



Collection of Cycle Concepts



2000



Road Directorate



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Contents

Preface	3
Introduction	5
Bicycle traffic in the year 2000	9
Bicycle traffic is more than cycle tracks	19
Communication and campaigns	29
Urban planning	41
Planning of traffic areas	47
Design of traffic areas	63
Direction signing and cycle maps	101
Bicycle parkings	107
Road maintenance	117
Roadworks	125
Collection of examples	131
From past to future	163
References	177
Index	182

Preface



Promotion of more and safer bicycle traffic produces healthier road users and helps to create better towns.

Collection of Cycle Concepts presents some ideas on how to increase the use of bicycles and how to prevent bicycle accidents.

The growth in car traffic is creating environmental problems and congestion. Compared to other countries in Europe traffic problems in Den-

mark are still modest. An important explanation for this is the development in the course of the last century of a robust bicycle culture. Today, one trip out of five in Denmark is by bicycle.

The future role of the bicycle must also be strong in order to create a sustainable society. It is important to develop an infrastructure that permits the optimal exploitation of the bicycle's qualities and possibilities.

A larger share of the short trips in towns can take place by bicycle. The car is often indispensable on longer trips. The bicycle can not be alone. Intermodality is important. The right balance of good roads and paths for pedestrians, cyclists and motorists can create better towns without losing the interaction between modes of transport.

The bicycle can more often be used as feeder traffic for coach, bus, train and plane on longer trips. This calls for safe and functional access roads and terminals with good possibilities for interchanges.

Not only road administrations, but also companies, institutions, schools, associations etc, must contribute to changing our attitudes to transport and making it more acceptable to cycle. The individual advantages are big. Half an hour's cycling daily increases our mean life expectancy by 1-2 years and gives better quality of life, both physically and mentally.

There are many measures that can be taken to improve cyclist safety. In spite of this, the accident risk for Danish cyclists has not changed over the past 25 years. It is necessary to approach the problem more systematically and introduce proposed solutions at places and among target groups where they will have the greatest impact.

The main challenge in promoting more and safer bicycle traffic is the need to implement a wide range of measures simultaneously. I therefore invite the reader to consider the many ideas contained in *Collection of Cycle Concepts* – and be inspired of those ideas, which apply to local conditions.

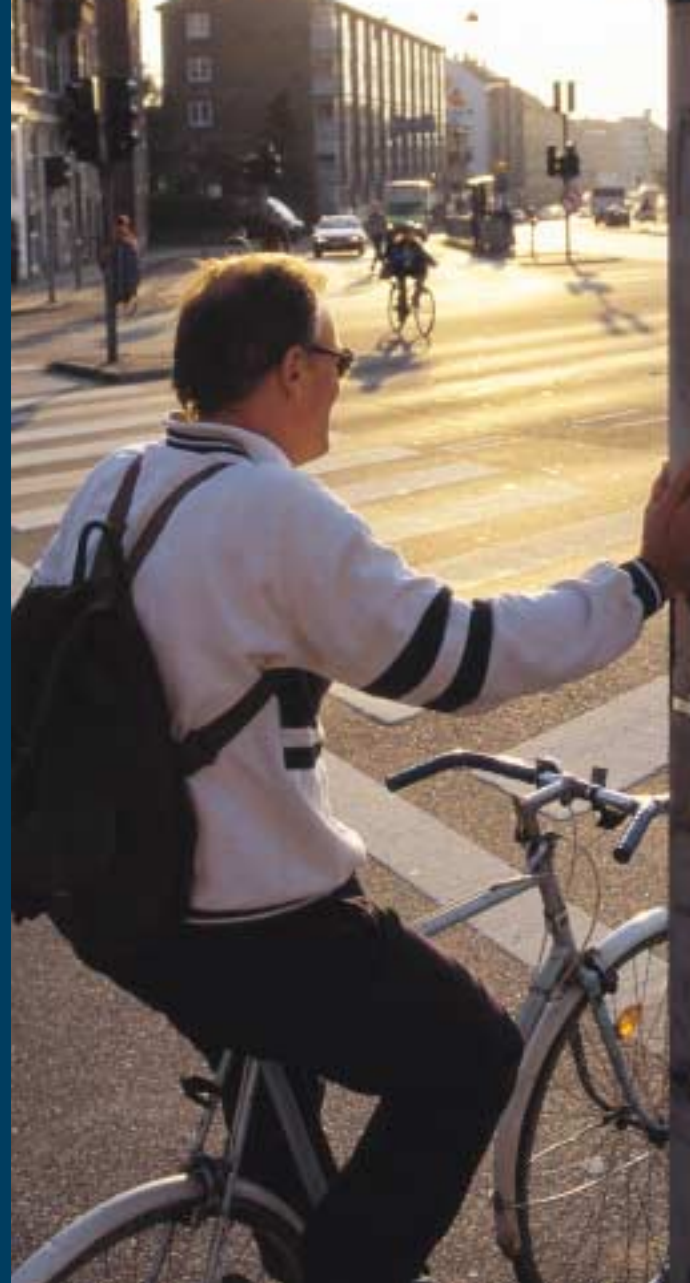
A handwritten signature in blue ink, reading 'Henning Christ.' with a stylized flourish at the end.

Henning Christiansen
Director General
Road Directorate

Introduction

Action is essential if we want to get more people to cycle. Many measures must be taken in order to improve cyclist safety.

Collection of Cycle Concepts is part of the Danish Ministry of Transport's overall plan for promoting more and safer bicycle traffic. The purpose of the book is to present an overview, inspiration and motivation regarding bicycle traffic. Use it for general orientation and improvement of qualifications and as a reference work.



Contents

More cyclists	6
Safer cyclists	6
Contents of the book	8
Reader's guide	8



PHOTO: Municipality of Odense

Being together – here as cyclists.

More cyclists

Cycling is healthy, environmentally-friendly and much, much more. For these reasons many choose to cycle. It is a big challenge to change travel patterns and get more people to cycle rather than take the car.

It is important to link soft policies (campaigns, instruction etc) with hard policies (infrastructure, taxation etc). The combination of hard and soft policies is necessary in order to achieve a big change in travel behaviour, both regarding transport mode choice and road safety. This combination also improves cost-effectiveness.

In soft policies often make use of two ways to promote cycling. Campaigns, which are intended to keep people who cycle a lot on their bikes and increase cycling among people who cycle once in a while, are a relatively cheap way to increase the level of cycling. Young and middle-aged people are the primary target group for these campaigns, and they can be reached

through companies and institutions. A good example is the Danish “We cycle to work” campaign, that have more than 50,000 participants.

The other way is to attract car drivers and passengers to cycling. Children are an important target group for this type of campaign, because the cycle culture is based on a regular accession of new

cyclists, primarily children. Competitions, lessons and instruction can increase the level of cycling among children, especially if these soft measures are combined with safe routes to school projects. It demands considerable resources to transfer inveterate car drivers to cyclists, so try to forget them as a target group.

A positive manner in soft policies about bicycle promotion, where good experiences, humour and joy make up the essence of the campaign, is more effective than raised fingers.

Better physical conditions for cyclists is needed, because the citizens have to experience a positive development, which mobilise a wish to cycle instead of going by car. Cycle tracks and paths are basic improvements, but also bicycle parking facilities and well-maintained roads and paths are important.

If the physical and economical conditions for motorists all together are improved, it becomes much more difficult to increase the level of



Try to see new perspectives!



PHOTO: Municipality of Odense

Children are safer cyclists than adults⁵².

cycling. The conditions for motorists are frequently being improved, especially because the actual value of cars and fuel decreases. In Denmark are restrictions on car use quite common eg petrol tax, parking charges and traffic calming in residential areas. These restrictions are necessary to implement in order to achieve the desired effect of other measures to promote cycling.

The society can function reasonably both socially, economically, envi-

ronmentally and in traffic, if the different modes of transport complement each other. To combine different measures and hard and soft policies is fundamental in the work towards better public health and better towns.

Safer cyclists

In a number of towns where the level of cycling has increased, there has occurred a drop in the total number of road accidents, which is

larger than in other towns¹³⁰. So it is possible to promote cycling and to improve road safety simultaneously. A basic point to be taken into account is that the more cyclists there are, the safer the individual cyclist⁵².

Vehicle design and equipment is of great importance for cyclist safety. For example, cycling in the dark along a rural road without cycle tracks is extremely dangerous if it is done without a rear lamp turned on. In Denmark stringent requirements are made of bicycle design and equipment. In addition to these requirements there are many other factors that influence safety. From a safety point of view it is dangerous eg to cycle with baggage in one hand. For the elderly it can be a good idea to use a three-wheeled bicycle.

Enforcement and control of vehicles, speed and behaviour is also of great importance for road safety.

Road design and marking influence behaviour.



PHOTO: Lars Bahi

Many can enforce and control. Road safety starts with you. Self-control is important. The bicycle dealer should inform customers of any illegal or inadvisable aspects of their bicycles. The police should intervene more often, when cyclists violate the Road Traffic Act.

Campaigns have proven effective to improve motorist safety. The aim must be to invent road safety campaigns that can change attitudes and behaviour, so cyclists become safer.

Improving road design and marking can cost a lot of money, but may be the only solution to a safety problem. When roads and paths have to be dug up anyway, it is important to seize the chance of redesigning them to make them safer – and more comfortable and easier to travel on for cyclists.

Road users make mistakes. The aim must be to minimise the risk of making mistakes. And if an accident happens anyway – to minimise the consequences by reducing the risk of fatal and serious injuries.

Contents of the book

This book is primarily intended for traffic planners, but may be read with advantage by anyone who is interested in cycling or other kinds of traffic, no matter whether they are planners, engineers, road administrators, politicians or NGOs.

Bicycle traffic in the year 2000 gives a basic impression of what bicycle traffic is. The chapter is supported by statistical data.

Bicycle traffic is more than cycle tracks is a process handbook for promoting more and safer bicycle traffic. The chapter presents an overview of possibilities for new projects and of the work processes involved.

Communication and campaigns describes effective ways of designing campaigns for both more and safer bicycle traffic.

Urban planning describes links between land use and the volume of bicycle traffic. The chapter presents preconditions of “the cycling town”.

Planning of traffic areas deals with the planning of cycle networks and the general principles for choosing layout, cross section, speed limits, junction design and pavement. Ways of financing plans and projects are also presented

Design of traffic areas illustrates a large number of designs and describes their advantages and disadvantages.

Direction signing and cycle maps makes it easier to find the right roads, paths and destinations. The chapter describes the Danish way of direction signing for cyclists and walkers and drawing up cycle maps.

Bicycle parking treats the location, capacity and standards for bicycle parking. Financing and protection against theft are also issues.

Road maintenance of cyclists’ traffic areas demonstrates the links between maintenance quality and the promotion of safe bicycle traffic. Ways of raising maintenance quality are described.

Roadworks illustrates the possibilities of ensuring good conditions for cyclists at roadworks.

Collection of examples describes 8 demonstration projects that have received support from the Ministry of Transport’s Traffic Pool. Many good ideas are shown.

From past to present recounts 100 years of Danish history about roads,

paths and bicycle traffic and puts forward some predictions on future traffic conditions.

Reader’s guide

The book contains many different topics and examples. The book is edited in the way that the chapters can be read independently of one another. Therefore it is possible to use the book as a reference work. The index at the end of the book can be useful to quickly find the relevant page. The raised numbers refer to references.

Bicycle traffic in the year 2000

As the second most used mode of transport the bicycle is a conspicuous feature of the urban scene in Denmark. We use the bicycle to get to work, to school, to our sports club, for shopping, to play with etc.

Cycling can be regarded in a number of ways. Cycling gives physical exercise, and it is seen as something positive. But the cycle trip can be perceived as a risk, and it is thought to be difficult to transport bulky objects and goods by bike. It is a fact that more cycling gives a longer life, but even this fact is regarded in different ways.



Contents

Mobility	10
Health	13
Bicycle accidents	13
Image	16



PHOTO: Lars Bahl

Most cycle trips start or end at home.



PHOTO: Lars Bahl

Danes often cycle to work.



PHOTO: Linda Hansen

... and to entertainment.

Mobility

Mobility is a basic human need. Every day we travel to fulfil social roles and activities. We leave our homes for work, to shop etc.

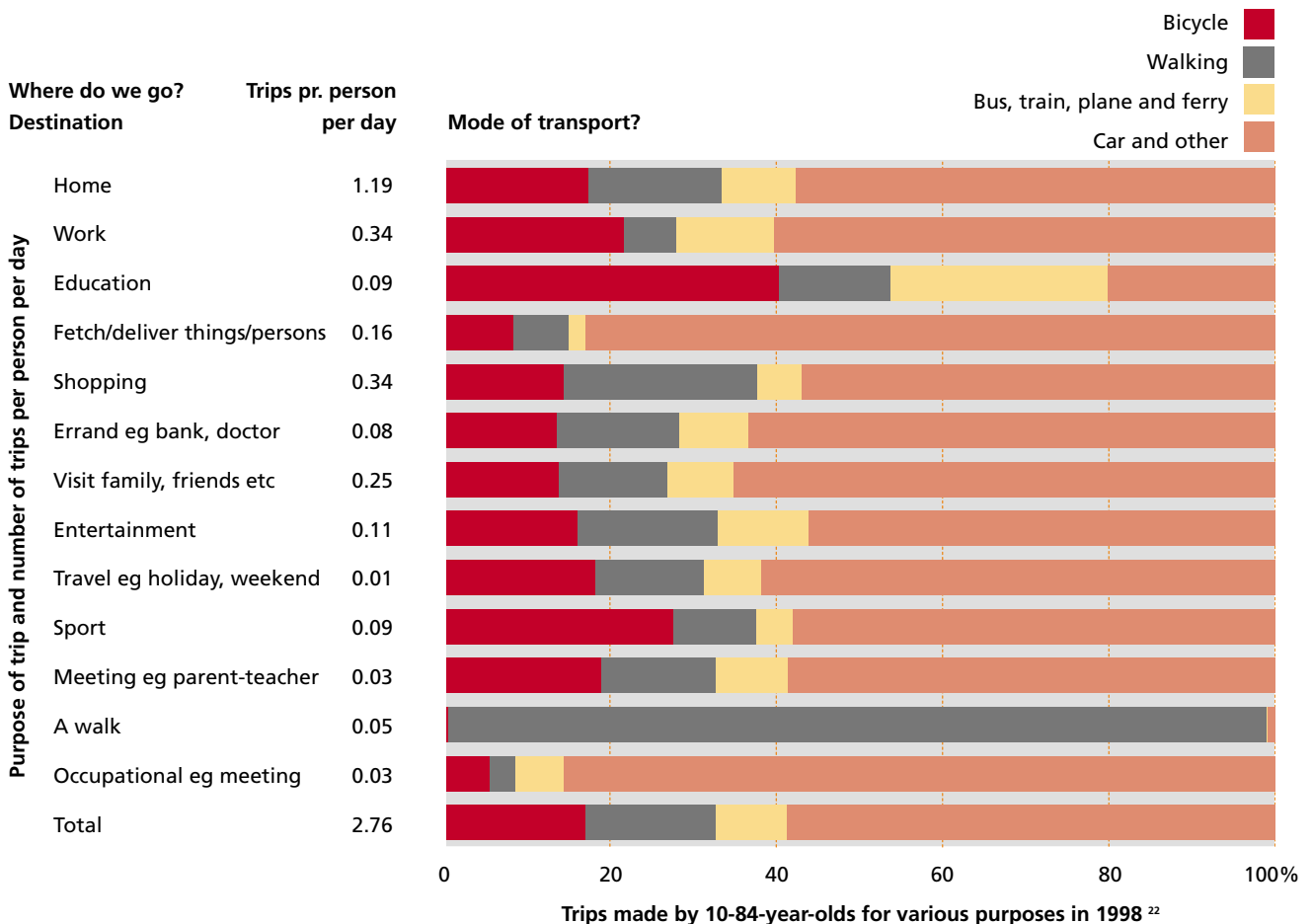
Studies show that transport time and the number of trips per person are on average constant – over time and for different societies. An increased use of one mode of transport means less use of another. Without population growth an

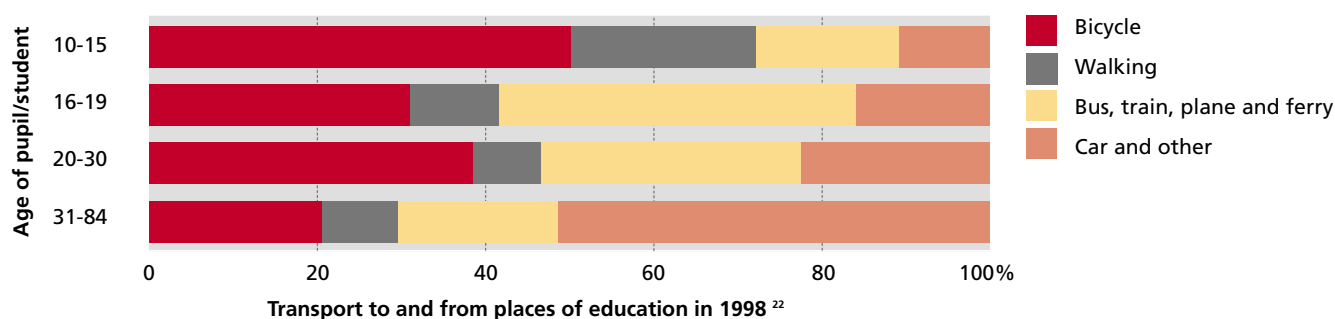
increase in passenger kilometres is merely an expression of faster trips either through a shift from one transport mode to another or through higher travel speeds ¹²⁷.

About 40% of all cycle trips made by Danes are between home and work/education. The importance of the bicycle as an everyday transport mode is illustrated by the fact that twice as many kilometres are cycled on weekdays as on Saturdays and

Sundays. In contrast, bicycles are rarely used for trips made during working hours.

The bicycle is also popular in our spare time. Every fourth cycle trip is between home and leisure activities. In most cases the bicycle is used to visit family and friends or go to the cinema, Bingo, badminton etc. A cycle trip is rarely a leisure activity in itself.





Half of all pupils at primary and lower-secondary schools cycle to school. A good 30% cycle to upper-secondary institutions, which tend to be further from home than schools for younger pupils. Pupils at both levels have free access to public transport if they have a long way to school. Many students at institutions of further education

leave home and live closer to the institution. Almost 40% of the students cycle to the institutions. Transport to and from in-service or further training is more car based and only 20% of this transport is by bicycle.

The number of cycle trips per household does not vary much even



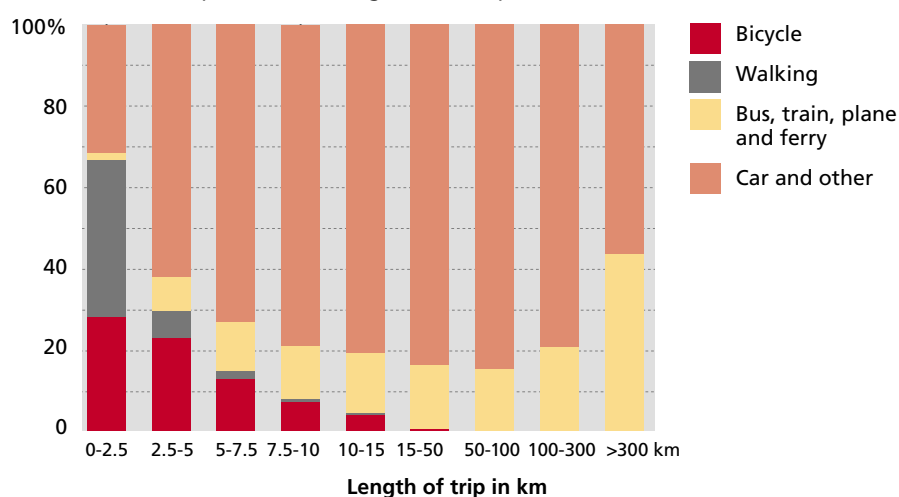
PHOTO: Linda Hansen

Student hostel - 2 cars and 100 bicycles.

though on average there are twice as many people per household in detached houses as in student hostels. On the other hand, there is considerable variation in the number of cars per household, so parking standards must vary according to the type of residence. In 9 cases out of 10 Danes walk to the bus or train.

