record

CENTRO DE INVESTIGACIONES SOCIOLÓGICAS (CIS) (1996) *Opinión pública y política fiscal;* Madrid

CENTRE OF TRANSPORT RESEARCH AND MINISTRY OF TRANSPORT OF THE CR (1996) *Transport Yearbook*, Prague

COMMUTER TRANSPORTATION SERVICES INC. (1994) *State of the Commute Report, 3550 Wilshire Blvd. Suite 300*, Los Angeles, Calif. 90010

COMMUTER TRANSPORTATION SERVICES, INC. *Guaranteed Ride Home: Taking the worry out of ridesharing,* Los Angeles, Calif. 90010

COMMUTER TRANSPORTATION SERVICES INC (1995) Developing a Transportation Plan. An overview for building owners, managers, employers, transit operators

CONSORCIO DE TRANSPORTES DE MADRID / SIGMA 2. (1998) *Encuestas telefónicas en el Municipio de Pozuelo.* Madrid

COUNCIL OF THE CITY OF PILSEN (1996) *Principles of the Pilsen Transport Policy*, Pilsen.

DAHLGREN, J. *Website: http://www.itsonline.com/ko_hov2.html,* UCB

DAHLGREN, J. (1998). *"High Occupancy Vehicle lanes: not always more effective than general purpose lanes*". Transportation Research A, Vol 32 No 2 pp. 99-114.

DEKKERS, MARIE-ANTOINETTE (1981) *Regroupement des usagers de la voiture particulière dans le cadre des déplacements domicile-travail (carpool),* Institut de recherche des transports, Rapport no. 55, Arceuil, Cédex (ETH)

DE VINNY, C. (1995) *California Trip Reduction and Clean Fuel Program. In: REINHARDT, E. Social Marketing of Promising Strategies in Transport and Urban Energy Management. Geneva workshop, 17-18 March 1994. Final report,* VdF Hochschulverlag, Zürich

DRIVE Project (1990) *Carpooling System Management*, Road User Demand Study, Literature Evaluation, V 1069

ECOTEK (1996) Geomatch (Ridematching Software) Demo Version 1.4 with Manual. Ecotek, 330 Main St. Suite 201, Seal Beach CA 90740

EUROSTAT (1991) *Eurobarometer,* Luxemburgo: Centro de Publicaciones de las Comunidades Europeas

EIRASS (July 1993) *Carpoolen: Welke factoren en omstandigheden spelen een rol?* Eindhoven.

EIRASS (May 1995) *Guaranteed ride home programmes: Een algemene verkenning & Een draaiboek voor pilot-projecten.* Eindhoven.

FERGUSON, E (1990) *The influence of employer ridesharing programs on employee mode choice.* In: Transportation, N°2, pp.179-205. Kluwer Academic Publishers

EVA Manual. Evaluation process for road transport informatics. Programme DRIVE funded by the Commission of the European Communities DGXIII.

FEDERAL HIGHWAYS ADMINISTRATION/PARSONS BRINCKERHOFF (1996) *HOV interactive 1.0 CD ROM,* FHWA/PB, California

FHWA/PB (Federal Highway Administration in Association with Parsons Brinckerhoff) (1996) *HOV INTERACTIVE 1.0, High Occupancy Vehicle Data Base from U.S.*, Canada and Europe, Compact Disk. FHWA/PB, 505 S. Main Street, Suite 900, Orange CA. 92668

FHWA, US Department of Transportation (1994) *Acquiring Highway Transportation Information from Abroad: Handbook, FHWA's Scanning Program,* Publication No. FHWA-PL-95-011(B), Washington D.C.

FHWA, US Department of Transportation *(*1996) *Predicting High Occupancy Lane Demand,* Final Report No. FHWA -SA-96-073, Washington D.C.