Length of trips in km for 10-84-year-olds in Denmark 1998 ²²

Mode choice depends on the length of the trip



Type of residence	Average no. of trips/day/household to and from home in 1998 ²²							Cars per household	Persons per household
	Walking	Bicycle	Bus & train	Car driver	Car pass.	Other	Total		
Student hostel	1.2	1.7	0.6	0.3	0.5	0.0	4.3	0.1	1.3
Rented flat	1.4	1.2	0.8	1.4	0.6	0.1	5.5	0.4	1.7
Owner-occupied fl.	1.4	1.4	0.8	1.6	0.6	0.1	5.8	0.5	1.7
Terraced house	1.2	1.3	0.7	2.7	0.8	0.1	6.8	0.7	2.1
Detached house	1.0	1.4	0.5	4.0	1.2	0.1	8.1	1.1	2.6
Farmhouse	0.3	0.6	0.3	4.5	1.1	0.2	7.1	1.3	2.8



PHOTO: Linda Hansen

Mode of transport	Travel speed kph in 1998 ²²
Walking	6
Bicycle	16
Coach and bus	23
Local train	30
Moped	30
Taxi	35
Other buses	46
Train	51
Car	54
Plane	139

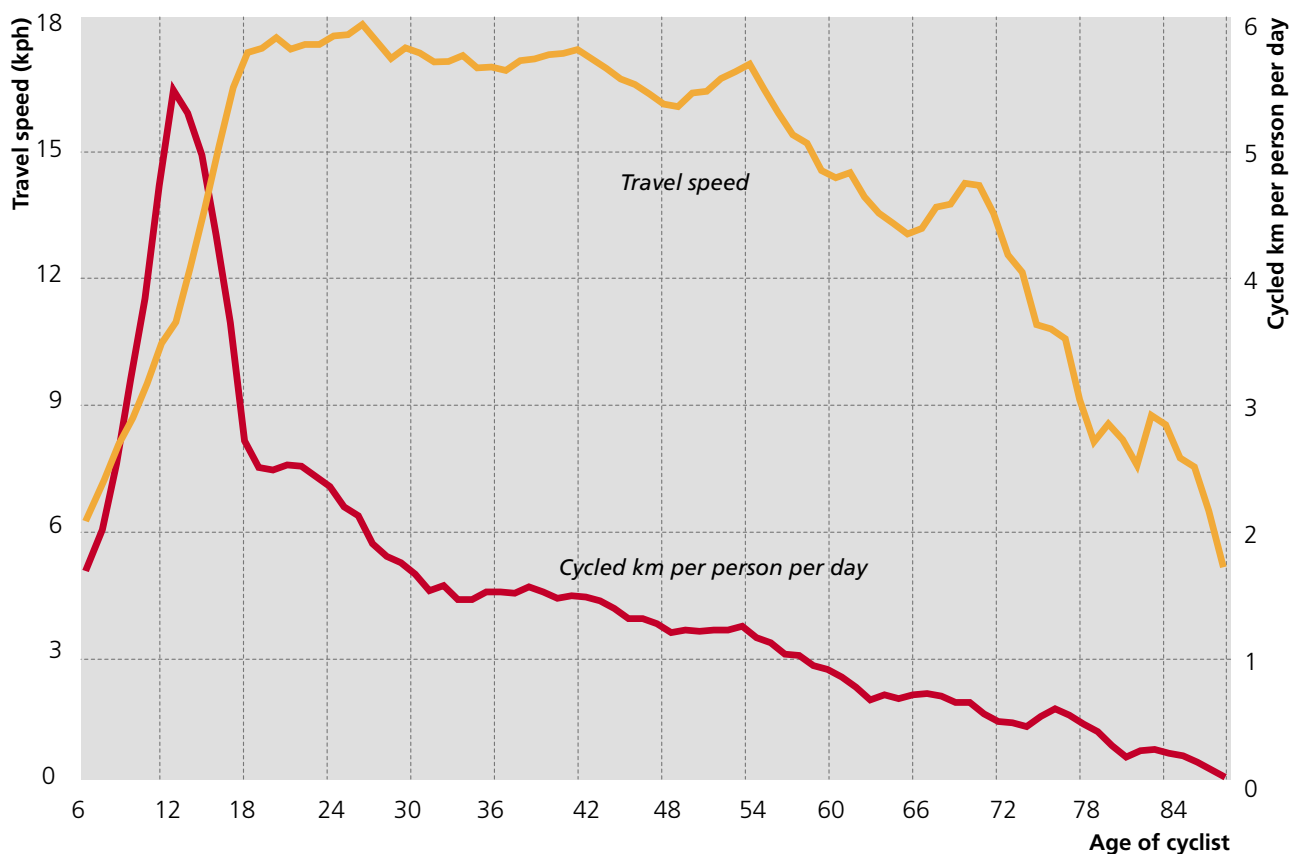
Fast cyclists going downhill.

The majority of cycle trips are short, while long cycle trips weigh heavily in the total number of cycled kilometres. Half the cycle trips are under 2 km, and 9 out of 10 cycle trips are under 5.5 km. Half of the car trips are under 7 km. Half of the distances walked are

shorter than 300 metres. The length of the cycle trip depends on the purpose of the trip, eg the trip to work often being longer than other cycle trips.

There is great variation in the speed of cyclists. On flat roads most peo-

ple cycle between 15 and 25 kph, a few per cent cycle over 30 kph, while the normal speed down steep hills is 30-40 kph ⁸⁶. Travel speed varies with age; while adults manage 16-18 km per hour, children and the elderly are slower – down to 6-8 km per hour.



The big differences in speed mean that there must be enough room for cyclists to overtake one another. A rough estimate says that a 2 m wide one-way cycle track has a capacity of 2,000 cyclists per hour, but capacity calculations are as a rule only necessary for signalised junctions ¹¹⁷.

Children between the ages of 10 and 15 cycle more kilometres than adults. 6-9-year-olds cycle a little less than older children, but nevertheless more than adults. Among children, 45% of cycle trips are in connection with leisure activities, while 30% are to and from school, and 10% are classified as “play”.

In the mid-1990s there were about 4.5 million bicycles in Denmark, and of these 300,000 were for children under 6 4. 82% of all households had at least one adult bicycle ¹⁰⁵. On average Danes cycled 1.5 km and made 0.6 trips per day in 1998. The average cycle trip is 2.7 km long and takes 12 minutes ²².

In the course of the 1990s Danes chose to cycle less and less. In 1993 23% of all trips by Danes of all ages were by bicycle, making it the most frequently used transport mode after the private car. In 1998 only 19% of all trips were by bicycle, a fall of 15% from 1993 ²².

There is considerable seasonal variation in the kilometres travelled by bicycle with fluctuations of 40-45% in relation to the mean and the high-

est number of trips in the summer and the lowest in the winter. Car kilometres also exhibit a seasonal but much smaller fluctuation of $\pm 13\%$ ¹¹⁵.

Health

For many Danes cycling is a natural way of getting exercise into their daily lives. It has been documented that physical activity like cycling is important for our health. The Danish Board of Health recommends half an hour of physical exercise daily as a “sure” supplement to our health. Children should have considerably more exercise, namely one hour a day.

The technological development in the fields of work and leisure activities has increasingly reduced the demand for physical activity in our daily lives. Roughly one third of the Danes is not active in such a way as to benefit from a preventive, health-promoting effect. Adult men get significantly more exercise than women ⁹⁷.

Many people do not participate in organised sport, and many only get regular exercise from walking and cycling. This is why our choice of transport mode is so important for our health. For instance, it is possible to get one’s half an hour of daily exercise by cycling 4-5 km to work.

Half an hour’s cycling daily increases our mean life expectancy by 1-2 years. Cycling has a preven-

PHOTO: Linda Hansen



Physical activity is healthy - also on bicycles.

tive effect on eg cardiovascular diseases, non-insulin-dependent diabetes, colon cancer, osteoporosis and depression ¹¹². The British Medical Association has found that the increased life expectancy to be gained from cycling exercise outweighs the added risk incurred from accidents by a factor of 20 ¹¹. Motorists who switch to the bicycle can thus expect to live longer!

Danes see the improvement in physical fitness as the most important advantage of cycling ⁹⁰. Better

Killed and injured per mill. hours travelled in Denmark 1993-95 ⁵⁴			
	Walking	Bicycle	Private car
Killed	0.56	0.35	0.26
Injury recorded by police	5.40	11.30	6.20
Hospital admission, minimum 1 night	4.30	19.40	2.60
Treated by doctor or at casualty ward (incl. falls)	14 (54)	176	17

mental health and fewer illnesses are also important. According to Danes themselves, the primary reason why they cycle is to get exercise and fresh air ⁶³.

Bicycle accidents

In 1998 the police recorded 58 cyclists killed and 1,780 injured on Danish roads ²¹. However, Danish casualty wards treated 19,830 cyclists in 1996 ²¹. 2 out of 3 injured cyclists at the casualty wards had been injured in single accidents ⁶⁹.

Many accidents occur because the involved parties fail to see each other or misunderstand each other's intentions. If the parties observed their duty to give way, a large proportion of accidents could be avoided. In the accidents between bicycles and cars in Greater Copenhagen for which the police have identified the party that failed to observe his/her duty to give way, this party was the motorist in 2 out of 3 cases ⁹⁵.

Many accidents could be avoided if the parties were more alert to one

another and took into account the errors that the other party might commit. Lower car speeds can contribute to this and also help to reduce the severity of accidents.

The chances of seeing cyclists in the dark can be improved by the increased use of good lamps and reflectors on bicycles. From 1 June 1999 the Ministry of Transport's statutory order on bicycle design and equipment has sharpened the requirements for, among other things, lamps and reflectors ¹⁰⁸. The severity of bicycle accidents could

also be reduced by more extensive use of bicycle helmets ²⁹.

Smoother road surfaces, fewer hazardous road layouts and better road lighting can help to prevent single accidents among cyclists. Road layout, unobstructed visibility conditions and road marking are also of great importance for road users' awareness of one another ²⁹.

The accident risk for cyclists decreases when more and more cycle in an urban area ⁵². The explanation may be that a larger number

Accident situation	
Killed cyclists per year 1995-1997	
Single accidents	10
Rear-end collisions	9
Head-on collisions between cyclists and motor vehicles	7
Motorists turns on to a side road	11
Motorists turns out of a side road	4
Cyclists turns left on to a side road	9
Cyclists rides on red light or stop signs	23
Miscellaneous	3
Total	76



PHOTO: Lars Bahl

Reflectors and lamps on bicycles and clothes increases recognition distance by 5-35%. Reflectors and lamps prevent many accidents. The more brakes, the safer the bicycle. Handbrakes are safer than footbrakes. Hard bicycle helmets prevent about half of all facial and head injuries ²⁹.



PHOTO: Lars Bahl



PHOTO: Linda Hansen

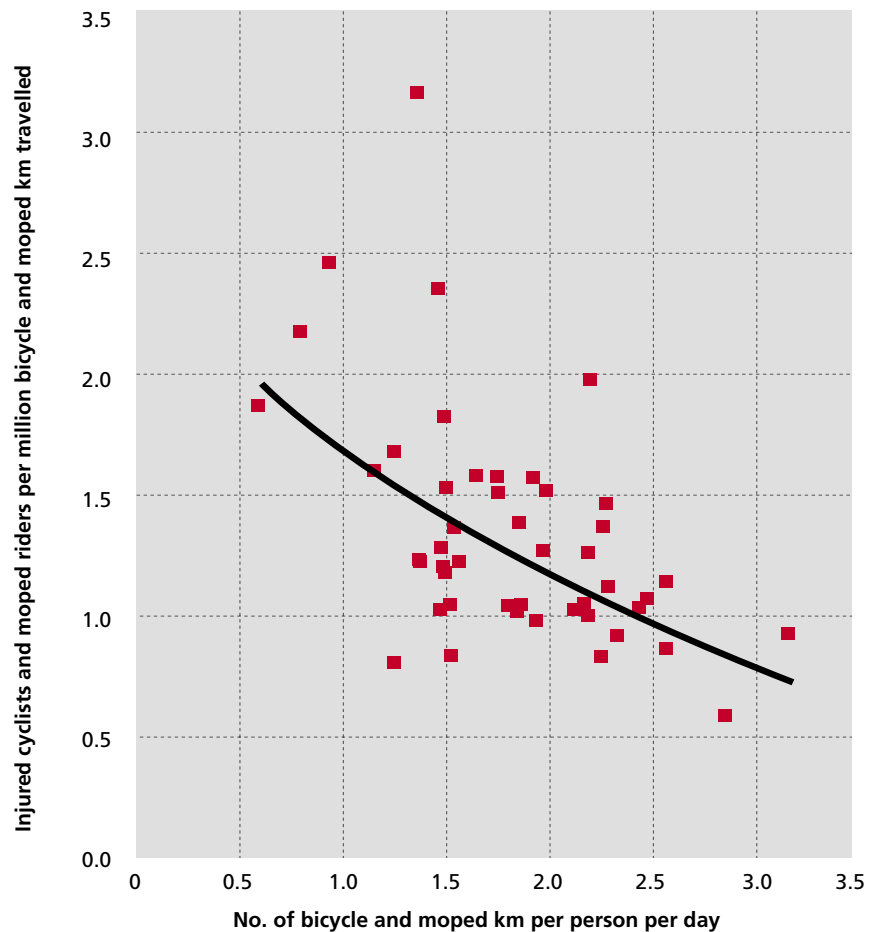
Many cyclists are more visible and safe than one.

Bicycle helmets prevent injuries.

of cyclists creates more awareness of their presence among other road users. At the same time the more cyclists, the more well-developed the cycle network tends to be³. Finally, more cyclists means fewer other road users, as the number of trips per person remains constant.

The total number of injuries on roads in Danish towns recorded by the police does not depend on the choice of transport mode⁵³. In a number of towns where the level of cycling has increased, there has occurred a drop in the total number of road accidents, which is larger than in other towns¹³⁰. So it is possible to promote cycling and to improve road safety at the same time.

Cyclists safety in 47 Danish towns⁵²



Which of the following reactions do you regularly experience when you travel by car/bus/train/bicycle?						
	Unsafe	Stress	Aggression	Relaxation	Enjoyment	None of these
... by car	8%	18%	16%	66%	34%	12%
... by bus	9%	22%	10%	64%	17%	12%
... by train	10%	9%	7%	75%	24%	8%
... by bicycle	15%	12%	11%	53%	58%	9%

The question was put to inhabitants of Greater Copenhagen who use the transport mode at least once a week ⁹.



PHOTO: Lars Bahl

Some feel unsafe in traffic.

unsafe in Greater Copenhagen. In central Copenhagen every fourth cyclist feels unsafe. On the other hand the bicycle is experienced, after the train, as the second least stressing transport mode, and cyclists experience aggression relatively rarely.

But there are other perceptions attached to cycling, perceptions that can play a part in preventing cycling from becoming more widespread. Perspiration and the sloppy, slightly grubby clothes do not project a streamlined, business-like image signalling success. Bathing and changing facilities can be a good idea at workplaces.

Image

Even though it requires energy – or perhaps because it requires energy – Danes enjoy cycling. People’s different feelings in traffic and perceptions of different transport modes is

basic knowledge for campaign managers.

Cyclists frequently feel unsafe in traffic, which might scare some from cycling. 15% regularly feel

The car can be a status symbol.



PHOTO: Lars Bahl

Cyclists’ behaviour - annoying?



PHOTO: Linda Hansen



PHOTO: Lars Bahl

The organic way is for sale.

Cycling is not a product as one can buy like organic foods, water-saving lavatories etc. The cyclist's everyday life and consumption is often different from the motorist's.

More cars is considered to be an important ingredient of economic growth or an inevitable consequence of more money. The bicycle does not enter into people's picture of a future richer world or into their dreams of winning the National Lottery. Recent research results show that more cars are not necessary to the achievement of high economic growth rates⁴⁸. Conversely, fewer private cars would mean that more resources could be used on other sectors eg health and housing.



PHOTO: Lars Bahl

Cyclist in wonderland.

Cyclists frequently contravene the Road Traffic Act, and many road users are irritated when cyclists ride on footways or cross against a red light. In one study cyclists were identified as the most irritating group of road users⁶¹. Cyclists are also perceived as "holier-than-thou" types who believe that they have the right to ignore the rules of the road.

On the other hand the bicycle has a positive image in many ways. It is associated with good experiences, fresh air, sun and summer. It is regarded as a healthy, sociable and environmentally-friendly mode of transport that is accessible to everyone.



PHOTO: Linda Hansen



PHOTO: Linda Hansen

Cycling and outdoor life go together.



PHOTO: Linda Hansen

Bicycle traffic is more than cycle tracks

The promotion of more and safer cycling involves a large number of problems and interested parties. These often interact in complex ways, so that we are facing a holistic challenge that calls for cross-disciplinary collaboration.

The present chapter has been conceived as a process handbook for the promotion of safe cycling, and it describes the stages in the formulation of a plan, from preparation to realisation. It is hoped that this handbook will make a contribution towards giving a broad overview of road safety for cyclists and people's choice of transport mode.



Contents

Plan & process	20
Preparation	20
Problem identification	21
Targets & strategy	23
Measures	24
Priorities	25
Finance	27
Realisation	28

Plan & Process

The Danish government's action plan *Trafik 2005* [Traffic 2005] from 1993 calls for 4% of private car passenger kilometres to be transferred to walking and cycling by the year 2005¹⁰⁶. This corresponds to a 30% increase in bicycle traffic or to an additional 200 kilometres to be cycled annually by every single Dane. The target of the Danish Road Safety Commission is a 40% reduction in the number of fatalities and severe injuries over the period 1998 to 2012³⁵. To pursue these targets will often mean a major new orientation of local traffic policy.

A possibility on a local level for the promotion of safe cycling is a politically adopted plan. The plan can create local anchoring and acceptance of the traffic policy. Whether the plan is a cycle action plan or promotion of safe cycling is part of other traffic plans is of course a local decision. Too many plans can result in contradictions between targets and projects, while a separate cycle action plan can lead to intensify local efforts, as it has been the case for several local road safety plans.

It is a good idea to build bridges to other policies, eg the work for better towns, public health and the like. In this way more co-operation between different administrations will arise, and maybe several projects become cheaper and more effective.

THE PROCESS



Preparation

The bicycle is individual and represents freedom. At the same time cycling is good for the town, the environment and public health. More cars and traffic growth is not necessary to maintain high economic growth rates on a national level⁴⁸. If citizens use less money on transportation, eg by cycling, then they have more money for other consumption.

An important starting-point for planning is an overview of the present state regarding accidents and

travel patterns and the possibilities of more and safer cycling. If there is not sufficient internal competence for the drawing up of a cycle action plan, it may be necessary to make use of consultant assistance. It is a good idea to develop competence within the administration by procuring know-how or hiring new staff, as the promotion of more and safer cycling is a long-term project. Another possibility is to co-operate with other administrations and draw on their competence, or to have a consultant coming regularly.

Due to many projects in different administration and organisations it is a good idea to hire a cycle co-ordinator, especially in larger municipalities. Cycle co-ordinators

POSSIBLE INTERESTED PARTIES

for the promotion of more and safer cycling

- Municipality and county councils
- Road administrations
- Bicycle user groups
- Business managers
- Personnel managers
- Shop stewards
- Health and welfare departments
- Hospitals
- GPs
- Politicians and civil servants from other municipalities and counties
- Chambers of commerce and trade promotion boards
- Local newspapers
- Public transport operators
- Police
- Nature conservation society
- Tourist office
- Schools, teachers
- Bicycle dealers and manufacturers
- Education and cultural departments
- Green guides

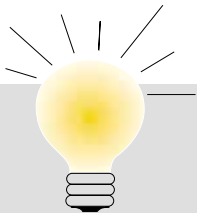


Bike and bus can be combined, if there is space for bicycle parking.

are seen in eg USA, Belgium and Great Britain.

Citizens should be involved from the start of the process. The admixture of the citizens' worries, visions, general views and everyday experience with the insights and overview of professional traffic planners makes a good combination for the achievement of the defined targets. Public participation can often give rise to new, creative and better projects.

It is important that the project should be locally rooted from the beginning, as this will increase the



To a large extent cyclists and motorists use the same roads in urban areas – where there are many cars, there are also many bicycles³⁸.

possibilities of co-operation and success. There is less danger that the project will end up on the rocks, if the local population and politicians is involved from the start. It is essential that ambitions, targets and funds are a coherent narrative from the start - both financially and in the process.

It could be a good idea to establish a local transport board, where im-

portant interested parties are represented, such as citizens, politicians, business, police etc.

Problem identification

In order to establish a strategy and choose measures that will work it is important to identify and analyse local problems. Many administrations are surprised by how little they know about local conditions for cyclists. There should be harmony between the extent of problem identification and the ambitions, targets and funds. Below follows a list of areas that it can be useful to look into.

PROBLEM IDENTIFICATION of local problems

Satisfaction, perceived risk and needs

- Review of complaints and debate in the press
- Questionnaire survey concerning trouble spots, prioritisation of measures and local attitudes to restrictions on car use
- List of problems
- Questionnaire survey as a follow-up to service targets – satisfaction and the importance of eg perceived risk, comfort, accessibility etc

Traffic structure

- Registration of cyclists' traffic areas, eg cycle tracks, access barriers etc
- Inspection and cycle tours
- Identification of main and local routes
- Congestion on roads and parking facilities

Traffic volumes

- Travel surveys to establish the level of cycle trips and km
- Questionnaires on travel patterns and chosen cycle routes
- Permanent traffic counters on cycle tracks, traffic roads, at traffic lights
- Manual counts
- Weather conditions have a great impact on the volume of bicycle traffic
- Maps with volumes of bicycle traffic

Operations and maintenance status

- Information from the most recent main inspection

Accident analysis

- Accident maps – pins on notice boards or digitally on a computer
- 5-year police records of accidents – and hospital records
- "Black bicycle spots"
- Speed measurements of cars and identification of hills with fast cyclists
- Thematic analysis of bicycle accidents with a view to campaigns and cheap physical measures

Bicycle parking

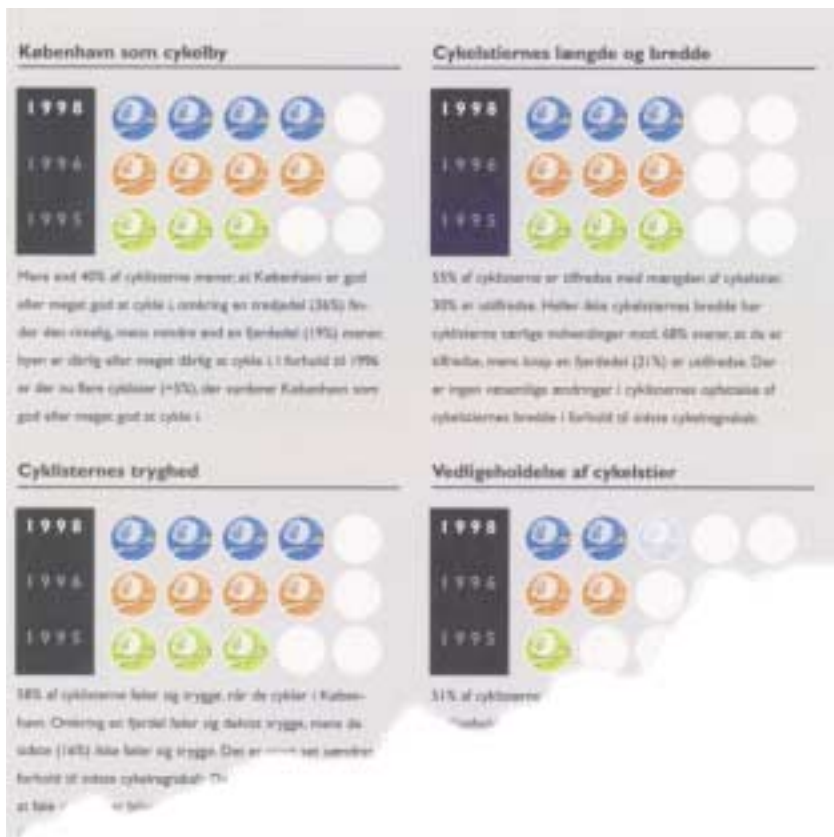
- Map of existing bicycle parking facilities with quality descriptions
- Map of peak loads for parked bicycles
- Map of lacks in facilities in relation to current guidelines
- Map of bicycle thefts

Analysis of local firms

- List of large firms
- List of firms participating in a "Cycle to Work" campaign

General

- Booklet containing maps, lists and ideas
- Get, eg the police, citizens associations, citizens groups, chambers of commerce etc, to comment on the booklet, perhaps in connection with on-site inspections
- Remember photos, many photos, as details are important for cyclists



Satisfaction surveys are part of the bicycle account in the Municipality of Copenhagen ⁶⁴.

that block footways and hamper shoppers.

The Danish Ministry of Transport has pointed out target groups and measures in their strategy *Promotion of safe cycling* ¹²⁶.

When establishing a local strategy for the promotion of more and safer cycling, it is necessary to make a number of choices. How should campaigns, police enforcement, and physical and economic instruments be prioritised in relation to one another? Will planned traffic investments inhibit the achievement of the defined targets? Are certain groups, eg children and commuters, more important than others?

Targets and strategy

Take your starting-point in national targets – eg in Denmark, 30% more bicycle traffic to be transferred from car by 2005 and 40% fewer deaths

and severe injuries by the end of 2012. Supplement with targets related to local problems, eg public health, carelessly parked bicycles

Promoting cycling solely through improvements in the physical conditions for cyclists is an expensive strategy, which moves relatively few motorists to bicycles, but reduces the number of bus and train

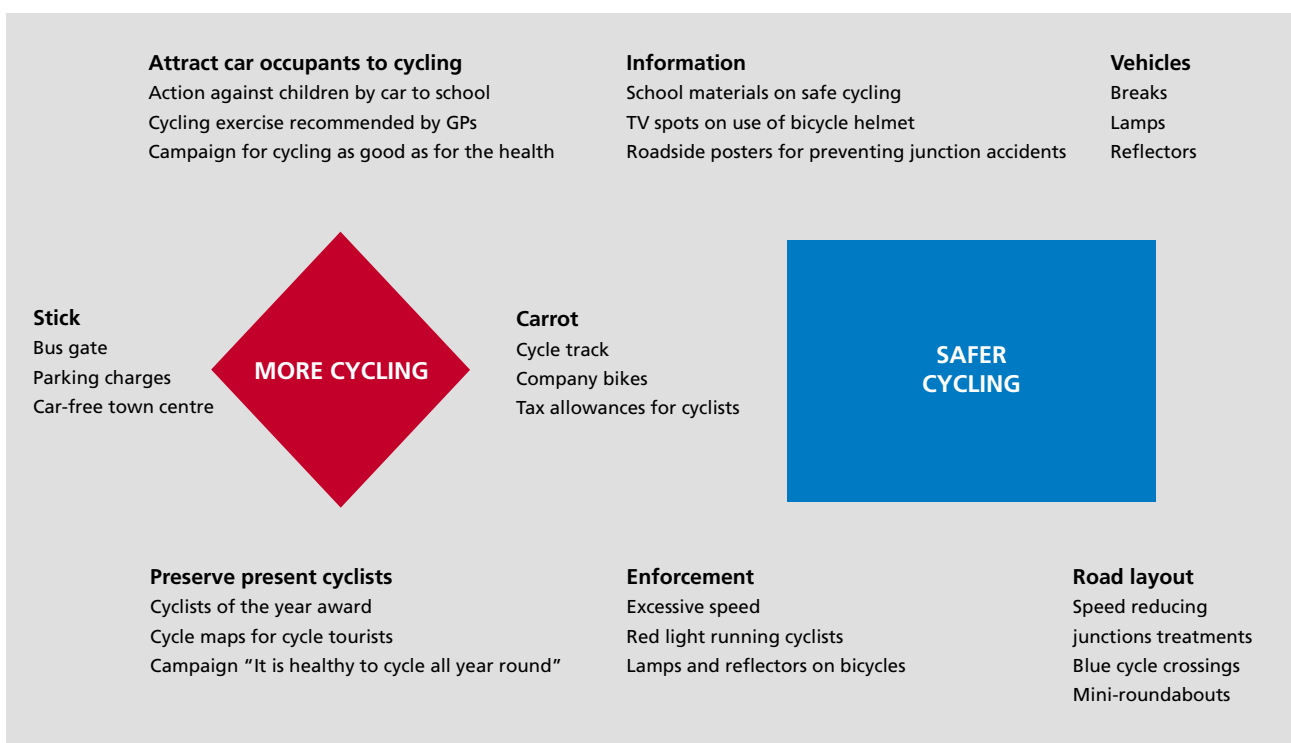


PHOTO: Linda Hansen



Bicycles are carelessly parked at the supermarket.

PHOTO: Lars Bahl



Safe routes to school is a fine measure.

passengers in the larger towns. If motorists' conditions at same time are improved, the result is more cars and the same number of cyclists. In the long term focusing exclusively on physical improvements for cyclists will be subject to pressure on the grounds that this leads to too few traffic changes in relation to the investment.

The optimal strategy combines campaigns with physical improvements for cyclists and restrictions on car use. This will lead to many

people changing from car to bicycle. At the same time it is possible to put together measures that link short-term and long-term projects, which may be both time-demanding and costly in terms of construction. The strategy can be devised so that the number of bus and train passengers increases or remains at the previous level.

Physical and economic instruments can be divided into *Sticks* and *Carrots*. In order to increase the effect of the carrots it is important to

inform the public, eg by distributing leaflets about new cycle tracks.

It is easier to get present passengers in public transport to ride more by bus or train than it is to attract new passengers. The market for more bus and train passengers is to be found among those who travel by public transport at least once a month¹²⁸. This market mechanism is probably the same regarding cycling. So the task is to promote cycling among those who cycle sometimes or once in a while.

Have an ice cream and participate in the campaign "We cycle to work".



PHOTO: Nils Mogensen

Greater road safety can be achieved in a number of ways. At places with many bicycle accidents, “black bicycle spots”, better road layout can help to prevent accidents. However, accidents occur rather scattered, though they chiefly occur on main roads. Enforcement and campaigns aimed at specific forms of hazardous behaviour, such as cycling in the dark without lamps, can help to improve cyclist safety.

Accident prevention must be seen in relation to the results from the problem identification phase – and also in the context of other accidents than bicycle accidents. If cyclists are to obtain the same safety benefit

as other road users, it is not sufficient to enforce and reduce speed limits, as cyclists benefit far less from this measure than other road users⁵⁴.

More and safer cyclists are two tasks that can be integrated. There are not many single measures that promote bicycle traffic, inhibit car use and at the same time improve road safety. The achievement of more bicycle traffic and better safety requires a large number of measures to be combined in a holistic approach.

Measures

Many types of measures are needed to improve road safety. Besides the measures shown on page 25 it can be a good idea to concentrate motor traffic on fewer roads and thus reduce the number of conflicts between motorists and cyclists, and then introduce safe road layout at the spots where many conflicts still occur. Teaching children safe cycling is an important measure.

Many single accidents among cyclists are primarily due to momentary inattention and a subsequent loss of control over the bicycle. This may be difficult to change without inhibiting the cyclist's

Choose the right measures – do plenty shopping – many measures.



Examples of measures

PLANNING FOR CYCLISTS

- Direct cycle routes
- Coherent cycle networks
- Revival of local communities through bicycle use
- Cycle audits of local, municipal and regional plans
- Cycle action plans
- Bathing and changing facilities at workplaces
- Green transport plans for workplaces and schools
- More and smaller shops, schools and leisure centres
- Fewer access barriers
- Contra-flow cycling permitted in one-way streets

BICYCLE SCHEMES

- City bikes
- Company bikes
- Employee bikes
- Commuter bikes
- Hotel bikes
- Beach and harbour bikes
- Bicycle hire schemes
- Cycle trailer and basket deposit schemes in shops
- Bicycle couriers
- VIP service for commuter cyclists

INFORMATION, CAMPAIGNS AND EVENTS

- Campaigns for increased use of bicycle helmets
- Enforce requirements of reflectors, lamps and brakes
- Promotion of new cycle routes
- Arranged cycle tours - with gimmicks
- Cyclist of the year awards
- Cycle to work campaigns
- Influencing attitudes and intentions
- Teaching the health benefits from cycling
- Teaching the effect of cars on urban environments
- Mobility centres with cyclist information
- Campaigns against drunk cycling
- GPs recommendations of cycling
- Workplace visits from the Heart Foundation
- Campaigns to promote the slimming effects of cycling
- Children to motivate parents
- Bicycle escorts of school pupils
- Bicycle days
- Bike-to-the-baker's campaigns

OTHER SCHEMES

- Car-sharing
- Bicycle delivery services
- Loan of bicycle lamps, rain clothes etc

SAFER ROAD LAYOUT

- Traffic calming of major roads
- Area-wide traffic calming
- Fewer fixed roadside objects
- Bridges and tunnels at major barriers
- Cycle crossings
- Staggered stop lines
- Advanced stop lines
- Pre-green for cyclists
- Stop signs
- Speed reducing junction treatments
- Humps
- Mini-roundabouts
- Roundabouts
- Cycle tracks on rural roads

RESTRICTIONS ON CAR USE

- Removal of car parking spaces
- Road closures
- Stopping and parking prohibitions for cars
- More and larger areas with parking charges
- Reduction of local speed limits
- One-way streets

INTERMODALITY

- Bikes-on-trains/buses schemes

ROAD SAFETY

- Black spot treatments
- Road safety audits
- Integrated safety management

BETTER ROAD MAINTENANCE

- Smoother road and path surfaces
- Better sweeping, weed control and winter maintenance

BETTER BICYCLE PARKING

- Bicycle parking funds
- More bicycle racks, some covered, some locked
- Cycle centres with service at major stations
- Temporary bicycle parking, possibly with surveillance

COMPETENCE DEVELOPMENT

- Cycle co-ordinator
- Networks, seminars and conferences
- Systematised information for specialists
- Research & Development
- Further training and education
- Demonstration projects

ECONOMIC SUPPORT

- Tax deductions for cyclists



PHOTO: Linda Hansen

Parking charges is a possible measure.

enjoyment from physical activity and without reducing the attention paid to other road users.

In order to increase the number of cyclists it is continually necessary to introduce new measures. Economic growth lead to more and

more cars and traffic growth. To counteract this development it is continually necessary to introduce new measures every year.

At present there are many indications that campaigns, bicycle schemes and restrictions on car use produce the greatest impact on mode choice for the money spent. But to achieve a large total effect it is necessary to apply a wide range of measures ¹²⁹.

This *Collection of Cycle Concepts* reviews a number of measures relating, and discusses their areas of use and effects. Inspiration with regard to the promotion of more and safer cycling can also be found in a number of other publications.

Priorities

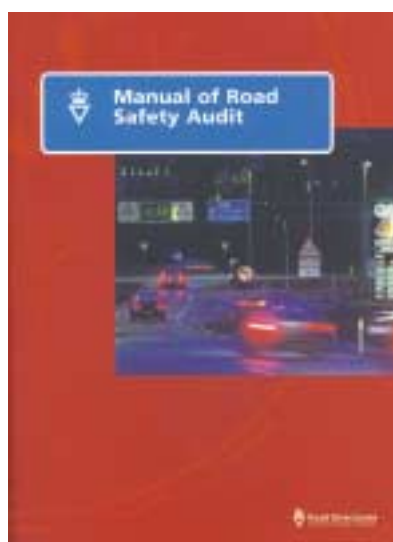
A description should be given of each individual measure that fits into the local strategy. It is a good idea to formulate alternatives with different effects and costs. Try to assess each measure in terms of modal transfer and safety effects. How many new cycle trips will the measure bring about? And how many bicycle accidents will it prevent?

It is difficult to measure effects on modal transfer – directly. A step-by-step assessment can be achieved by answering the following questions: How many road users will be affected by the proposed measure? What will the measure mean for the road user in terms of comfort, enjoyment, perceived risk, image etc? What percentage of road users can be expected to change their behaviour?

Fictitious example: A 4 week cycle-to-school competition among children. Number of children in the school: 400, 20% of whom are driven to school. This corresponds to 80 pupils or 32,000 car trips per year. Expected effect: 50% of the parents do not drive their children to school in the first 4 weeks and 20% leave the car in the garage for 6 months, corresponding to 4,000 trips being transferred from car to bicycle.

In order to draw up a budget it is necessary to estimate costs. This provides the opportunity to compare costs and effects.

It is important to review the proposed measures to identify events, key issues and possibilities of attracting attention from the outside



world to the local area and its politicians. Here are some possible priorities that can help to obtain and retain the interest:

- Projects that improve conditions at the most problematic spots first.
- Projects that produce greatest effect for the least money.
- Solid successes that are important for the public's feeling that it is worth it.
- Distribute the carrots equally, so most people benefit from the measures.

Deciding between road safety and modal transfer is a political matter. There are so many considerations to be taken into account – public health, air pollution, noise, freedom etc. A possible way forward is to ask citizens for their priorities.

Finance

The municipality, county or state normally pays the entire expense in connection with the promotion of more and safer cycling. Other forms of financing do occur, but only to a modest extent.

Danes think that the five following measures are most likely to get them to use bicycles:

1. Better maintenance of traffic areas for cyclists
2. Campaigns
3. More cycle tracks and paths
4. Safe road layouts for cyclists
5. Restrictions on car use ⁶³

Cycle routes may be entirely or partially financed in connection with major rehabilitation of pavements and mains and cables. By drawing attention to the tourism aspect it may be possible to get co-financing from various funds, large hotels and the like.

Companies sometime show interest for road safety and traffic management projects. However, it is not known to which extent companies are willing to co-finance these projects.

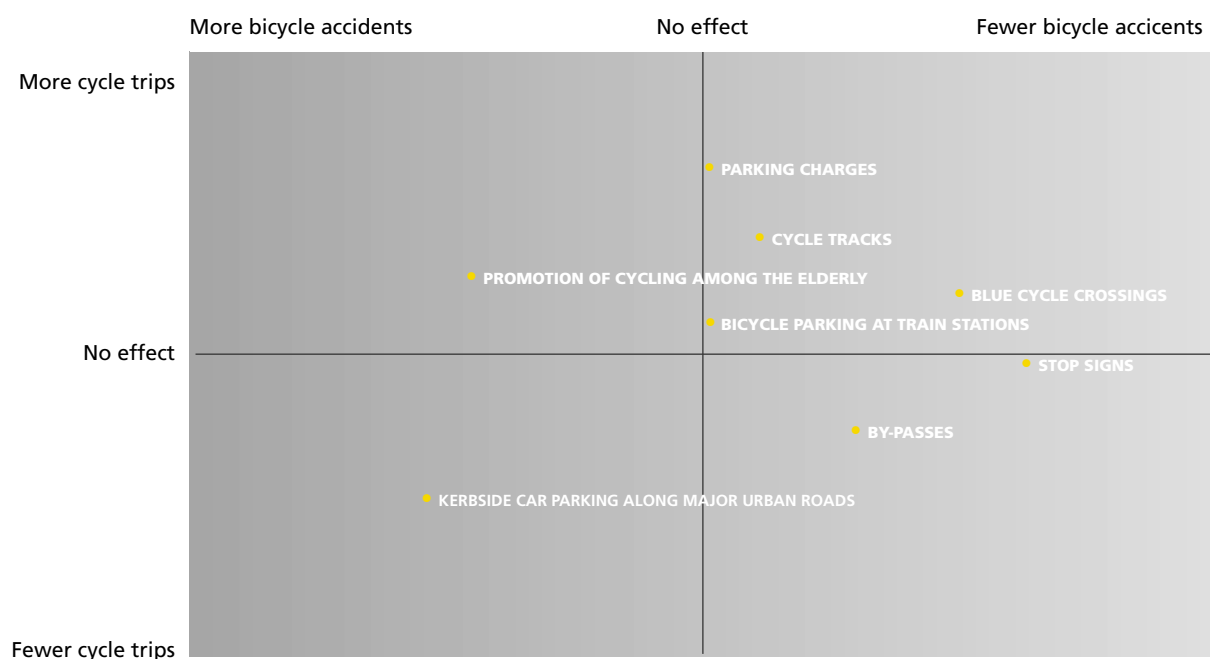
Advertising-financed city bikes have already been introduced in cer-

PHOTO: Municipality of Copenhagen



The city bike – a different gift for president Bill Clinton and the people.

A factitious local assessment of various measures





Traffic calming can increase house prices.



Good opportunity to improve physical conditions for cyclists.

tain cities. Other types of measures are also to a certain extent financed by advertising, eg events and campaigns.

Traffic calming on residential streets is often exclusively an advantage for the residents. It is they who benefit from improved road safety, and their houses that increase in value. There are many examples of residential associations etc, paying for traffic calming on public roads.

User payment for bicycle parking can to a certain extent finance part or all of the expenses in connection with a bicycle parking facility. There are numerous examples of private paths and bicycle parking facilities. Sometimes chambers of commerce are willing to contribute to the financing of physical improvements to shopping streets. Campaigns for more cycling can to a large extent be financed in co-operation with other bodies, for example, organisations in the health sector. It is a good idea to create partnerships, as otherwise it may be too expensive to get the message across.



A working day for the cycle co-ordinator.

Realisation

It is important to secure backing from important parties. Make sure to consider everyone. A cycle co-ordinator can ensure a good process.

Things develop quickly in society, and the plan and process must be adjusted, so that targets can be achieved. A plan is important to form basis and overview, but the budget and time schedule should

leave room for new measures to be initiated and other measures to be given higher or lower priority.

A certain issue may suddenly be taken up by the media, eg children's motor skills – seize the opportunity and create some new cycle trips for children. Or petrol prices go up – use this opportunity to make people consider their travel and requirements for cars – see new perspectives.



Communication and campaigns

Communication is an important tool for promotion of cycling and road safety. Effective co-operation among the actors involved is necessary to produce desired behavioural changes. After discussing such subjects as communication strategies and campaigns for more cycling the chapter ends with a section on campaigns for improved road safety.



Contents

Necessary knowledge about communication	30
Communication strategies	30
Campaigns for more cycling	35
Campaigns for improved road safety	39

Necessary knowledge about communication

Travel behaviour is not solely the product of rational processes. Up-bringing, feelings and habits play a considerable role. But upbringing, habits and feelings can be influenced, and when applied appropriately, be used to change travel behaviour.