FIEDLER, Joachim, HOPPE, Rolf, WERNER, Harald (1987) *Zusteiger-Mitnahme Ein Beitrag zur Verbesserung der Mobilität Nichtmotorisierter in ländichen Regionen*, Universität Wuppertal, Wupertal.

FINK, J.W. et al. (1992) *Site Design Handbook. A Guide to Making Your Work Site Work for You,* Commuter Transportation Services Inc

GASSNER, R., KEILINGHAUS, A. UND NOLTE, R. (1994) *Telematik und Verkehr; Elektronische Wege aus dem Stau?,* Beltz Verlag, Weinheim und Basel (ETH)

GIULIANO, G., HWANG, K. (1993) *Employee trip reduction in Southern California: first year results*. In: Transportation Research, part A. Vol. 27A, 1993. Pergamon Press Ltd

HAGUE CONSULTING GROUP (July 1991) *Analysis an Evaluation of HOV facilities: Travel Times and Traffic Assignments.* Den Haag.

HAGUE CONSULTING GROUP (November 1993) *Report, Predicting the impact of carpooling policies: outcomes of a fundamental research project.* Den Haag.

HIGGINS, T. (1990) *Demand management in suburban settings.* In: Transportation, 1990, N°17, pp.93-116, Kluwer Academic Publishers

HOPPE, FIEDLER AND WERNER (1987) *Ein Beitrag zur Verbesserung der Mobilität Nichtmotorisierter in ländlichen Regionen,* Wuppertal, Zusteiger-Mitnahme,

JONG, G. de, GUNN, Hugh, and BLUM, Ursula (1994) "*Carpool models: literature and development in the Netherlands"*, in 22nd European Transport Forum. PTRC Summer Annual Meeting. Seminar G.

JONG, Gerard de, BRADLEY, Mark, and HOFMAN, Frank (1995) "*Systems Dynamics and search/duration nodels for carpool formation and dissolution*", in European Transport Forum. PTRC Summer Annual Meeting.

KNIEPS, GÜNTHER UND BARBARA, ED. (1994) *Stauprobleme im Verkehr, Ursachen und Lösungsansätze* 26. Verkehrswissenschaftliches Kontaktseminar. Bergisch Gladbach: DVWG (ETH)

KOZEL, S.M. (1997) *The Virginia Highwayman Highway and Transportation History Website For* Virginia, Maryland, and Washington, D.C.!

LAREAU, BRIGITTE ET TRUDEL, MICHEL (1994) *Favoriser le covoitage au Québec: Pourquoi et comment,* Document de travail, Ministère des Transports du Québec, Montréal

LOMAX, D., DOWLING, R., SAMDAHL, D., STAMM, H (1996) *HOV training course;* Transportation Research Board

LEMAN, CHRISTOPHER L., SCHILLER, PRESTON L., PAULY, KRISTIN (1994) *Rethinking HOV, High Occupancy Vehicles and the Public Interest* The Chesapeake Bay Foundation, 162 Prince George St., Annapolis, Maryland 21401

McFADDEN, D. (1973). "Conditional Logit Analysis of Qualitative Choice Behaviour". *Frontiers in Econometrics (P.Zarembka, ed.), Academic Press, 1973, pp. 105-142*.

MCQUEEN, LEVINSOHN, WAKSMAN, MILLER (1975) *The Shirley Highway Express-Bus-on Freeway Demonstration Project: Final Report* U.S. Department of Transportation, Washington, D.C.

MINISTÈRE DE L'EQUIPEMENT; SOFRES (1994) *Opinion Poll on the Image of Transportation Infrastructure*. Paris: M.E

MINISTÈRE DE TRANSPORTS DU QUEBEC (1995) *Vers un plan de transport pour la région de Monréal* Ministère des Transports, Montréal

MINISTERIE VAN VERKEER EN WATERSTAAT (1995) *Carpoolplan*. Den Haag.

MINISTERIE VAN VERKEER EN WATERSTAAT (January 1995) *Carpoolplan.* Den Haag.