Campaigns can be used to advantage by municipal administrations, NGOs, commercial enterprises, associations etc. As the message or the angle of a campaign will vary depending on whether it focuses on, for example, traffic, environmental, health, road safety or educational conditions, a wide range of administrations and organisations may be interested in participating in or initiating a campaign. Experience has shown that collaboration and co-financing are often necessary in order to achieve significant results.

Campaigns in this context should be broadly understood to comprise TV

Two Danish ministers Svend Auken and Thorkild Simonsen on bicycles.



PHOTO: Danish Cyclists Federation



PHOTO: Birgitte Høj Nielsen

Abilities on bicycle are tested during the Cyclist Trial.



Good ideas about road safety campaigns are presented in this book.

spots, contributions to the public debate, events, roadside posters, police enforcement etc.

The purpose of this chapter is to present the basic knowledge about communication and campaigns, and about perceptions and the stages of behavioural changes.

Communication strategies

Much has been written about effective communication and campaigning. For an overview of communication strategies for the promotion

of cycling reference can be made to the EU project INPHORMM¹¹⁰, while for road safety campaigns we recommend the guidelines published by the Danish Road Safety Council "Kør kampagnen sikkert hjem"[Drive Your Campaign Home Safely]¹⁴.

A communication strategy must explain who says what to whom, when and using what medium. The most effective approach is to direct the communication at interested groups and persons who intent to change their behaviour.

Broadly speaking, there are three kinds of campaign: Campaigns to raise public awareness, campaigns to targeted groups and settings, and campaigns to individuals and households. Campaigns to targeted groups, individuals etc, are more effective when public awareness campaigns have been carried out locally or nationally, because the

The Danish channel TV2's revenue from advertising in the category "land-based" transport in 1997¹¹¹:

Motorised transport	DKK 82,454,920
Public transport (train)	DKK 17,010,003
Bicycle traffic	DKK 3,677,171

public will then be more receptive to attempts at influencing attitudes and behaviour.

It is essential to know what stage the general public has reached in the process of behavioural change, as otherwise money will be wasted on campaigns that miss their target. The basic goal of communication strategies is to influence the public just sufficiently to tip the balance in the direction of modal transfer and safer behaviour – at minimum expense. Once the balance has been tipped, it is important to maintain the change of behaviour.

Public awareness campaigns

To carry out a successful awareness campaign it is necessary to have a basic knowledge concerning people's attitudes to and acceptance of eg restrictions on car use and promotion of cycling and improved road safety in order to be able to define messages of the campaign. Attitudes vary from the major cities to rural districts and from city centres to the suburbs. If there is a larger potential among some groups than others, it is important to identify target groups both with respect to the choice of message and media and also for later use in more targeted campaigns at, for instance, selected companies or households.

Awareness campaigns reach the widest public by using a number of media at the same time and spontaneously making use of other related events that have received broad media coverage as an inexpensive way of disseminating the message. Events, gimmicks, "surveys", other campaigns and new infrastructure can all help to draw attention to the message. Since most people react positively to the message of more and safer cycling, it is possible to make extensive use of the mass media.

The primary goal is to create awareness of problems and solutions, acceptance of the need for change and to change attitudes to the bicycle, the car and road safety. Awareness campaigns alone rarely change people's behaviour, but can help to keep cyclists cycling and reinforce safe behaviour.

Experience has shown that it can easily take three years to get people to accept a new message and, as a consequence, acknowledge that there is a need for change.

Credibility is important. There is nothing to be gained from referring cyclists to unsafe roads or combat-

An example of a communication strategy for more cycling¹¹⁰.





Hvor sætter du smertegrænsen?

Danish Road Safety Council's campaign "Lower Your Top Speed" [What is your pain tolerance?]

ing bad habits that may be irritating but are not dangerous. Both the problems and solutions must be clearly presented, but keep an eye open for topics that the media are already dealing with.

Campaigns to targeted groups and settings

These campaigns aim at demonstrating how citizens can promote more and safer cycling in practice. The settings could be eg schools, universities, companies, medical

clinics, shopping streets and centres, sports clubs etc. It is the solidarity and social norms at these settings, which can change the behaviour of the individual.

In order to start the campaign, the school, sport club etc, must agree to participate. A credible persuasion strategy is essential. Appropriate messages in this part of the process could be: Fewer cars at schools mean safer roads, an accident is a tragedy and cost, more cycling

gives fewer days lost through illness and better mental health, fewer parking spaces for cars can save money, more cycling and improved road safety can create a green and caring image.

Seen from the outside it is important to find one or several persons at the setting who are willing and have time to partly carry out the campaign. The person chosen does not have to be a director or school principal, but may be a cyclist or safety steward.



PHOTO: Danish Cyclists Federation

The chosen persons should be informed and motivated to such a degree that the process of promoting more and safer cycling becomes self-supporting or, even better, becomes self-reinforcing in the group or setting in question. It is important that the chosen persons can root the campaign at the setting and maintain behavioural changes.

The campaign is about promotion of cycling and greater road safety among pupils, employees etc. A way to start is to mention the cam-

The bicycle lift, Trampe, has set focus on Trondheim and the promotion of cycling.

paign in the house organ, the local newspaper and the like. Right after this measures have to be implemented.

Rewards are often a catalyst for behavioural changes, and could be a possible measure. Rewards could in this case be, eg company bikes, bicycle lamps or helmets. Rewards can also be used to maintain good behaviour, eg awards for the cyclist of the month at the company or the safest schoolchild of the year etc.

Other measures could be: Competitions, improvement of physical conditions for cyclists, claim for bicycle equipment, claim for bicycle helmets and claim for safe driving in company cars.

A good idea is to define goals for changes in the particular setting. These should be short-term goals, eg over a period of a year, so that the project does not run out of steam.

Schools are an obvious target for promotion of more and safer cycling. The subject can be naturally integrated in teaching on traffic, the environment or social conditions. It can be carried out locally through contact between the municipality and schools by, for example, staff responsible for Agenda ²¹. This can lead both to an increased awareness among schoolchildren and also to the influencing of parents “from below”.

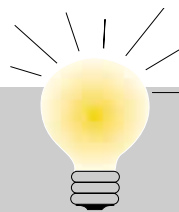
At two schools in Belgium parent and teacher escorts for cycling school pupils has led to a 12% increase in the number of children who cycle ²⁶.

Individualised campaigns

The motivation parameters in personal approaches concerning the promotion of more and safer



The campaign “Nakskov cycle to work”.



Initiatives for GPs

- Leaflet in waiting-room on physical activity and health
- Recommendations when talking with patients concerning physical activity, eg daily cycle trips
- Leaflet in waiting-room on physical and mental state and road safety
- Recommendations to patients of safety precautions when cycling
- Leaflet in waiting-room about local activities for the promotion of more and safer cycling
- Visits to schools and commercial enterprises with health checks and the like

Dutch experience from travel plans for companies has shown that 0-8% of all employees can become new cyclists ¹⁰⁴.

cycling are primarily a matter of individual benefits, such as financial savings, health, reduced risk, enjoyment etc. Even minor changes in travel behaviour of individuals make a difference to the overall picture. Mode choice for certain trips can easily be changed – just as it is easy for motorists to drive more slowly. It is often necessary for individualised campaigns to be supported by a prior public awareness campaign.

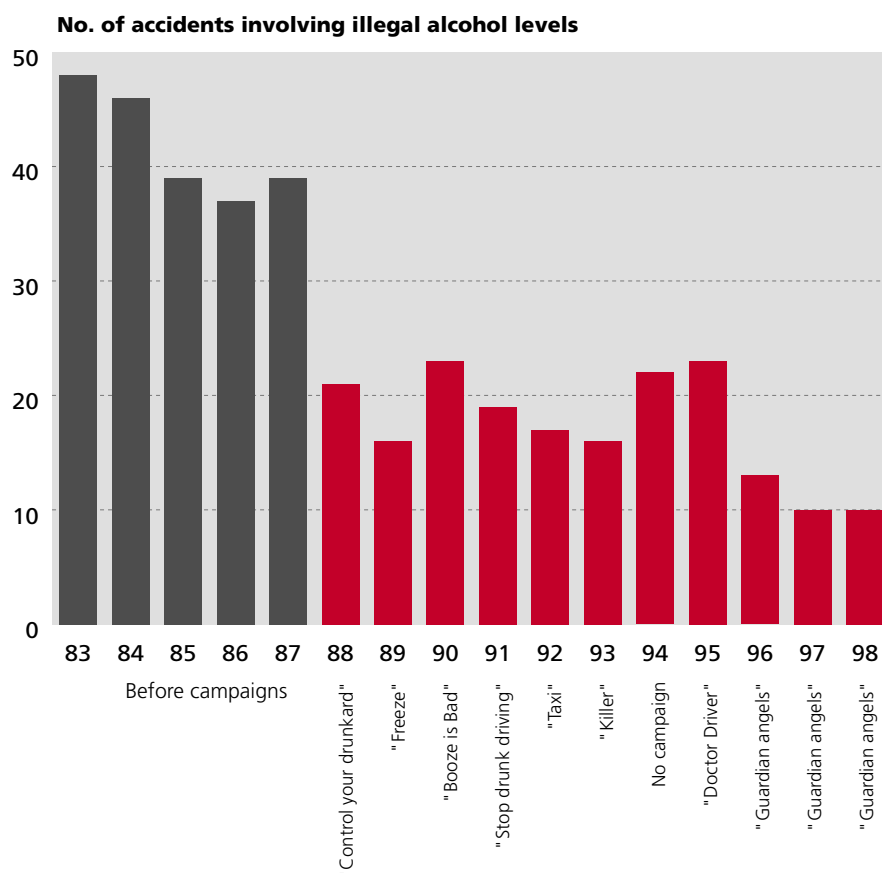
The goal is to increase awareness of cycling and road safety among selected persons and households

and to change erroneous perceptions of cycling. It is especially effective to inform and influence persons who has moved, changed job/school and now has a new cycle network and other local services, eg shops, institutions and leisure activities. Such persons are easy to access. A cycle map can contain information on individual benefits. The personal approach has proved effective for road safety, eg in combating drunk driving. Bicycle accessories and helmets can also be improved/disseminated through personal contact. Recurrent violators of the Road Traffic Act are an obvious but unfortunately rarely used target group for approaches from Road Safety Councils, the police and road administrations. Finally, house owner and residents associations can be used to identify particularly careless cyclists and motorists.

Telephone calls, letters, newspaper ads and brochures are ways of recruiting individuals and families who are motivated to change their travel behaviour. Travel diaries are a good instrument to this end, since they make it simple to identify trips, which easily can be made by bicycle, and to follow individual transport patterns. Personal contact with specialist guidance is particularly productive. Here experience has shown that a monthly follow-up for 3-6 months changes individual travel behaviour and consolidates this change.

Local features in nation-wide campaigns

It is a general rule that the more uniform the target group, the more effective communication will be. The effect for the individual is larger as the target group becomes



Individualised campaigns more than halved the no. of accidents involving illegal alcohol levels.





In its BikeBus'ers project the Municipality of Århus induced habitual motorists to cycle or take the bus between home and work and to keep travel diaries on their transport patterns – with free bicycles, season tickets for the bus, rain clothes etc. The offer was made through the local press and in brochures for motorists. Almost 10 times as many people applied as the 175 who participated in the project. The travel diaries showed that the project increased the bicycle share of all trips by a factor of almost six in the summer and a factor of three in the winter. Car trips were more than halved. The changed travel patterns were maintained after the end of the project ¹²⁴.

smaller ¹²⁸. On the other hand, it is of course true that the narrower the group, the fewer the people who will be influenced.

A good idea is to introduce a local delimitation into a national or regional campaign. As an inhabitant of Copenhagen one will feel that “Copenhagen cycles to work” is a more relevant message than a nation-wide “We cycle to work”, even though there is no other local content than the changed name of the campaign. This also applies to road safety campaigns.

Links between hard and soft policies

The majority of people will not change their travel behaviour solely on the basis of campaigns. It is

therefore an advantage to co-ordinate campaigns with better physical conditions for cyclists, restrictions on car use, safer road layout and police enforcement. A co-ordinated programme has the greatest chance of success.

On the one hand, it is extremely important that there should be broad support for and an understanding of changes in or the introduction of new infrastructure or charges. On the other hand, the effects of hard policies are greater when they are served together with soft messages.

Campaigns for more cycling

The goal for cycle promotion campaigns may be to transfer short car trips into cycle trips, but it may also

be to do the same with longer car trips. There is a tendency for people to make long trips in order to shop if they are travelling by car. With a little thought the shopping can be done by bicycle if one chooses local shops.

The majority of the population would like to see fewer cars on roads and streets. Citizens are highly aware of the problems caused by traffic growth and have partially accepted that something needs to be done, eg by treating cyclists better than motorists ¹³¹. It is therefore a question of influencing the general public's view of cycling as a possible substitute for the car and at the same time showing that more bicycle traffic benefits both the individual and society.



PHOTO: Linda Hansen



PHOTO: Linda Hansen

situation. In some circles and contexts it would be seen as quite inappropriate to cycle, in others it would be inadvisable not to do so.

It is people's perceptions of the conditions and not the actual conditions that determine their mode choice. For this reason campaigns in connection with new bicycle facilities can have a strong effect. People do not change their perceptions of infrastructure if they do not see or hear about or try out new or reconstructed facilities.

One example of this is a cycle route in Lund, Sweden. After it had been completed many people continued to use other routes. Only after an awareness campaign was there a significant increase in the number of cyclists using the route⁷⁰.

People who rarely or never cycle tend to judge a cycle trip as not so comfortable or safe than it is. Similarly new cyclists are surprised by how quick bicycles are, how much one can transport on a bicycle and how good the weather is⁹³.

It is widely recognised that cycling gives exercise and health. But many



PHOTO: Linda Hansen



PHOTO: Lars Bahl

Mode choice is influenced by perceptions

The volume of bicycle traffic is not solely determined by the physical conditions for cyclists, topography, public transport supply and economic factors. Other components enter into the individual's mode choice such factors as weather, attitudes to health and physical activity, the need to transport things or people, clothing and other people's expectations of one's mode choice.

Norms and expectations vary from person to person and situation to



PHOTO: Linda Hansen



PHOTO: Polfoto/Patrick Kovarik

Doping in cycle races – what does that mean?

people tend to assess air pollution and road safety as bigger problems for cyclists than other road users. Many people are therefore not aware that cycling increases one's mean life expectancy. With respect to air pollution it has been documented that, contrary to the general belief, motorists are exposed to 3-4 times higher concentrations of particles, benzene, toluene etc, than cyclists^{34, 59}.

Many people, especially women, are astonished when the Danish Heart Foundation tells them that they are in poor form¹²⁴. Experience show that women are more susceptible to influence through campaigns than men. Only one in four adult Dane gets the recommended amount of exercise²⁷. An increasing proportion of children has poor motor skills as a consequence of insufficient physical activity.

Examples of campaigns

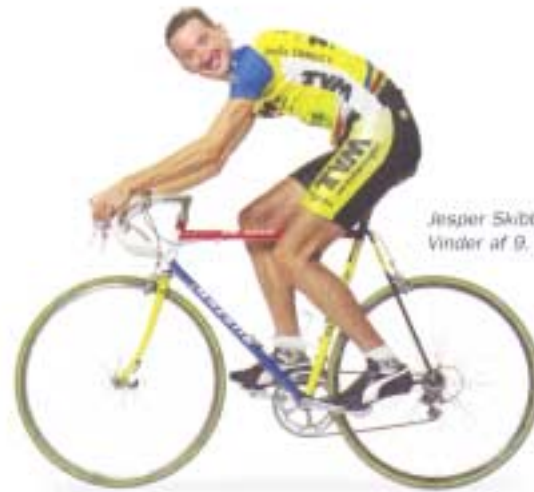
Over a number of years the Municipality of Copenhagen has arranged various activities aimed at getting more people to cycle: Large posters

with the message "Det er sundt at cykle året rundt" [It's healthy to cycle all year round], distribution of company bikes to interested enterprises, distribution of breakfast and information in the morning peak hour, the "Vi cykler til arbejde" [We Cycle to Work] campaign with prizes for participants.

Copenhagen's introduction of city bikes in 1995 gave colossal publicity and a large advertising effect for the enterprises that have had their

logo on bikes and stands. The effect on mode choice has been modest, but the city bikes have made Copenhagen known to the outside world as the city of bicycles.

In 1995 the Holstebro section of the Danish Cyclists Federation carried out the campaign "Kom en puter på cyklen" [Com a Puter On Your Bike], which has given rise to other similar projects. Participants in the campaign were inspired by a health festival and rewarded with a bicycle



Jesper Skibby
Vinder af 9. etape, Spanien Rundt.

Det er hårdt at cykle Spanien rundt.



Og sundt at cykle året rundt.

PHOTO: Municipality of Copenhagen

STYR PÅ CYKLEN og sundheden



COMPUTER
PÅ CYKLEN

Vær med i Dansk Cyklist Forbunds
konkurrence i august.
Tilmelding på biblioteket.

computer if they managed to cycle 250 km in the month of August. 864 people took part and 825 achieved the necessary number of kilometres and could get their deposit back. Participants cycled over 300,000 km, and there was considerable media coverage.

The annual nation-wide “We cycle to work” campaign is arranged by the Danish Cyclists Federation in collaboration with the Danish Federation of Company Sport and local authorities. Participants must enter in teams of at least four people and report on their travel patterns on special forms. In return they can win prizes in nation-wide and local competitions by cycling to and from work over a 3-week period. There is considerable media coverage. One cyclist in 10 has not cycled prior to the campaign and 75% state that they cycle more in the campaign period than usual.

A spin-off effect of successful campaigns for the promotion of cycling may be an increased interest in conditions for cyclists. Experience has shown that when such campaigns are arranged, there is a rise in the number of approaches from the public concerning travel behaviour and physical conditions. A follow-up on improving the conditions that are pointed out will strengthen the credibility of the campaign.

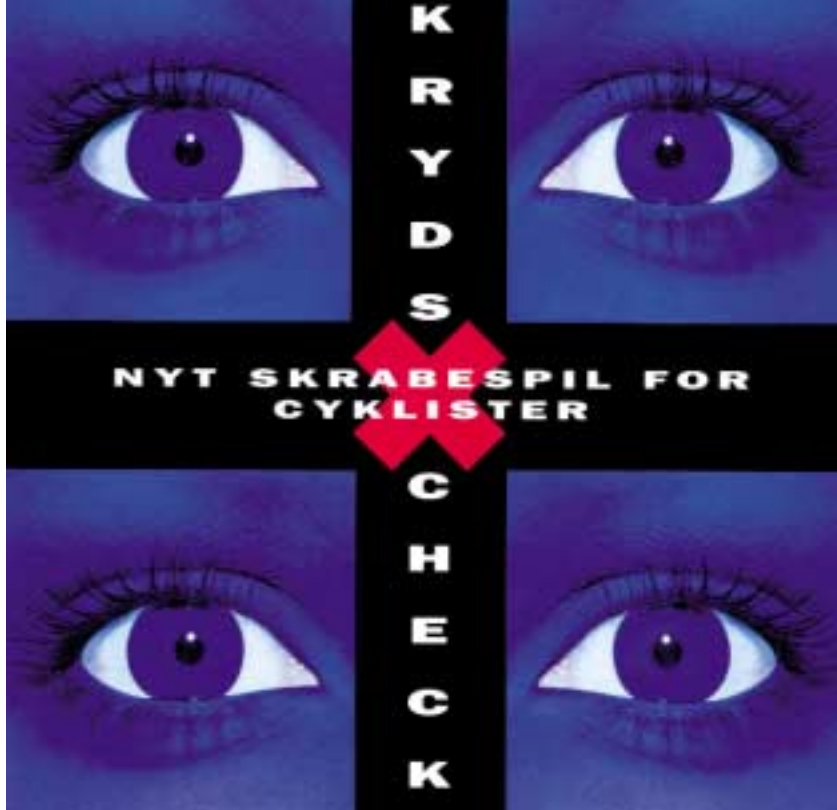
Campaigns for improved road safety

Many people see a conflict between promoting cycling and improving road safety. The conflict derives from the fact that the risk when cycling one kilometre is considerably higher than the corresponding risk when covering the same distance by car, bus or train. However, there is much to indicate that in

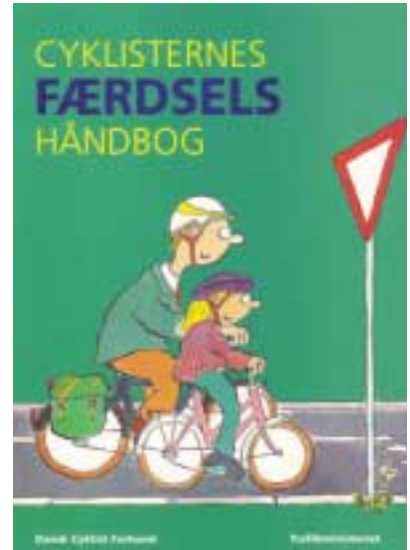
Mounting of a bicycle computer.



PHOTO: Tove Jørgensen



"CrossCrossroadsCarefully".



The cyclists' instruction book.

practice this conflict is without importance. Thus, Danish children are the safest road users of all groups despite the fact that they cycle more than any other age group. Cyclist safety is best in towns where people cycle most. In other words, more cycling and safer cycling can be achieved at the same time, and this has already been exemplified a number of times ^{52, 130}.

While nearly all cycle promotion campaigns are of recent date, there is a long tradition of road safety campaigns. These have been both nation-wide campaigns, which have been given a certain degree of local colouring, and also purely local campaigns.

In road safety campaigns it is important to make it clear what kinds of behaviour are to be changed and how. This is simple in the case of car speeds, but rather more difficult when it is a matter of cyclist behaviour at junctions.

In contrast to mode choice, road safety is subject to legislation, which can be followed up with firm enforcement and penalties. A combination of information and

enforcement has proved to be effective. A good example of this is drunk driving. Here many years of combining enforcement with campaigns has led to a situation in which not only do far fewer people drive when drunk, but also to a situation in which it is no longer socially acceptable to do so.

Experience, consideration and an understanding of other road users'

Leaflet about reflectors..



Urban planning

The planning of our towns helps to create the framework provided for traffic. However, urban planning will have little effect on the volume of bicycle traffic unless the conditions for bicycle traffic are at the same time significantly improved.

Furthermore, changes in land use and settlement patterns are slow. Nevertheless urban planning can have an immediate and large transport impacts when major traffic generating functions are to be located, and thereby influence accessibility and conditions for cyclists.

PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen

Contents

Public management and planning	42
Population, density and the shape of towns	42
Location of workplaces	44
Location of shops	45



PHOTO: Linda Hansen

Building site on the outskirts of the town.

Outside the metropolitan area it is up to the individual municipality to determine development and urban renewal within existing town boundaries except for retail outlets and firms that have special requirements with respect to location.

Population, density and the shape of towns

The topography has a great influence on the volume of bicycle traffic. If the town is flat, a lot of people cycle, while in a hilly terrain there is not much cycling⁵³. In fact, topography can explain more than two thirds of the differences in bicycle use in Danish towns (further details on page 96). On the other hand, the size, density and shape of the town have only a limited effect on the volume of bicycle traffic in larger towns.

Results from modelling using data from travel surveys of larger Danish towns with more than 10,000 inhabitants show that cyclists constituted a little over 20% of all traffic irrespective of the size of the town. For larger Danish towns there is no rela-

Public management and planning

Urban sprawl has contributed to increasing distances between homes and destinations, and this has led to a more use of cars. The Danish government has defined a number of overall targets for physical planning in Denmark with the aim to reduce energy consumption by transport and the pollution it causes, while at the same time retaining a wide range of retail outlets⁷⁵. The main aim is that new housing can only be placed within existing urban areas and zones designated for urban development, while industrial and commercial building only can be erected in regional and municipal centres.

In the metropolitan area of Copenhagen housing quotas lay down binding guidelines for urban development in the individual municipalities and for the placing of urban functions of regional significance. The objective is that both housing and industrial/commercial developments should be concentrated in

areas with easy access to public transport. Despite this, urban development in the metropolitan area has hitherto tended to take place in areas less advantageously located in relation to public transport⁶.

Studies have shown that more will cycle if a town has more than 10,000 inhabitants, is densely populated and circular shaped, has no hills, and has most workplaces in the town centre⁵⁶.

PHOTO: Linda Hansen



New housing close to stations result in more train passengers.



PHOTO: Erik Nielsen



A village has only few urban functions, so villagers often have to shop, work etc in other towns.

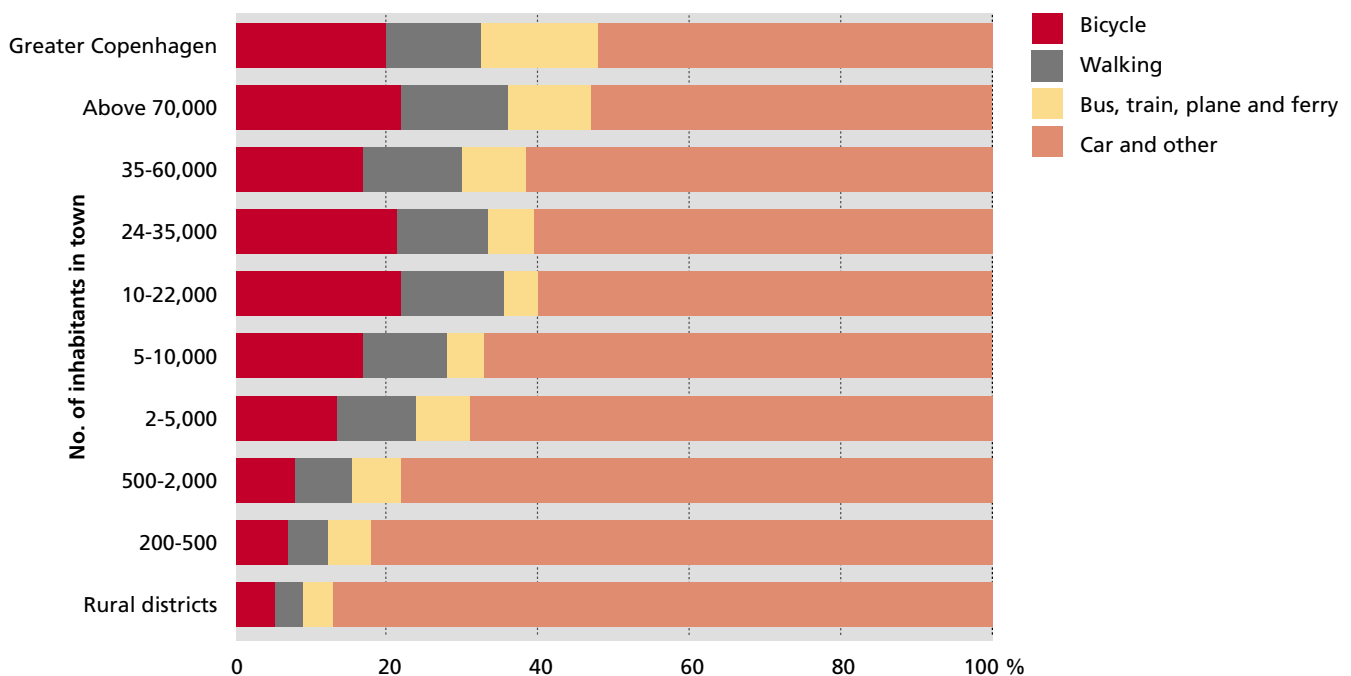
relationship between population and the share of trips made by bicycle ⁵⁶. However, a larger and larger share chooses public transport with increasing population, while the share of car trips falls. For towns with less than 10,000 inhabitants the share of bicycle traffic increases with population, as an increasing number of destinations will be situated within the town and therefore within a reasonable distance.

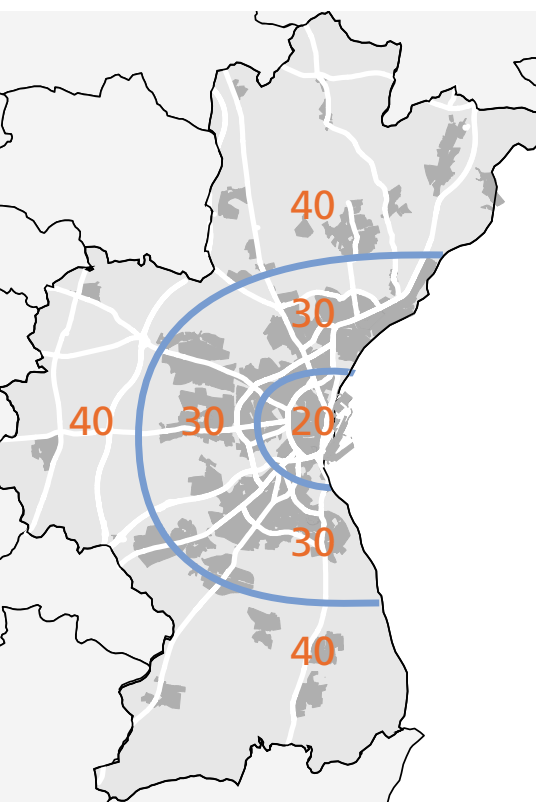
The share of bicycle use in larger towns varies according to the distance between home and town centre. The closer to the town centre people live, the more they tend to cycle ^{41, 56}.

A more dense land use produces shorter distances between homes, workplaces, shops etc. At the same time higher population density means an increase in the customer

basis for local services, thereby reducing the need for longer trips. The higher the population density, the more people choose public transport and the fewer choose to go by car. On the other hand, when the number of inhabitants per hectare rises from 10 to 25, there is little effect on the volume of bicycle traffic, which has been shown in model predictions to rise by only 20% ⁵⁶.

Mode choice in Danish towns 1993-97 ¹⁵





Residents transport in Århus depends on the location of the home⁴¹. Numbers is no. of travelled kilometres per person per day.

An urban structure, in which a large share of housing is concentrated in narrow ribbons along public transport routes, will result in short walking distances to and consequently a high standard of public transport.

The amenity value of locations near sea or lake also contribute to the creation of ribbon developments in Denmark. However, trip lengths are considerable in ribbon towns and this means a high degree of dependence on motorised transport. Such towns will therefore have fewer cyclists than towns with a more compact shape.

Location of workplaces

Other things being equal, a balance between the number of people in employment and the number of workplaces will mean least commuting. According to experience in England, however, this does not have much effect on passenger kilo-

metres and mode choice. The placing of people's homes has a stronger effect on passenger kilometres than where the workplaces are situated¹³².

Studies of commute made by office workers in the metropolitan area of Copenhagen show that the percentage of walking and cycling employees increases with the percentage of employees live close to their work^{42, 47, 80}. Employees in public service live closer to their work than employees in the private sector. More residents in the city centre live close to their work than in the suburbs.

Enterprises situated in town centres have more cycling employees than enterprises on the outskirts. On the other hand, placing in relation to public transport terminals has no effect on the number of cyclists.

In the Netherlands the government has drawn up guidelines for the sit-

Almost twice as large a share cycles to office in the city centre as at the office 5 km from the city centre.



PHOTO: Road Directorate



PHOTO: Road Directorate

ing of enterprises and the extent of car parking provision on the basis of environmental considerations. The aim is to co-ordinate the transport requirements of enterprises with the accessibility of the transport system in order to achieve the optimal environmental effect ⁷⁷. All existing and future enterprises are categorised according to how accessible they are by public transport and car. Three categories of location have been defined:

- A. Locations with high-standard public transport and low accessibility by car, permitting a maximum of 1 parking space per 10 employees.
- B. Locations with high accessibility both by public transport and by car, permitting a maximum of 1 parking space per 5 employees.
- C. Locations with high accessibility only by car with unlimited parking spaces.

In existing commercial and industrial areas a voluntary co-operation between enterprises and public authorities seeks to limit parking opportunities. Companies with many employees per square meter or many visitors per square meter and with little dependence on goods transport are placed in category A, while category C is reserved for industry and distribution and is not allowed to contain office workplaces and retail trade.

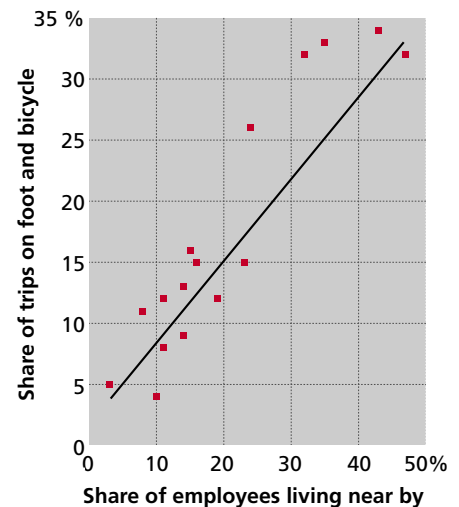
This policy has been applied in, for instance, Amsterdam, where attempts are also being made to improve conditions for cyclists. As early as in the general plan from 1935 the aim was that it should be possible to cycle from home to work in less than 30 minutes. For this reason the city has for many

years been developing a system of cycle routes, which has in a number of instances resulted in curtailments in the capacity of the road system ⁷⁸. Car traffic is expected to grow by 70% if there is no public intervention, but the location policy and the maximum parking norms will reduce this by 23% ⁴⁰.

Location of shops

Fewer cycles to shops than for other purposes, as shopping is usually a matter of many, very short trips that Danes often make on foot. But at the same time many people often choose not to cycle on shopping trips of the same length as other cycle trips. The great majority of shopping trips start from the home. Few people shop on their way home from work.

The use of cars to reach individual shopping centres varies a good deal according to its catchment area. The



Share of employees living near by
Mode choice related to percentage
of office workers living within 6 km
of 17 workplaces in Greater Copen-
hagen ⁴².

location of the individual shopping centre is of less importance for the total shopping patterns of households. If a car is available, people choose a shopping centre outside walking distance, if the range and

Large shops must no longer be established in Denmark.

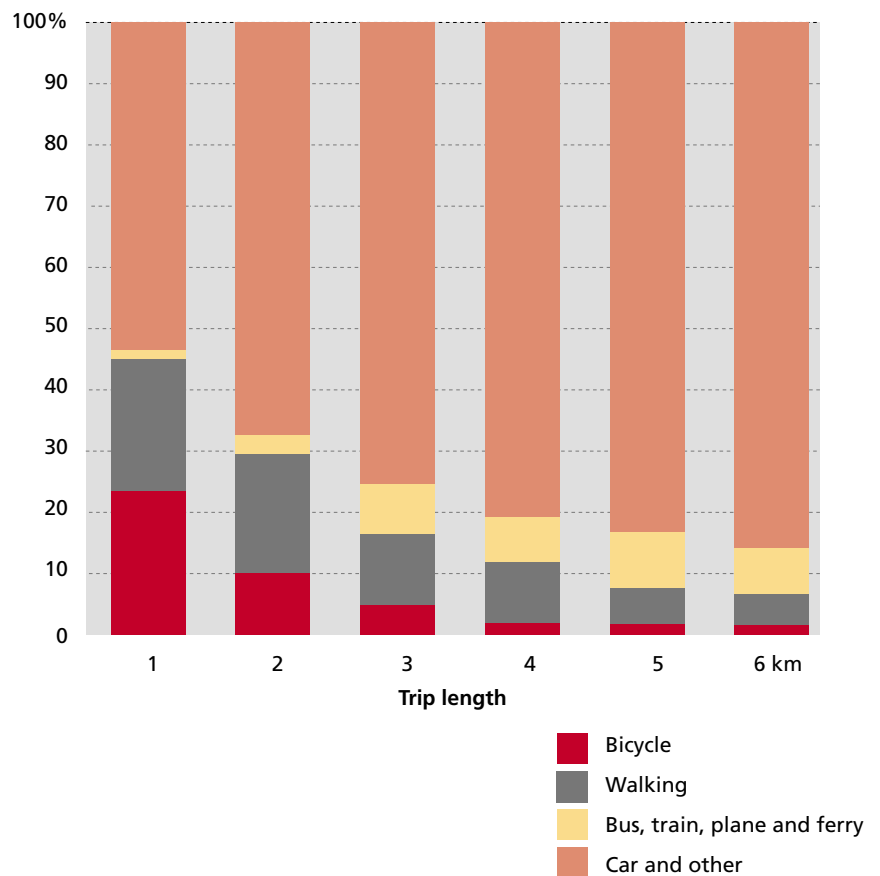


PHOTO: Linda Hansen

prices of goods in the nearest shopping centre do not suit them. A Norwegian study has shown that while 50% of the population could shop for their everyday necessities within 500 metres of their homes, only 27% did so ⁴⁶.

In Denmark it is very difficult to get permission to establish new food outlets of more than 3,000 square metres and non-food outlets of more than 1,000 square metres. The planning law and system help to maintain a decentralised structure and to stabilise the number of retail outlets, which would otherwise fall.

Cyclists only spend slightly under half as much money per shopping trip as motorists in three Danish town centres ⁹⁶. On the other hand, cyclists shop more frequently in town centres. The traffic to large shopping centres and hypermarkets on the outskirts of towns is far more car-based than traffic to shops in town centres. One reason is that shopping centres and hypermarkets have far bigger catchment areas than other outlets, which means that on average customers have to travel further.



Mode choice on shopping trips in Denmark 1998 ²².

The bicycle is often used to shopping centres in the town centre.



The bicycle is rarely used to shopping centres on the outskirts of the town.



Planning of traffic areas

This chapter describes good networks and principles for cyclists' traffic areas. The chapter also discusses implementation processes.

In a number of Danish urban areas there are sensibly designed and coherent cycle networks. But there is a need for more cycle routes and for traffic calming. The quality of cycle networks can often be improved, with respect both to their coherence and to individual routes.

PHOTO: Linda Hansen



PHOTO: Lars Bahl



PHOTO: Linda Hansen



PHOTO: Linda Hansen



Contents

Plan & process	48
Good planning for cyclists	48
Speed and cross section	52
Junction design	54
Materials, construction and aesthetics	57
The process	60



PHOTO: Road Directorate

Physical conditions for cyclists can often be improved in relation to cables, pipes, mains and road works.

Plan & process

Planning in this chapter should be understood in two ways, namely as plan and process. The plan can consist of network planning and draft design, while the process is a matter of getting the projects implemented, often as cheaply as possible and in the right sequence.

Network planning for bicycle traffic deals with, among other things, choice of corridor, desired speed, standard, number and type of junctions. Here decisions are made concerning whether, for example, the traffic area should be a field track or a cycle track with asphalt, street lighting and winter maintenance. And whether junctions should be eg signal-controlled or roundabouts.

Network planning for bicycle traffic is often seen as part of municipal planning and other traffic planning. At the draft design stage decisions are made regarding, eg alignment, cross section and junction design.

In general planning it is advisable for road administrations to lay down principles for draft design in order to achieve a uniform level of service. Such principles can form the basis for quality control of completed projects.

The principles set the level for, among other things, road safety, costs and the experience of road users and neighbours of and in the traffic. For example, an urban street with cycle tracks will often be more expensive with respect to maintenance than without cycle tracks, while cyclists will experience a higher level of service.

The Road Standards and Guidelines are a set of principles. As culture, traffic, technology and economy are in a state of constant development, the possible and desired levels of road safety, service etc, are also constantly changing. This makes periodic revision necessary.

The process revolves around two factors. The first is better utilisation of the resources that are already being spent on construction and maintenance of roads, cables etc, so road safety and the level of service for cyclists can be improved. The second is a focus on the general public's wish for better traffic conditions for cyclists and information regarding experiences and accidents on cyclists' traffic areas. This focus will hopefully lead to more funds being allocated to the process.

Terminology:

The **cycle network** is a coherent system of cycle routes. A **cycle route** goes from A to B, and is planned for bicycle traffic with a high level of safety and service. On the **main routes** there are many cyclists for a long time. **Local routes** are for few cyclists for a short time. In practice, cyclists should be able to detect when they are on a cycle route, and when they are leaving one.

Good planning for cyclists

The functional demands that a successful road and path network must fulfil are banal: Mrs Jensen needs to get from A to B, and the trip must be a good and safe experience. At the same time as the surroundings must not suffer from Mrs Jensen's transport.

The philosophy behind cycle networks and routes is often to get more people to cycle by making a better offer to cyclists, rather than by making life difficult for motorists. But in residential areas and shopping streets, for instance, there is often a wish to avoid through-going motor traffic. It is

A cycle path directly to the school – and the bicycle racks.



PHOTO: Road Directorate



PHOTO: Road Directorate

An interrupted cycle route.

important to incorporate these wishes in traffic planning so that the cycle network provides a higher level of safety and service.

Accessible and coherent

The cycle network should run directly from residential areas to the most important destinations for cyclists, such as schools, other educational institutions and workplaces. Shops, sports arenas, places of entertainment, transport terminals are also important destinations. Similarly the cycle network should connect residential areas.

A coherent cycle network, in which the main routes have priority over side roads and local routes, can attract a major part of the bicycle traffic. Coherence can be interrupted by, for instance, the absence of cycle tracks and street lighting, barriers, too many traffic lights or poor

maintenance. These interruptions reduce use of the cycle network.

More cycle routes enhance the coherence of the cycle network, as cyclists have more possibilities of adapting their trips to the network. There are different kinds of cyclist. A direct but very busy road is interesting for adults but not for school-children, who need a sense of security. Tourists want new experiences.

Meshes of 500-800 m in breadth in the networks of main routes are acceptable in urban areas, except in areas with many destinations, eg town centres, where breadth should be halved. Main routes can run along very busy roads with a number of junctions, which gives children a sense of perceived risk. In such cases there should be coherent alternative cycle routes.