MINISTERIO DE OBRAS PÚBLICAS, TRANSPORTES Y MEDIO AMBIENTE; CONTRAPUNTO S.A (1993) *Comprensión y actitudes ante el carril BUS/VAO.* Madrid

MINISTERIO DE OBRAS PÚBLICAS, TRANSPORTES Y MEDIO AMBIENTE; GABINETE DE ESTUDIOS ECONÓMICOS Y SOCIALES ALEF- MILLARD BROWN S.A (1993) *Encuesta a habitantes del corredor de la N-VI*; Madrid

MODARRES, A (1993) *Evaluating employer-based transportation demand management programs.* In: Transportation Research, Part A, 1993, N°3, Pergamon Press Ltd

MUNICIPALITY OF METROPOLITAN SEATTLE (1993) *Managing Employee Parking in a Changing Market,* Municipality of Metropolitan Seattle Service Development Division, Seattle, WA

MUNICIPALITY OF METROPOLITAN SEATTLE (1993) *How to Develop your CTR Program (Commute Trip Reduction) How to implement and promote your CTR Program*, Two separate folders, Municipal Publication, Seattle, WA

OGDEN, B, MCDOUGALL, R (1996) *An HOV strategy for the greater Toronto area (paper presented at the HOV conference Pittsburgh, 1996),* Ontario Ministry of Transportation / IBI

PARK, C. (1992) *Evaluation of Second-Year effectiveness of GUARANTEED RIDE HOME Service at Warner Center Transportation Management Organisation.* Transport Research Board Record, n°1338.

PERRIN, BERNAND (1998) “Yverdon teste le covoiturage” *Journal du Nord Vaudois*, Yverdon.

PISCHINGER, R. et.al. (1997) “Volkswirtschftliche Kosten-Wirksamkeitsanalyse von Maßnahmen zur Reduktion der CO_2 - Emission des Verkehrs in Österreich, Graz, Linz, Wien”.

POLENA, C., GLAZER, L.J. (1991) *Examination of 11 Guaranteed ride home programs Nationwide.* In: Transportation Research Record, n° 1321, 1991, Transportation Research Board

POWERS, J.C. (1989) *George Washington Bridge Bus-Carpool Lane: 1-Year Operational.* Report Transportation Research Record 1212

REINKOBER, Norbet (1994) *Fahrgemeinschaften und Mobilitätszentrale* Schriftenreihe für Verkehr und Technik, Bielefeld.

REINHARDT, E. (1995) *Social Marketing of Promising Strategies in Transport and Urban Energy Management. Geneva workshop, 17-18 March 1994. Final report.* VdF Hochschulverlag, Zürich

REINKE, V. (1985) *Fahrgemeinschaften im Berufsverkehr; Möglichkeiten und Grenzen der Förderung*, Dortmund: IRPUD (ETH

REINKOBER, N. (1994) *Fahrgemeinschaften und Mobilitätszentrale,* Schriftenreihe für Verkehr und Technik, Bd. 81. Erich Schmidt Verlag, Bielefeld (ETH)

ROY, SYLVIE ET TRUDEL, MICHEL (1986) *L'incitation au covoiturage: où en sommes-nous? Document de travail,* Ministère des Transports du Québec, Montréal

SAMMER, G. (1984-96) *Verkehrssimulationsmodell Sammer*, Graz

SAMMER, G., FALLAST, K., WERNSPERGER, F (1994) *Change of travel behaviour in conditions of road pricing and zero co_2-emissions in urban traffic-methods and results,* Institute for Highway Engineering and Transportation Graz, University of Technology

SCAPINAKIS, D.A., LIEMAN, L., BOUAOUINA, M., MAY, A.D. and OSTROM, B.K. (1991) “Demand estimation, benefit assessment and evaluation of on-freeway high occupancy vehicle lanes”. *Research Report: Chapters 4-13 for use with FREQ model UCB-ITS-RR-91-6.*