In rural districts broader meshes of perhaps 3-5 km are acceptable as there are fewer destinations. Because of high car speeds on rural roads a network of cycle paths and tracks is necessary. The cycle network should include schools, larger towns and tourist attractions as destinations.

Direct and easy

A feature common to towns where bicycle traffic has increased as the result of physical measures is the



PHOTO: Lars Bahl

construction of direct main routes with a high level of service for cyclists. If the cycle network is not direct, logical and easy to use, some cyclists will choose roads not planned for bicycle traffic.

Most cyclists will immediately choose the shortest/quickest route. Cycle paths and tracks attract cyclists from roads with mixed traffic. Large volumes of motor vehicles and poor pavement quality repel cyclists. The surroundings and traffic calming play little part in cyclists' choice of routes. Cyclists

A main route on the outskirts of the town.



PHOTO: Road Directorate

PHOTO: Road Directorate

Cyclists ride on roads despite good cycle paths.



PHOTO: Linda Hansen

Wide paths give more possibilities.

routes with fewer cars by having few roads with through-going car traffic, eg by closing some roads and use traffic calming on others. Remember – it is rarely feasible to move cyclists to other routes.

The road administration has a choice: either car speeds must be adapted to the conditions, or conditions must be adapted to car speeds. On cycle routes where cyclists and cars use the same traffic area, a desired speed for cars of up to 40 kph is suitable. The speed level should also depend on the volume of crossing pedestrians. If car speeds are higher than 40 kph, traffic calming or separation of the types of traffic is advisable.

Cyclists on very busy roads often experience a perceived risk even though speeds are low. Here, too, visual or physical separation is a good idea if the road is part of a cycle route. The design and maintenance of cycle tracks and lanes should always ensure that cyclists are kept off the carriageway.

Adequate visibility and curve radii should make it possible for cyclists

on their way to and from work, shops and places of education hardly ever choose a detour ¹³.

Delays for cyclists at junctions, access barriers etc, should be minimised, especially on main routes. Stops, half-stops, upward grades and uneven pavements require a greater consumption of energy from cyclists, and this contributes to reducing the number of cyclists ⁷³.

Safe and secure

The number of conflicts between

The desired speed, V_D , is the speed that the road administration wishes the drivers of private cars to observe out of regard for road safety and the environment. The desired speed, which must be less than or equal to the speed limit in force, forms the basis for the detailed design of individual road sections.

In connection with new road construction 20 kph is added to the desired speed when determining the elements that are important for road safety, eg visibility at junctions, stopping sight and distance to fixed objects. On existing roads calculations are based on the measured V_{85} , ie the speed that 85% of road users do not exceed in wet conditions. If V_{85} is greater than V_D , the two factors should be equalised through the use of visual and/or physical measures ¹³⁴.

cyclists and motorists can be minimised by traffic planning. In existing urban districts it will often be quite impossible to completely separate cyclists and motorists. It is possible to obtain direct cycle



PHOTO: Lars Bahl

Speed adapted to conditions.

PHOTO: Lars Bahl



Conditions adapted to speed.



PHOTO: Linda Hansen

PHOTO: Road Directorate

The dividing verge reduces cyclist visibility.



The town is a landmark.

to travel safely at a minimum of 25 kph. Design speed increases with 2 kph for every 1% fall, which means that cyclists should be able to travel at a minimum of 35 kph down a hill with a 5% gradient.

The visibility of cyclists in traffic is an important pre-condition for road safety. Parked cars, dividing verges, curves, vegetation, noise barriers etc, can result in poor or reduced visibility. Where necessary, awareness of the presence of cyclists can be heightened by signing and road marking.

Accidents between cars and bicycles occur mainly at junctions. Signalised junctions and roundabouts

are in general fairly safe for cyclists, while priority junctions are far less safe. To obtain better road safety for cyclists much attention must be devoted to junction design.

Self-explanatory design

Cyclists must be able to form a map of the cycle network. The alignment and design of main roads is often more logical and easier to understand than that of cycle path networks or of routes on local roads. Cyclists can lose orientation as a result of changes of direction along a cycle route. With a view of landmarks it is possible for cyclists to know where they are going.

Edge lines, bicycle symbols, coloured cycle tracks and lanes and channelisation of bicycle traffic make it easy to understand where cyclists should place themselves. Uniformity of design over long stretches is an important component in the design of cycle routes. When road and path elements are easily identifiable, eg a one-way cycle track, there is less need of signing.

Comfortable and attractive

Even and uniform road and path pavements help cyclists to maintain their speed without having to look at the pavement all the time. This makes cycling more comfortable and makes it easier for cyclists to observe other road users and sights of interest along the route.

In view of the number of cyclists and out of consideration for their safety, perceived risk and comfort, cycle tracks and paths should be kept negotiable in winter to at least the same extent as roads. The main routes for bicycle traffic can be regarded as being on a level with the regional road system.

Strong headwinds reduce cycling speed. On some stretches comfort can be enhanced by the use of wind-breaking elements such as trees and hedges. Canopies, trees etc, can be used for, among other things, shelter from short and intensive showers. If the cycle track is placed lower than the road, cyclists can be dazzled by the lights of approaching cars.



PHOTO: Linda Hansen

Large junction, but easy to grasp.

PHOTO: Linda Hansen



Canopy as shelter from rain.

Cycle routes that are visible from the road – indeed, human activity of all sorts improves the sense of social safety. When cycle routes are hidden away from other road users, there is an increased fear of assault. Cycle path networks are used less because people perceive social risk on them, a reaction that can to a certain extent be countered by lighting.

Speed and cross section

Separating cars and bicycles costs more in construction and maintenance. On the other hand, it can improve road safety and comfort and reduce perceived risk. If it is not possible or desirable to separate these types of traffic, car speeds can be reduced.

How much space do the individual solutions require? The table adduces recommended widths for cycle tracks, paths and lanes. If a cyclist without a trailer is to overtake another cyclist without a trailer in reasonable safety and comfort, a width of 1.7 m is necessary. A cycle lane of 1.5 m in width means that overtaking cyclists have to ride on

	Along roads	In separate layout
Cycle track (one-way)	2.2 m (1.7 m)	
Cycle path (two-way)	2.5 m (2.5 m)	2.5 m (1.7 m)
Cycle track (one-way, at footway level)	1.7 m (1.5 m)	
Shared-use path	3.0 m (3.0 m)	3.0 m (1.7 m)
Cycle lane (incl. 0.3 m edge line)	1.5 m (1.2 m)	

Recommended widths (and minimum widths) for cycle track, path and lane ¹²².

the carriageway. A cyclist with a trailer blocks a 1.7 m wide cycle track almost completely. Although prohibited from doing so, roller skaters use cyclists' traffic areas, and if this is to be taken into account in the cross section, the recommended width of a one-way cycle track will be 2.6 m.

The following example of principles for separation on road sections places a strong emphasis on road safety, but the separation of motor traffic and bicycles has been taken a couple of steps further in order to give cyclists greater comfort and to minimise perceived risk. The example is illustrated on page 53.

Some of the documentation supporting the example is described in the chapter on the design of traffic

areas. It is, of course, possible to choose cheaper principles – this is only an example – but less separation means a lower level of service for cyclists.

Mixed traffic

At low car speeds and low volumes of motor vehicles, separation rarely results in safety benefits for cyclists. In fact, separation on roads with many junctions will often result in more bicycle accidents. Separation can be undesirable if one wishes to avoid having a wide road. Nevertheless the establishment of cycle tracks or lanes may be considered with a view to achieving coherence in a cycle route. Traffic calming is often necessary to obtain suitably low desired speeds in mixed traffic.

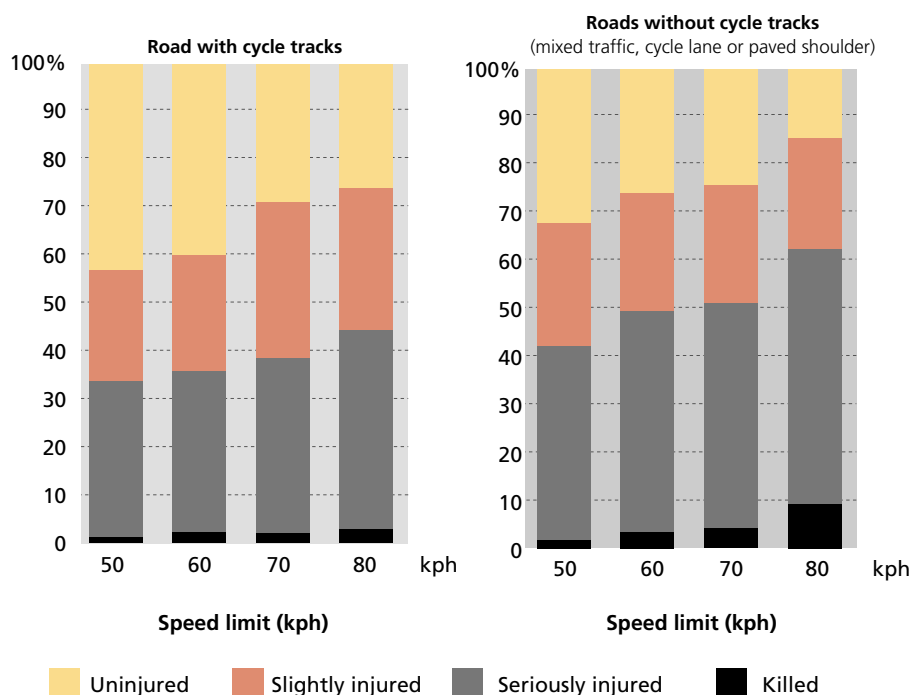
Cycle lane

With speeds of 50 kph and less and moderate traffic volumes cycle lanes may be a solution. Cycle lanes are cheap and enhance the level of service experienced by cyclists, though not to the same extent as cycle tracks. Cycle lanes can be recommended on urban roads without shops and with few junctions. Cycle lanes do not solve the safety problems caused by parked cars. Like cycle tracks, cycle lanes can result in more bicycle accidents at junctions. Cycle lanes are marked with broad continuous white lines and bicycle symbols. It is prohibited to park motor vehicles on cycle lanes.

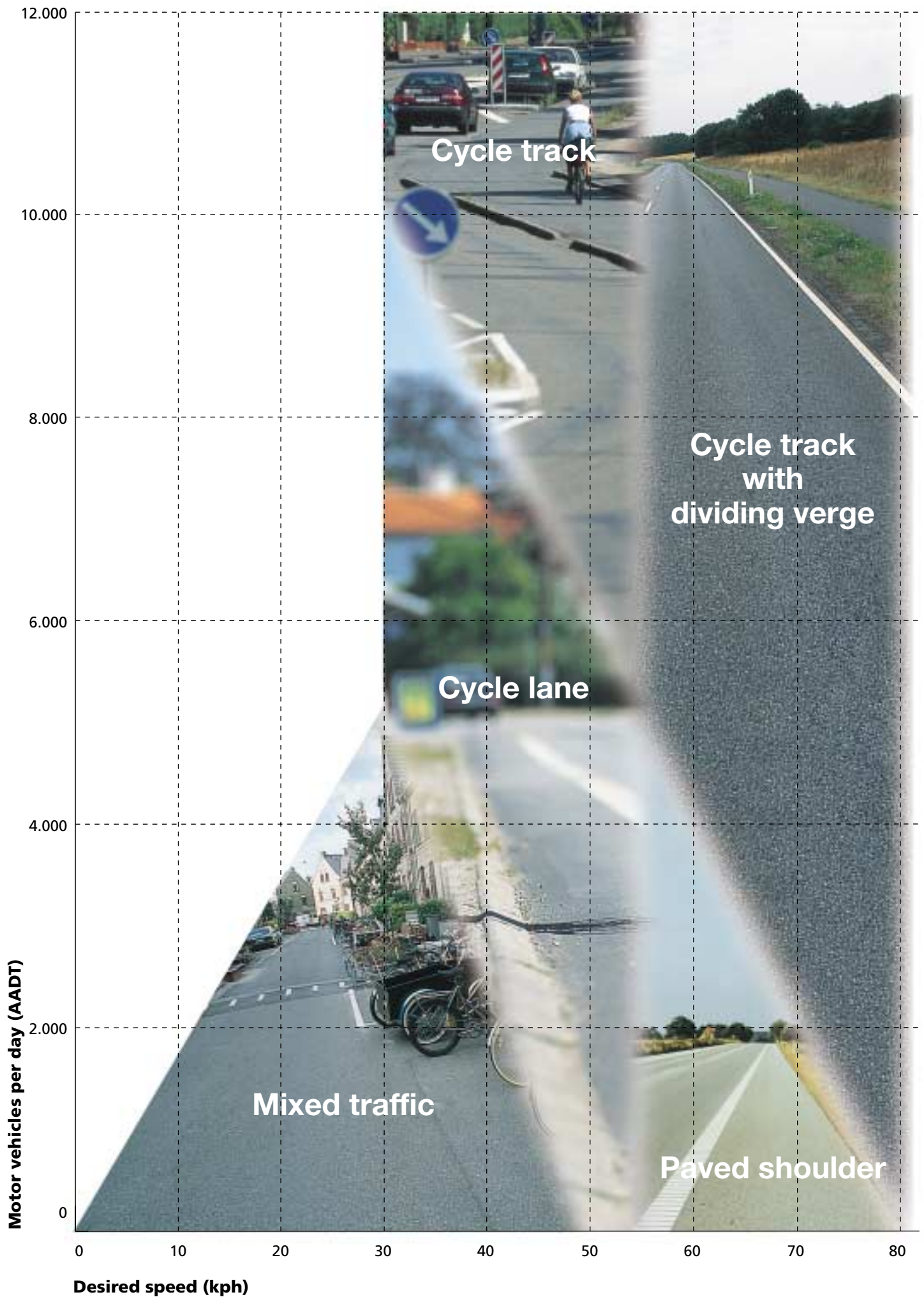
Paved shoulder

In small towns with through-traffic and few cyclists and on highways

Severity of cyclists' injuries



Example of separation principles



with limited motor traffic, broad paved shoulders can be a good solution, provided the paved shoulder can be established without widening the road. If it is necessary to widen the road in order to establish paved shoulders, the construction of cycle tracks should be considered. Paved shoulders function best at a width of 0.9 m including the edge line or wider. Traffic calming is often required in towns to meet the needs of the inhabitants and of vulnerable road users. Broad paved shoulders reduce the severity of bicycle accidents considerably less than cycle tracks at high-speed levels.

Cycle track

A kerb or the like between cars and bicycles is beneficial even at moderate speeds and traffic volumes. Cycle tracks improve safety, comfort and lower perceived risk. Cycle tracks enhance the level of service experienced by cyclists twice as much as cycle lanes and can lead to more bicycle traffic.

Road safety problems in connection with parked cars are almost completely solved by the construction

of cycle tracks. Parking closer than 20 m from junctions will give rise to visibility problems.

Cycle tracks lose many of their advantages with respect to safety and comfort on roads where there are many major and closely spaced priority junctions. On the other hand, cycle tracks function well on roads with signalised junctions and minor side roads, as the entering side roads can be given speed reducing exit constructions, and signalised junctions lights can be quite safe even with cycle tracks in entry roads.

Cycle track with dividing verge

On roads with high speeds distances between junctions are often greater than on roads where speeds are lower. The extra comfort and reduction in perceived risk afforded by a dividing verge are arguments in favour of this solution. From a road safety perspective, however, dividing verges are a bad solution at junctions. Roads with many junctions – basically all roads with a desired speed below 60 kph – should, therefore, not have a dividing verge. Dividing verges should

always be avoided on the approaches to signalised junctions.

Junction design

The following section presents an example of principles for junction design. Junctions involving cycle paths, junctions where traffic coming from the right has priority and grade-separated junctions are not included in the example. Junctions where traffic coming from the right has priority cannot be recommended. To give cyclists greater safety corner radii should be as small as possible in order to make the junction as undynamic as possible for turning vehicles. Parked cars and stopped buses alongside cycle tracks and lanes should not occur closer than 20 m before a junction. Not all road design elements are shown, as the example only illustrates the general design of some few of the many possible ways of designing junctions. For example, junctions where left and right turns are forbidden have not been included.

Signalised junctions

Pedestrian and cyclist safety will benefit if the stop line for motor vehicles in all lanes is drawn back some 5 m in relation to the pedestrian crossing. This makes cyclists more visible and reduces the number of potential conflicts at the beginning of the green stage.

Cycle tracks and lanes can be brought up to the stop line and continued as a blue cycle crossing provided that there is a right-turn lane for motorists, and cyclists ride at a normal or low speed. This solution reduces perceived risk and will especially benefit children, as they cycle slowly and can easily feel at risk.

Cyclists get up high speeds downhill. Here the primary solution is to

Two-way path along road sections with many junctions can't be recommended.



truncate the cycle track and let cyclists and motorists merge. A truncated cycle track can be a good solution, if space for the right-turn lane cannot be obtained in other ways. If the cycle track is truncated, the right-turn lane must be about 4 m wide to facilitate safe merging manoeuvres. Another possibility is to insert a cycle lane between the right-turn lane and the straight-on traffic lane.

A narrow cycle lane approaching the junction can give the necessary meter for a right-turn lane and, as opposed to a truncated cycle track, has the effect that cyclists avoid merging with motorists and move into the crossing before cars at the beginning of the green stage. The narrow cycle lane can cause capacity problems for cyclists. Exits and entries for motor vehicles should

not occur across truncated cycle tracks, nor on cycle lanes that continue up to the traffic lights.

In mixed traffic the choice is between a short cycle lane just before the stop line, where cyclists can move ahead of motorists and take advantage of a cycle crossing, or simply to recess the stop line.

Priority junctions

For side roads with less than 1,500 motor vehicles per day in urban districts speed reducing exit constructions are as a rule a safe, reassuring and comfortable solution for cyclists. Footways, cycle tracks and lanes should be continued through crossing at minor side roads. As an exception, the cycle track can be recessed 5-7 m from the crossing and cross the side road on a flat-topped hump. This solution is par-

ticularly relevant when the primary road is very busy, possibly with 4 lanes, as in such cases the side road motorist is liable to drive right up to the nearest lane. The flat-topped hump is necessary for cyclist safety. If trucks use the side road, recessing the cycle track is not a good solution.

Poor visibility conditions because of parked cars, vegetation etc, can lead to cars waiting on the cycle track at a junction, but here recessing the track is not a good solution. Instead visibility conditions should be improved in other ways.

On major side roads and highways the cycle track may be interrupted. Cycle tracks and lanes may also be continued as cycle crossings marked with bicycle symbols. Cycle tracks and lanes can be inter-



PHOTO: Road Directorate

Staggered stop lines.



PHOTO: Road Directorate

Staggered stop lines and blue cycle crossing.



PHOTO: Road Directorate

Downhill - truncated cycle track.



PHOTO: Road Directorate

Cycle lane between the right-turn and straight-on traffic lane.



PHOTO: Danish Cyclists Federation

Narrow cycle lane after truncated cycle track.



PHOTO: Road Directorate

Short cycle lane.



PHOTO: Road Directorate

Speed reducing exit construction and continued cycle track.



PHOTO: Road Directorate

Interrupted cycle track and cycle crossing.



PHOTO: Road Directorate

Recessed cycle track.

rupted about 30 m before a side road if cyclists are riding at high speeds downhill. Right-turn lanes should be avoided, however, at priority junctions with two-way traffic

on side roads. If there are more than 2,000 motor vehicles per day on the side road, it may be a good idea to reconstruct the junction as a roundabout or as a signalised junction.

Roundabouts

With fewer than 6,000-8,000 motor vehicles per day in roundabouts or mini-roundabouts it is unnecessary to separate cyclists and motorists. In this situation separation does not lead to greater road safety – in fact, it can reduce road safety. Similarly, cyclists can get through the roundabout faster with mixed traffic.

In roundabouts with more motor traffic, which have one circulating lane and one lane for each entry, cyclists can be separated from the motor traffic. In roundabouts

designed for low speeds the cyclist can be led round on a cycle track about 5 m from the circulatory carriageway, possibly on a raised surface. In dynamic roundabouts the cyclist can be led round on a cycle path about 30 m from the circulatory carriageway with a duty to give-way to entry and exit roads. This large distance is necessary if cyclists are to be able to manoeuvre in respect of cars leaving the roundabout.

In roundabouts with more than one circulating lane and possibly also more than one lane for each entry, cyclists should be led outside the roundabout via bridges, tunnels or as in dynamic roundabouts on a cycle path about 30 metres from the circulatory carriageway.

Mini-roundabout.



PHOTO: Road Directorate

Large roundabout with a blue circulating cycle lane.



PHOTO: Road Directorate

Materials, construction and aesthetics

If a town's streets and roads are to be more than mere traffic arteries, but also attractive spaces that it is pleasant to pass through and spend time in, it is necessary to work with total concepts. In order to achieve a harmonious result, specialists such as architects, engineers and landscape designers must co-operate closely, co-ordinate their efforts and acquire insight into one another's specialist fields ¹²².

Signal value

The various groups of road users experience pavements very differently. For example, granite paving stones signal that pedestrians can walk here without regard for other types of traffic. Granite paving stones should only be used on cyclists' traffic areas where there is a clear difference of pavement or level in relation to the footway. A cyclist's eyes will naturally be directed somewhat downwards, and for cyclists the pavement plays an important role in their total experience of the space ⁴⁴.

Choice of pavement and colour can



PHOTO: Road Directorate

Clear perception of cyclists' traffic area.

make it clear what road users should be where. These choices should always be made in such a way that road users do not misunderstand how and by whom the space is to be used, and who has an obligation to give-way. By using a colour that is different from the rest of the surroundings certain traffic areas can be made to stand out, thereby helping to emphasise give-way conditions. Blue cycle crossings are an example of this. Changes of pavement, eg using sett or concrete block paving at junctions can help to make road users more aware of one another.

Cycle tracks and paths

For the comfort and safety of cyclists all tracks and paths carrying daily bicycle traffic should be constructed with a smooth pavement with sufficient friction to prevent skidding. The construction of the track and path should be able to withstand the pressure of the vehicles that use it, eg of maintenance equipment and illegally parked trucks. It is a good idea to continue the road foundation beneath cycle tracks along roads where there is no dividing verge. Unfortunately crack formation is all too often encountered in the half meter of the cycle track closest to the carriageway. On paths the base etc, should be constructed in such a way that maintenance equipment does not cause crack formation on the sides of the path.

Hot-mixed asphalt of hot soft bitumen and small stones (< 16 mm) forms a suitable wearing course for cycle tracks and has a normal life-time of 15-20 years ¹⁰⁰. Its fine surface makes it easy and pleasant to cycle on, provides good friction and can be produced in many colours. Asphalt should always be machine-poured.

Granite

A natural material like granite is a popular type of pavement, which

A poor construction narrows the cycle track and path.



PHOTO: Road Directorate

appears in many forms, for instance as cobblestones, sett paving, cut kerbstones, ordinary flagstones and special oblong granite flagstones.

Granite is an almost imperishable material, which becomes more beautiful with the passing of time. Its disadvantages are its price and the amount of processing it has to undergo before it is a suitable pavement for cyclist areas. Thus, cobblestones are unsuitable for bicycle traffic, because they are uncomfortable, slippery when wet and baggage tends to fall off. Nor can uncut sett paving be recommended for cyclists' traffic areas, while cut, rounded or polished flagstones can be used.

Concrete pavements

Concrete blocks and flags can be used for both heavy and light traffic. The flags should be laid correctly with the right filler to avoid frost bursts and the like. Concrete blocks and flags can be obtained in various shades of colour, shapes and surfaces. A large part of stone pavements available today can be laid by machine. By using different kinds of stone and pattern, moreover, it is



PHOTO: Road Directorate

Smoother sett paving on cyclists' part of the road.



PHOTO: Road Directorate

Concrete flags are more pleasant to cycle on than sett paving.

possible to change the sound picture in a car and thereby heighten the driver's awareness. The various shades of colour may be used to express a further signal value for road users.

Provided that the road is designed for the actual traffic load, the functional life time of concrete will normally be in excess of 20 years. Flagstones and concrete blocks can today be produced from a special strong kind of concrete, which gives high durability and resistance to frost and salt ¹²³.

Coloured cycle crossings

When establishing coloured cycle crossings at junctions, one can

Blue thermoplastic improves safety at this spot.

choose among different kinds of material. Blue cycle crossings are often laid in thermoplastic, which is cheap and visible, but not especially durable. An alternative to thermoplastic is blue asphalt. Asphalt is more durable and, with respect to friction, a good alternative to thermoplastic, though considerably more expensive. Blue asphalt is not as strongly coloured as thermoplastic. On the other hand, the asphalt preserves a uniform colour throughout its lifetime. The lifetime of blue asphalt is expected to be the same as that for ordinary asphalt ⁵⁰.

Gravel etc

On minor recreational routes and short sections where there are few cyclists gravel, slag etc, can be accepted as pavement material on condition that the gravel is tamped and rolled so that the pave-



PHOTO: Road Directorate



PHOTO: Lars Bahl

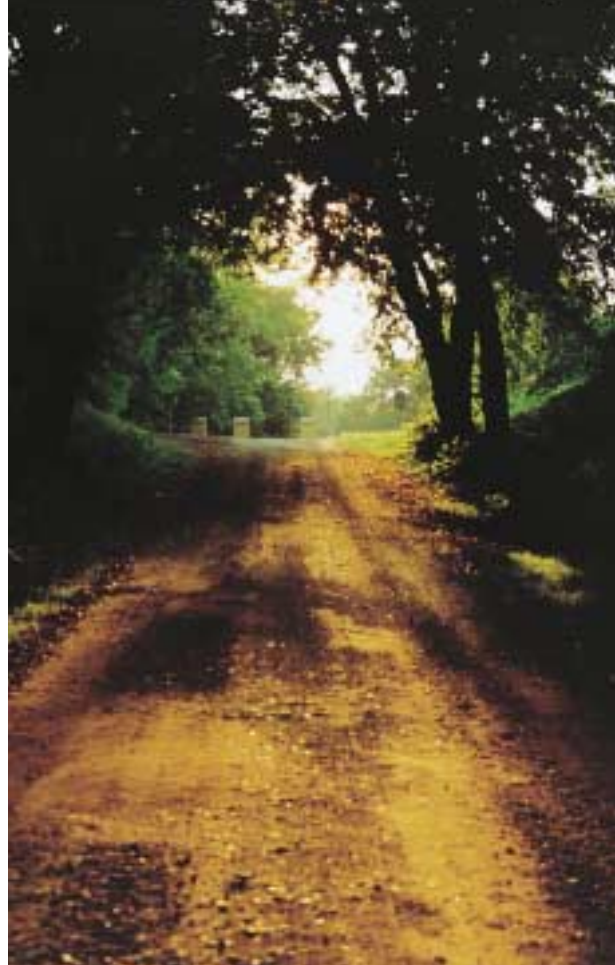


PHOTO: Road Directorate

Roads without asphalt can be beautiful.

ment is not too uneven and the gravel remains on the road.

Comfort

Cyclist comfort on different types of pavement has been investigated. Ten different test sections were ridden over. For each section a peak value was measured for the vertical acceleration over 8 m, and the test persons gave an assessment of the comfort of the pavement. The results are added in the table below ¹¹⁶.

Other studies of the importance of pavement for cyclist comfort have shown similar results. If it is a service goal that at least 80% of cyclists should be satisfied with pavement quality on main routes, these routes must be asphalted and without noteworthy patches, cracks etc.

The process

The first step is to determine the

structure of the cycle network. Then the cycle network can be implemented. It is important to determine the structure, as many persons are actively involved in the process of changing road and path systems. The plan for the cycle network is part of the basis for mutual understanding and co-operation and, in addition, a good checklist.

Formulating the plan

The final product should be a

visionary plan for the cycle network. A large part of the resources for the implementation of the cycle network will not be earmarked for bicycle projects, but for maintenance of roads, cables etc, urban development and other projects. The plan will have to take into account how these resources are used so that the cycle network can be implemented.

Pavement	Share of satisfied cyclists	Measuren peak value
Asphalt pavement	100%	0.12
Asphalt pavement	98%	0.17
Patched asphalt	44%	0.33
Rough surface-treated asphalt	44%	0.55
Depression in cracked asphalt	33%	0.68
Concrete blocks	43%	0.73
Uneven asphalt due to trees, frost etc.	28%	1.05
Manhole covers in asphalt pavement	15%	1.23
Set paving, neatly laid	2%	1.81
Ramp, asphalt pavement	2%	2.28

For example, there may be a 50% discount for the construction of a path in connection with the laying of a new natural gas system, so that the price for the path falls from DKK 1 million to DKK 0,5 million per km. Nevertheless the remaining DKK 0,5 million must be procured, otherwise the cycle network will not be implemented. It is a good idea to budget the DKK 0,5 million for the cycle network plan rather than elsewhere. Part of the plan for the cycle network can contain new construction of cycle paths, tracks and lanes and improvement projects for existing cycle routes with signs, road marking, contra-flow cycling etc. These projects should be included in a long-term investment plan.

Quality requirements

The purpose of identifying a physical cycle network is so that the road administration can meet a number of specified quality requirements. It is a question about the offer that politicians wish to give cyclists. The quality requirements could include:

- Road safety
- Level of service, including perceived risk and comfort
- Mesh size for main routes.

The requirements to be made of the cycle network are therefore not just a matter of the cross section – the presence and width of cycle paths, tracks and lanes – but also of such factors as road lighting, number of stops per km, maintenance etc.

Background knowledge

Once again the point of departure for functional requirements is banal: Mrs Jensen has to get from A to B. Therefore we have to know where Mrs Jensen comes from and where she wants to go – her destination. We must also know the routes road users choose, that is, the



Bicycle traffic in Virtual City.

Background knowledge

- Existing traffic structure
- Present destinations for all road users
- Future destinations (urban development and renewal)
- Route choices for all road users (traffic flows)
- Motor vehicle speeds
- Parking of cars, vans and trucks

traffic flows. This knowledge is necessary in order to be able to offer the greatest possible number of cyclists the best quality, ie the main routes, at the lowest possible price.

The volume, speed and parking of cars also influence the ways in which the quality requirements can be met. Why? The volume and speed of motor traffic exerts a decisive influence on the choice between cycle track, cycle lane and mixed traffic. If cars are to be allowed to park on the road, it may be impossible to find space for a cycle track or lane.

Determining the cycle network

Before the fateful lines are drawn on the map, it is important to consider previous ideas and plans regarding the volume, speed and parking of vehicles. Thus, a planned road closure may mean that it is more appropriate to traffic calm a

Check list – main routes

- Mesh width adapted to the number of destinations
- Collect motor traffic on few roads with separation
- Traffic calm or separate
- Few stops – give priority to the main route
- Few hills and easiest route
- Good lighting and maintenance
- Least possible car parking

road than to construct cycle tracks. An upcoming car park may create space for contra-flow cycling in one-way streets or for cycle tracks. It is best for these ideas to be collected in an overall traffic plan.

Many studies have shown that it is particularly difficult to move cyclists from one route to another without prohibiting cycling on a given route. In fact, the alternative route has to be more direct or logical (ie few stops) and perhaps also have a higher level of service, if cyclists are going to be prepared to change routes. Together with the difficulty of acquiring land, this fact sets a limit on how many local roads and paths can form part of the network of main routes both in the rural and urban areas. A quite different possibility is to move motor traffic away from main routes in order to improve road safety and level of service on these routes for cyclists.

The safety of cyclists will undoubtedly be one of the main requirements, and here junction design is important. The road administration will have to take the consequences of having chosen one road as the main route for cyclists. In towns this may mean that a number of junctions will have to be redesigned with shorter corner radii, speed reducing exit constructions at minor side roads and roundabouts/signal-control at larger side roads.

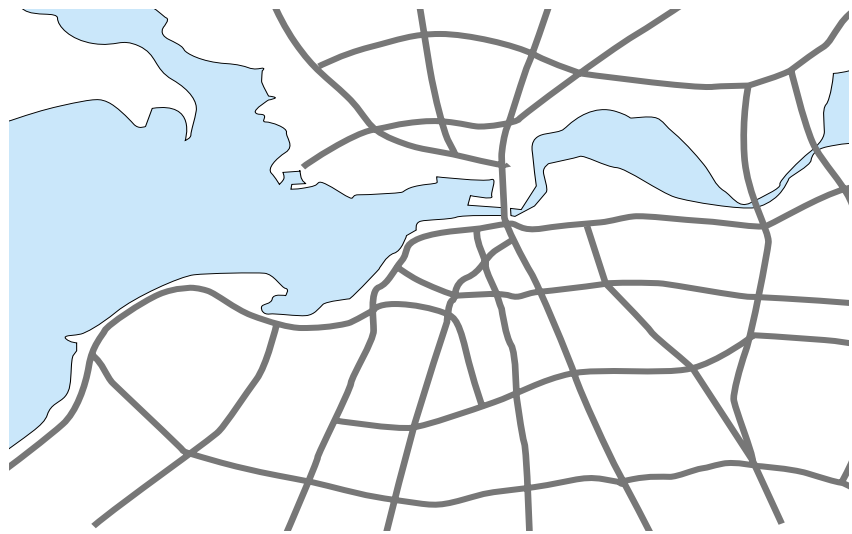
The local routes must also be safe. Their safety is mainly the product of traffic calming and a modest amount of car traffic. On local and recreational routes a high level of service for cyclists is not so important, as they spend only short periods on them. But remember that eg cycle tourists may constitute the majority of users of a main route.

Accumulate knowledge and experience - and keep motivation high

To create something is basically a matter of knowledge, experience and motivation – and funds. The cycle network plan will presumably have been thought up by one or more traffic planners. And it is the planners who have the knowledge, experience and motivation to improve the offers made to cyclists. But they dispose over only a small portion of the funds needed to build up the cycle network.

Part of the implementation process therefore consists of inculcating the plan in road maintenance personnel, town planners, owners of mains, sewers, cables etc, utilities and contractors.

The road administration may require that as early as possible an audit should be carried out of various tasks and projects where there is a possibility of implementing parts of the cycle network. Thus, it is natural that the funds the road



Draft structure of main routes in Virtual City.

administration receives from independent user-financed utilities in connection with the re-establishment of roads should be incorporated in the plan for the cycle network.

The general public wishes and needs should be an important part of the reason for changing the traffic system. These wishes and needs can be obtained by questionnaires and debate and can form basis for service targets.

A purpose of such questionnaires is partly to give the public clear information about the administration's traffic services. The replies can be used as an argument for the allocation of greater funds, but more importantly, they can motivate co-operation partners – the owners of utilities, road maintenance personnel etc.

3 types of project

The following section presents a brief overview of the different kinds of project and the possibilities for linking up the cycle network plan with other projects.

Today a lot of funds are spent on the maintenance of roads, cables, mains, sewers and railways. It is important that the cycle network plan is seated at the table when decisions are made as to where the funds are to be spent. It is often a question of acting swiftly – of more or less having a draft design ready for all parts of the cycle network. By being visionary new possibilities of more and safer cycling can be obtained by already allocated funds.

A cycle audit should be carried out in connection with new construction, reconstruction and repaving

Roadworks in Virtual City year 20??

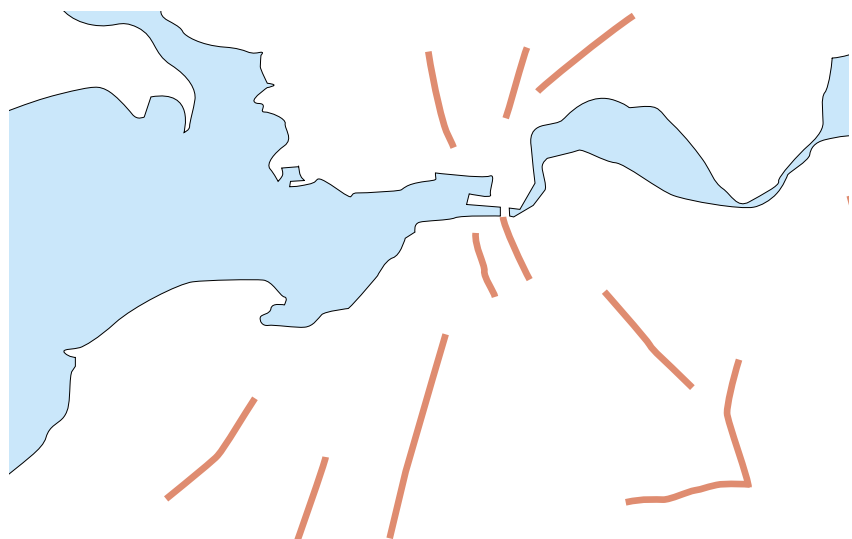




ILLUSTRATION: Philip Rasmussen

Cycle route established in connection with district heating pipes.

Maintenance	Roads and paths Cables, district heating, mains, railways etc
New construction, reconstruction and repaving	Roads and paths Cables, district heating, mains, railways etc Urban development and renewal
Bicycle projects	New construction, reconstruction and repaving Options Minor improvements

projects that are based on other factors than bicycle traffic. A political demand might be that those parts of the cycle network that can be implemented must be implemented in connection with new construction, reconstruction and repaving. How-

ever, it is not a good idea to place all cables, district heating pipes, sewer mains etc, beneath the cycle track, as the track will become uncomfortable to cycle on after it has been dug up sufficiently often. Try the footway.

The main objective of bicycle projects is to improve the traffic situation for cyclists. Projects for new construction, reconstruction and repaving can be implemented individually, ie one cycle route at a time. There can be advantages with respect to costs and information activities in implementing minor improvements, such as signs, road marking etc, as mass initiatives, ie on a large number of cycle routes simultaneously. Finally, there are option projects, where areas are physically reserved for cyclists, but where one does not have the funds or it is not the right time to implement the cycle network plan. Such an option might be the construction of cycle lanes along a road with the intention of constructing cycle tracks at a later date.

Price examples

Construction costs for the cycle network are one thing, maintenance costs another. Here are a few figures for construction in year 2000 prices.

The prices depend on the volume of work to be done. The prices are based on ordinary new construction, reconstruction and improvement projects, which is not part of maintenance.

	Approx. year 2000 prices
4.5 m wide cycle path incl. excavations and 3 m asphalt pavement (on virgin land) and excl. drainage	DKK 1,000 per meter
2 x 2.2 m cycle tracks on existing urban road incl. asphalt pavement and drainage	DKK 2,000-5,000 per meter
Comprehensive traffic calming	DKK 4,000-8,000 per meter
0.3 m broad edge line in thermoplastic	DKK 20 per meter
0.1 m broad edge line in thermoplastic	DKK 10 per meter
10 bicycle symbols	DKK 5,000
Signing of cycle routes with symbols, signs, stopping and parking prohibited signs etc	DKK 50-100 per meter
2.2 m broad blue cycle crossing in thermoplastic	DKK 300 per meter
Road closure	DKK 3,000-25,000
1 hump on existing carriageway – kerb-to-kerb – including road marking	DKK 10,000
1 mini-roundabout	DKK 100,000-350,000
1 roundabout with 1 circulating lane and deflection islands in all branches	DKK 1.5-2.5 million
30 m truncation of cycle track	DKK 50,000

Design of traffic areas

For cyclists the design of traffic areas is a question of ease of passage, perceived risk and safety. In order to choose the right solution it is important to identify the problems that one wishes to solve or prevent, and to consider whether the solution will create other problems.

A good design is both functional and easy to understand. For safety reasons it is important keep the number of errors in the traffic system as low as possible. And when accidents do happen nevertheless, it is important to minimise the possible consequence of these errors so that serious injuries can be avoided. Natural behaviour by road users should be safe behaviour.



Contents

Adapted design	64
Mixed traffic	64
Cycle lanes	68
Paved shoulders	71
One-way cycle tracks	72
Two-way cycle paths	77
Priority junctions	82
Signalised junctions	85
Roundabouts	90
Pedestrian areas and squares	93
Bridges, tunnels, hills and stairs	94
One-way streets	97
Traffic control measures	98

Adapted design

A basic principle is that the design of a traffic area should be self-explanatory. Everybody should have a clear understanding of their “natural” place in the traffic at all times. Road design should be determined by the speed and number of road users and by the composition of traffic. The pavement, signs and marking in a pedestrian street are not the same as on a highway. This is a matter of 6 kph architecture versus 80 kph architecture. Together with the multiplicity of functions that roads and paths fulfil these principles constitute the complex of demands that the design of traffic areas must meet.

Paths in a separate layout

These paths are established exclusively to satisfy the needs of pedestrians and cyclists. The latter are not fond of hills or of stopping. Paths in a separate layout with too many hills and stops are a waste of funds – give priority to paths that cross roads and let the motorists give way.

Shopping streets

In shopping streets the most important thing is space for pedestrians. If people cannot move around on foot, without risk and obstructions, there will be no trade. If pedestrians are to be able to cross shopping streets without difficulty, the maximum desired speed for motor vehicles is 30 kph, and then there is rarely



PHOTO: Road Directorate

Closed railway lines now serve as paths for cyclists and pedestrians.

need to establish cycle tracks. If there are many motor vehicles passing through, the street is in reality divided into two shopping areas, and then a good idea is guard rails between signalised junctions.

Residential streets

Here the main thing is to feel safe. Motor vehicle speeds must be kept low. A solid knowledge of speed-reducing measures and parking facilities for motor vehicles will make it possible to solve many of the problems on residential streets.