SIMPSON, T. (1995) *HOV Design guide for the Northwest Region* T. Simpson, 15700 Dayton Av. North, PO Box 330310, Seattle WA 98133-9710

SOUTHERN CALIFORNIA RIDDESHARE (1996) *California's Parking Cash-Out Law: A Guide for Employers,* Southern California Association of Governments, Los Angeles

STAMM, H. (1996) *High Occupancy Vehicle Public Involvement, Education and Promotion.* Presented at the HOV Conference, Pittsburgh, 1996, Pacific Rim Resources

SURFACE TRANSPORTATION POLICY PROJECT (STPP) (1994) *ISTEA Year Four, (Intermodal Surface Transportation Efficiency Act,* STPP, 1400 16th Street, NW, Suite 300, Washington D.C.

THE CZECH STATISTICAL OFFICE (1997), *Statitical Yearbook of the Czech Republic,* Prague

TEAL, R. F. *Carpooling: Who, How and Why* (1987) in: Transportation Research, Oxford U.K. Vol. 21a, Nr. 3

TELEWAYS AG (1993) *Auto-Pooling Realisationsstudie,* Forschungsauftrag Nr. 57/92 Auftraggeber: Bundesamt für Strassenbau, CH-3003 Bern

TRANSPORTS DEPARTMENT OF E.T.S.I.C.C.P. / SIGMA 2. (1998) *Encuesta de preferencias declaradas en el corredor de la N-VI*. Madrid.

TRANSPORT RESEARCH LABORATORY (1989) *O-D survey in the city of Thessaloniki* , volume 6.

TRANSPORT RESEARCH LABORATORY (1989) *Trip-generation zones and their characteristics,* volume 2.

TRANSPORTATION RESEARCH BOARD (TRB) (1986) *Innovations in Ridesharing*
National Research Council, TRB Record 1082, National, Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1987) *Recent Ridesharing Research and Policy Findings,* National Research Council, TRB Record 1130, National, Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1989), *Ridesharing - Transportation Demand Management,* National Research Council, TRB Record 1212, National, Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1990) Transportation Management, HOV Systems and Geometric Designs and Effects, National Research Council, TRB Record 1280, National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1991) *HOV Facilities and Transportation Systems Management,* National Research Council, TRB Record 1299, National, Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1991) *Rideshare Programs: Evaluation of Effectiveness, Trip Reduction Programs, Demand Management, and Commuter Attitudes,* National Research Council, TRB Record 1321, Washington D.C.
(ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1992) *Public Transit: Bus Paratransit, and Ridesharing,* National Research Council, TRB Record 1338, National
Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1993) *Preferential Lane Treatments for High-Occupancy Vehicles; A Synthesis of Highway Practice,* National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1994) *Multimodal Evaluation in Passenger Transportation,* NCHRP Synthesis 201. National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1994) *Public Transportation: Bus, Rail, Ridesharing, Paratransit Services, and Transit Security,* Transportation Research Record No. 1433. National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1994) *High-Occupancy-Vehicle Systems and Freeway Operations*

TRANSPORTATION RESEARCH BOARD (TRB) (1995) *Program of Research for HOV Systems,* Transportation Research Circular, No. 441, April 1995; National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1995) *Expanding Metropolitan Highways; Implications for Air Quality and Energy Use,* Special Report 245. Washington D.C.: National Academy Press (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1995) *HOV Systems in a New Light. 7th National Conference on High-Occupancy Vehicle Systems,* National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1995) *Public Transportation,* Transportation Research Record No. 1496. National Academy Press, Washington D.C. (ETH)

TRANSPORTATION RESEARCH BOARD (TRB) (1996) *High Occupancy Vehicle Training Course,* Folder for Participants, 8th International HOV Conference,
Pittsburgh, August 25, 1996

TURNBULL,K.F., HANKS, J.W. (1991) *A Description of High-Occupancy Vehicle Facilities in North America July 1990,* U.S. Department of Transport

UDIMO (1996*) Study of the Integrated transport System for the pilsen Region, Draft,* UDIMO Ltd., Ostrava

U.S. DEPARTMENT OF TRANSPORTATION (S.A.), *ISTEA Reauthorization, Policy Statements and Principles,* USDOT, Washington D.C.

VAN VLIET, DIRK (1995), “SATURN User Manual” (version 9.2).

WERNSPERGER, F. (1995) Spontane Fahrgemeinschaften als Zubringerverkehrsmittel zum öffentlichen Verkehr, Dissertation TU Graz, Graz

WILLEKE, R. UND HOENER, W. (1981) *Möglichkeiten und Erfolgsaussichten für die Bildung von Fahrgemeinschaften - unter besonderer Berücksichtigung der Gegebenheiten im Raume Köln,* Zeitschrift für Verkehrswissenschaft, 52. Jahrgang, Heft 3

WSDOT (Washington State Department of Transportation) (1995) *State Highway System Plan, 2 vol. Seattle WA*

WSDOT (Washington State Department of Transportation) (1995) *"HOV it your Way"*
Commuter's Guide (Depliant)

WSDOT (Washington State Department of Transportation) (1996) *Puget Sound High Occupancy Vehicle Pre-design Studies,* Folder containing Summary, Digests and factsheets. WSDOT, Seattle, WA.

WSDOT (Washington State Department of Transportation) (1995) *Transportation Policy Plan for Washington 1995, Report to the legislature,* A publication of the Washington State Transportation, Commission and WSDOT, Seattle

Guaranteed Ride Home: Taking the worry out of ridesharing, Commuter Transportation Services, Inc.

State of the Commute 1994, Commuter Transportation Services, Inc.

Carpooling in Californië (1989) Bureau Goudappel Coffeng bv

Transportation control measures. How cities can help clean up the air. (leaflet) (1993,) South Coast Air Quality Management District

Free Parking? Parking Management Strategies. (leaflet) (1990) Commuter Transportation Services Inc.

Express yourself. It just takes 2 to use the HOV Express Lanes,, Regional Public Transportation Authority (Phoenix, Arizona

I-15 Express lanes congestion pricing project (1996), SANDAG, CALTRANS, FHWA, FTA

Commuter Connection. (Information package for mobility management) (1996) Southwestern Pennsylvania Regional Planning Commission

The ETC Handbook - A Commute Management Guide for Employee Transportation Co-ordinators (1990) Commuter Transport Services, LA

Transportation Co-ordinators' Handbook, South Coast Air Quality Management District

The Green Commuter Plans - a resource pack for Nottingham's Employers (1995) Nottingham City Council et alii

Le Car Sharing, Véhicules partagés, liberté, mobilité, Car Free Cities Club, European Car Sharing, DGXI, s.d
Wirksamkeit von verkehrsberuhigenden Massnahmen bei Smogalarm in Graz. Study ordered by the provincial government of Styria „Amt der Steiermärkischen Landesregierung (1990)

Belastbaarheid van vergoendingen en aftrekbaarheid van kosten m.b.t. het woonwerkverkeer. (Taxability of remunerations and deductibility of costs in home to work traffic") (1997) in Kijk uit, 9/97, p.2-6.

Ongeval op de arbeidsweg (Accidents in home to work traffic) (1997) in Kijk uit, 9/97, p. 7-9

Fiscaal vriendelijk verlonen (Fiscal friendly remuneration) (1997) in Kijk uit, 9/97, p. 12-23

Een ongeval tijdens het woon-werkverkeer (An accident during home to work traffic) (1994) in Budget & Recht 6/1994, p. 12-16

Zijn uw passagiers verzekerd? (Are you passengers covered by insurance?) (1992) in Budget & recht, 12/1992, p. 30-32