Main roads

The town's main roads – the great traffic arteries – constitute its traffic machine. Their most important function is to facilitate the flow of traffic. It is here that 70-80% of all

road accidents in towns occur. It is here that we find the great conflicts between safety, the environment and ease of passage, and it is here that marginal factors make all the difference. In order to manage these conflicts effectively it is necessary to have an intimate knowledge of signing, marking, junction design etc.

Highways

At high speeds it is necessary to separate cyclists from motor traffic. For bicycle traffic the primary task is the establishment of cycle tracks and paved shoulders.

Mixed traffic

Cyclists often feel unsafe in mixed traffic, especially with large volumes of motor traffic travelling at high speeds. The level of safety depends on such factors as speed levels, parking conditions and the width of the road. Bicycles and motor vehicles should therefore only be mixed where there is little motor traffic and speeds are suitably low.

What is this? Cycle track or parking lane?



PHOTO: Road Directorate



PHOTO: Road Directorate

Here the speed is naturally low.

6 cyclists out of 10 experience problems in mixed traffic, while on roads with cycle tracks only 1 cyclist in 3 experiences problems. The behaviour of other road users, parked cars and junctions are frequently giving problems for cyclists in mixed traffic, while junctions and side roads give cyclists problems on cycle tracks ³⁰.

Almost half of all cyclist deaths and injuries in Denmark occur in mixed traffic ¹³⁵.

Cross section

The width of the carriageway plays a relatively small role in cyclists' level of service in urban areas ⁶⁸. The width of urban roads has only slight or no impact on the safety of cyclists, while their risk declines with increasing carriageway widths on highways ^{39, 81}.

With a carriageway width of under 6.5 m motor traffic should not exceed 30-40 kph. Higher speeds require wider carriageways. If motor traffic is travelling at speeds higher than 40 kph, one should con-

With high traffic volumes and many parked cars it is often a good idea to separate motor vehicles and bicycles.

sider reducing the speed level or separating cyclists from the motor traffic.

On roads where motor vehicles drive at 30-50 kph and often overtake cyclists at the same time as opposing traffic passes in the other direction, the choice between separating cyclists from motor traffic and mixing cyclists and motor traffic on a broad carriageway should depend on, among other things, the volume of traffic, parking conditions and the amount of space available.

Parking

Parked motor vehicles are often perceived as a problem by cyclists in mixed traffic, and the accident risk for cyclists in mixed traffic does in fact rise with the presence of parking bays and bus stops ^{81, 114}.



PHOTO: Danish Cyclists Federation



PHOTO: Road Directorate

It is a good idea to reduce speed on this road by eg humps.

Parking manoeuvres and open car doors can injure cyclists. Scattered parking along a road can make cyclists less visible for other road users. Either parking should take place in parking lanes and bays or motor traffic speeds should be reduced to around 30 kph.

With angle or perpendicular parking motor traffic speeds should only be 10-20 kph.

Prohibiting parking leads to a 20-25% reduction in accidents even though it can also result in higher speeds ²⁹.

Where there is parking only on one side of the road, the accident risk is even higher because this result in dangerous parking manoeuvres and changing visibility conditions.



PHOTO: Road Directorate

Footway crossovers shelter parking.

Bus stops

With bus bays head-on collisions between cyclists and motor traffic are avoided, and cyclists do not need to look back to check on buses and cars. In fact, cyclists rarely check on what is behind them.

In streets with a lot of parking a stopping and parking prohibition at bus stops can be supplemented with build-outs. In mixed traffic footway widening at bus stops will often be inconvenient for cyclists.



PHOTO: Road Directorate

A bus bay.

Traffic calming measures

Physical traffic calming measures are often necessary in mixed traffic in order to improve road safety and reduce perceived risk for cyclists.

In connection with chicanes and narrowings it is important to have an independent area for bicycle traffic – a cycle gap, track or lane. Cyclists feel safer when passing chicanes and narrowings with a cycle gap than without^{24, 113}. It is important to keep 10-15 m before and after the cycle gap free of parking, eg by the use of build-outs or 30-40 m long cycle lanes.

Parking lane prevent slalom cycling.

Play on bikes and cycling in the wrong side of the street is common on streets with few cars and low speeds.



PHOTO: Road Directorate



PHOTO: Lars Bahl



PHOTO: Road Directorate

A good cycle gap is 1.3-1.4 m wide. If the cycle gap is too narrow cyclists will use the carriageway, and if it is too wide some cars will use the cycle gap.

Area-wide traffic calming and speed reduction will lead to an increase in pedestrian and bicycle traffic, most markedly for children and the elderly ¹⁰¹.

An English study of accidents in 72 traffic calmed areas reported a fall in the number of accidents of more than 60%. The decrease was greatest for motor vehicles and pedestrians and lowest for cyclists. The average speed of motor vehicles fell from 40 kph prior to traffic calming to 26 kph after ¹⁰². Speed reducing measures do not have the same beneficial effects for cyclists as for other road users, among other things because the majority of bicycle accidents occur at junctions.



PHOTO: Road Directorate

Rumble devices can lower speed.



PHOTO: Road Directorate

Mini-roundabouts are speed reducing.



PHOTO: Road Directorate

Humps are very efficient as speed reducers. The hump can be constructed from kerb to kerb without cycle gaps, which is best for cyclists and the cheapest construction.



PHOTO: Road Directorate

To prevent side by side collisions cycle tracks or lanes can be established at central islands.



PHOTO: Road Directorate

Cycle gap, manhole cover, dirt and parking - a bad combination.



PHOTO: Road Directorate

Mini-roundabout on road section with cycle lane.

At junctions cyclist safety on quiet urban roads with mixed traffic is relatively good compared to cyclist safety on urban roads with cycle tracks or lanes. Cyclist safety on highways with cycle tracks is satisfactory – also at junctions. Mixed traffic necessitates greater interaction among road users.

Cycle lanes

Cycle lanes are mainly used in urban areas. Cycle lanes can be a good alternative to cycle tracks, and where lack of space or funds makes it impossible to establish cycle tracks. Broad cycle lanes give a large reduction in accidents on road links, but can give rise to safety problems at junctions. Three studies have each shown a 10% rise in the number of bicycle accidents in connection with the establishment of cycle lanes in urban areas. The total increase in accidents is a result of a large drop in accidents on road links and more accidents at junctions^{16, 83, 94}.

Studies indicate that accidents on road links in connection with parked motor vehicles do not disappear with the establishment of cycle lanes. Rear-end collisions, where motor vehicles hit cyclists from behind, still occur because of too narrow lanes^{1, 83}.

Road users turning left are a big problem on roads with cycle lanes. The severe accidents at junctions occur with cyclists turning left.

At motor vehicle speeds of 40-50 kph cycle lanes can be a good permanent solution, if there are few junctions and a modest need for parking cars.



PHOTO: Lars Bahl

Bicycle symbol.

Mini-roundabouts, marked cycle crossings and reducing motor vehicle speed are measures that may be able to eliminate some junction accidents on roads with cycle lanes.

Danish traffic counts show that establishing cycle lanes on a single road brings about a minimal increase (0-5%) in the number of cyclists⁸³. If, on the other hand, a whole network of cycle lanes is established in an urban area without cycle tracks and paths, the number of cyclists will increase. In comparison with cycling in mixed traffic cyclists feel safer on cycle lanes and experience them as a real improvement in the level of service⁶⁸.



PHOTO: Lars Bahl



A daily battle about space.

Establishing cycle lanes

In Denmark, a cycle lane is marked on the carriageway with a 0.3 m broad, unbroken edge line and bicycle symbols at intervals of ca. 100 m and after each interruption of the edge line (after junctions). Bicycle symbols can be replaced with a cycle track sign at junctions. The cycle lane is established on both sides of the road for one-way bicycle traffic. Motor vehicles are not permitted to park on the cycle lane, but unless there is a parking prohibition, parking is permitted between the motor traffic and the cycle lane.

Ever since the 1930s cycle lanes and the like have in certain situations been viewed as a temporary solution that should be replaced with cycle tracks in due course. One possibility is to stripe cycle lanes if cycle tracks are only to be established a number of years later. This signals that the area is reserved for cyclists in the future, while problematic junctions and road links can be identified prior to the planning of cycle tracks.

Cross section

Cycle lanes should be at least 1.5 m wide including the 0.3 m edge line. Where the lane is narrower than 1.5 m, overtaking cyclists often use the carriageway¹⁷. Reasonable overtaking conditions require a width of 1.7 m. The edge line itself must be continuous, but may, for instance, be profiled. Thermoplastic is a good material for marking with regard to visibility, durability, friction and cost²⁰.

Cycle lanes can be paved in different colours, eg red or brown, from the rest of the road to emphasise the cohesion of the cycle routes and the purpose for which they are intended. The coloured pavement can be

continued through junctions marked as a cycle crossing with a broad broken line and bicycle symbols.

Coloured pavements give fewer disturbances for bicycle traffic from motor vehicles, and cyclists are positive towards colouring³⁷.

Coloured pavements are important on cycle lanes broader than 1.8 m, as these may be mistaken for parking or traffic lanes. There is no documentation of the safety impact of coloured cycle lanes.

A number of studies have pointed out that narrow cycle lanes are less safe on road sections than mixed traffic⁴⁵. If the width of the cycle

Good different colour - but an unsafe dividing verge.



Parking occur despite it is prohibited.





PHOTO: Road Directorate

Marked parking spaces reduce the number of parked vehicles on the cycle lane.



PHOTO: Road Directorate

Too narrow parking bay - a car door is 0.9 m wide.

lane is increased, there is a greater distance between cyclists and motor vehicles, and there is a fall in number of cyclists who make brief excursions onto the traffic lane.

Parking

Parking should be prohibited on roads with cycle lanes if there is much coming and going of parked motor vehicles as is the case for roads with shops or multi-storey buildings. Parking spaces must always be designed so that the area cannot be used for anything else than parking, eg an extra traffic lane at peak hours.

Where parking is permitted between the cycle lane and the traffic

lane, a 2 m broad cycle lane will allow cyclists to overtake safely and improve their chances of avoiding open car doors and pedestrians. Where possible, a 1 m broad island or ghost island can be established between the cycle lane and the parking lane. Sheltered parking outside the cycle lane is a good alternative. If the sheltered parking areas are close together, the cycle lane can be regarded as a cycle track. If this form of cycle track is unusual in an urban area, signing or bicycle symbols can be used to make it clear what this part of the road is to be used for.

Parking between the cycle lane and the footway calls for a broad park-

ing bay of 2.5 m so that motorists do not open their doors onto the cycle lane. On the other hand, the cycle lane does not have to be wider than normal, but the edge line must be broken.

Only parallel parking can be accepted on roads with cycle lanes. Angle and perpendicular parking increases the accident risk so markedly that these types of parking can only be accepted in car parks and on minor local roads, where cycle lanes are unnecessary.

Bus stops

At bus stops, depending on how much space there is, one can establish a bus bay, a short cycle track or

This design is unsafe!



PHOTO: Road Directorate

A broken edge line next to the bus bay is missing.



PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate

Different edge lines.

a bus-boarder between the cycle lane and the traffic lane. This means that bus passengers do not have to struggle with high steps when boarding and alighting. Along the bus bay the cycle lane should be marked with two broad broken edge lines and extra bicycle symbols.

Paved shoulders

Paved shoulders can be used to advantage in rural districts and

through villages. Besides giving cyclists the possibility of cycling on them, paved shoulders also give pedestrians a safer possibility of walking on a pavement. In addition, paved shoulders, if sufficiently

The majority of bicycle accidents on roads with paved shoulders is rear-end collisions, where motor vehicles hit cyclists from behind ¹³⁵.

broad, lessen problems with degradation of a road's edge ⁹². The broader the paved shoulder, the more acceptance it receives from Danish cyclists ¹¹⁴. Parking is permitted on paved shoulders.

Paved shoulders are established by moving the edge line or by widening the carriageway. It is not advisable to widen the carriageway to get room for a paved shoulder. This is because widening the carriageway costs the same as cycle tracks, but does not improve the level of service and road safety nearly as much for cyclists ⁸¹.

The marking of edge lines can result in increased motor traffic speeds ^{20, 91}. A good proportion of the accidents on roads with paved shoulders occur with cyclists turning left. In general, the establishment of paved shoulders and cycle lanes will not reduce this kind of accident ⁷¹.

Cross section

The recommended width of paved shoulders in urban districts is 1.5 m

Bus bays and paved shoulders go well together.



PHOTO: Road Directorate



PHOTO: Road Directorate

Broken edge line and hump.

including 0.3 m unbroken edge line. In rural areas the recommended width is 1.2 m with edge line, but it should not be less than 0.9 m. The paved shoulder must be a minimum of 0.9 m with edge line, if 0.3 m edge lines are to be used. Otherwise the edge line may only be 0.1 m broad in Denmark. The edge line must be unbroken.

The width of paved shoulders is decisive for their safety impact in rural areas. Overtaking, cycling side by side and cycle trailers do not function on narrow paved shoulders. Motorists are surprised by cyclists' temporarily use of the traffic lane. On roads with cycle tourists and roads with more than 100 cyclists per day the paved shoulder should be 1.5 m wide, but a cycle track or cycle lane is to be preferred.

A Danish before-and-after study shows that the number of accidents on highways falls in step with increased width of paved shoulder. The fall is greatest for vulnerable road users ⁹².

Parking

Especially in urban areas stopping and parking prohibitions should be considered, as broad paved shoulders can be used for undesired parking. In urban areas the possibility

should always be considered of turning paved shoulders into cycle lanes – ie marking bicycle symbols, which means that parking is forbidden.

Road administrations receive complaints from motorists who do not

know the parking rules for roads with paved shoulders. As an experiment broken edge lines have been used on paved shoulders in villages in Northern Jutland to make it clear that motor vehicles are permitted to park on the paved shoulders ⁹¹. Paved shoulders are easier to implement than cycle tracks and cycle lanes, as they do not involve parking restrictions. In villages extended along a through road it is rarely possible to park elsewhere than on the through road, which means that paved shoulders together with traffic calming may be a good solution.

Cycle tracks

One-way cycle tracks are established along roads with large volumes of motor traffic and/or high speeds. The choice of track type and width should not depend solely

A cycle track with dividing verge is a fine solution on highways.



Separated cycle-footway is useable at low cyclist and pedestrian volumes.



4 types of one-way cycle tracks



Extruded kerbs can function, where very few pedestrians cross the road.



The Danish cycle track gives a good separation between road users.

PHOTO: Road Directorate



PHOTO: Road Directorate

A 2.6 m wide cycle track is necessary, if this manoeuvre must be easy and safe – however, it is illegal in Denmark.

drainage and experienced level of service.

On highways the safety impact is greater for broad than for narrow cycle tracks⁸¹. Accident figures for cyclists are halved in connection with the construction of cycle tracks along highways, while the effect in urban districts depends on, among other things, the volume of motor traffic^{58, 81}. The more motor traffic, the greater the impact³.

The construction of cycle tracks appears to have a modest traffic calming effect on both cyclists and motorists. Depending on the breadth of the traffic lanes and possibly on a reduction in the number of traffic lanes a fall of about 1-5 kph in motor traffic speeds can be expected. Cyclists ride 1-2 kph slower on cycle tracks than in mixed traffic⁸⁶.

Cyclists prefer cycle tracks or separate paths with good lighting and a smooth pavement. Sometimes cyclists have negative experiences of cycle tracks, and this is primarily due to uneven pavements, manhole covers, gratings, junctions with obstructed visibility, narrow track

on criteria like road safety and costs, but also on ease of passage, perceived risk, comfort and what can be experienced en route. The establishment of cycle tracks reduces the number of accidents involving cyclists and motorists on road links. Almost half of all bicycle accidents in Denmark occur on roads with cycle tracks. With desired speeds above 50 kph cycle tracks contributes to lessening the severity of bicycle accidents.

There are 4 main types of cycle track along roads with differences in costs, space requirements,

On roads with cycle tracks one accident in four occurs on road links. On road links, one accident in four is single accidents and half of the accidents are between pedestrians, cyclists and moped riders¹³⁵.

profiles or poorly designed bus stops. A foreign study has shown that in comparison with cycle lanes cycle tracks give cyclists a significantly higher degree of experienced level of service⁸⁹. Counts before and after the construction of 25 km of cycle track along 10 Danish main highways showed an increase of 37% in the number of cyclists on these roads¹¹⁵.

Cross section

Both in urban and rural areas the recommended width for cycle tracks separated by a kerb, a verge or extruded kerb from the carriageway is 2.2 m. The recommended minimum is 1.7 m. For cycle tracks that are part of a separated cycle-footway the widths are 1.7 m and 1.5 m respectively.

Studies show that the accident risk for cyclists falls with increased width of cycle track and increased width of separating verge on highways⁸¹.

A cycle track width of 2.2 m will ensure that overtaking can take place safely. As cyclist speeds vary considerably, there is much overtaking among cyclists.

Dividing verge

Dividing verges between the cycle track and the carriageway are a good solution on roads with high

Trees can be placed between footway and cycle track.



PHOTO: Road Directorate

The dividing verge should end 20-40 metres before the junction in order to increase cyclists' visibility.



PHOTO: Road Directorate

speeds and few junctions per km of road. Verges are especially used on highways, so that the laying of kerbs and drainage can be avoided. For reasons of safety, verges should be avoided on urban roads with closely spaced junctions.

Dividing verges with grass up to the carriageway are favourably assessed by cyclists, as they give lower perceived risk and a greater sense of comfort¹¹⁴. To avoid parking on the verge and to improve drainage conditions a kerb between the verge and the carriageway is recommended for urban roads.

The width of the verge should be determined on the basis of an overall assessment of wishes regarding vegetation, requirements concerning visibility and distance from solid objects and space conditions. On highways 1.5 m verges are normal, while their widths vary more in towns. On highways fixed objects, eg trees, must not be placed on verges as they impair motorist road safety.

Verges with trees between the cycle track and the carriageway should be at least 2 m broad in towns. Trees between the footway and the cycle track can be planted in a 1-1.5 m



PHOTO: Road Directorate

Despite change in pavement too narrow cross sections is a problem.

wide verge. A grass verge should be at least 0.6 m wide.

As a rule, safety fences should be placed on the shoulder, as a placing between the carriageway and the cycle track renders mowing, snow-clearing etc, more difficult and more expensive. Safety fences on verges may make emergency stops unsafe.

Separated cycle-footway

A separated cycle-footway without kerb between pedestrians and cyclists can be established where there is sparse bicycle and pedestrian traffic and where there is not much space. With the cycle track and the footway at the same level and distinguished only by marking or differences in pavement, there is a greater risk of accidents between cyclists and pedestrians. Pedestrians will tend to stray onto the cycle track more or less unawares unless marking and pavement clearly indicate who should be where. The narrower the cycle track, the more cyclists will tend to use the footway.

Extruded kerbs

The choice of extruded kerbs instead of conventional kerbs is primarily due to economic considerations. The basic idea of extruded

kerbs is to avoid expenditure on drainage and laying kerbs while obtaining the advantages of cycle tracks. In general, cyclists feel slightly safer on extruded kerb tracks than in mixed traffic. Road users may react negatively towards extruded kerbs if the extruded kerb is not sufficiently conspicuous, and pedestrians tend to stumble over them. Extruded kerbs can be obtained in various forms and materials, eg rubber, plastic, concrete, asphalt and kerbstones.

The extruded kerb can be made visible by starting it as an island at a junction and by marking edge lines and making differences of pavement. At private drives and driveways extruded kerbs made of concrete, asphalt and kerbstones should be provided with asphalt slopes. Other types of extruded kerb should be interrupted. Deformation problems and the like can occur because of wheel pressure from trucks and buses. Road drainage should take place through 30 cm wide gaps in the extruded kerb. The gaps should be placed 1 m upstream from the drain or at regular intervals on roads without sewers. It has not been documented whether extruded kerbs increase or reduce the number of cyclists⁶⁶.

Extruded kerbs should not be constructed, where many pedestrians cross the road. As ordinary kerbs



PHOTO: Road Directorate

At junctions the extruded kerb should be interrupted.



PHOTO: Road Directorate

Danish cycle tracks

On free sections of road, kerb heights along the carriageway should measure between 7 and 12 cm and between 5 and 9 cm between the cycle track and footway. These heights give a number of advantages. Most motorists refrain from parking on the cycle track. Vehicles exit from and entry to properties take place at low speeds. Drainage functions well. Cyclists rarely cycle on the footway, and pedestrians will register when they leave the footway. The heights represent a balance between positive and negative factors, such as pedestrian and cyclist accidents from falling and also mobility problems for the disabled.

The kerbs separate road users.

the height of extruded kerbs should be about 10 cm.



PHOTO: Road Directorate

Island between parking bay and cycle track.



PHOTO: Road Directorate

The island between the cycle track and the carriageway makes it safer for pedestrians to cross the road.



PHOTO: Road Directorate

Well-constructed drainage is important - here the depression around the gully is too big.

Drainage takes place through gullies on the carriageway and the cycle track. If gullies on the cycle track are to be avoided, the whole road foundation must be lowered. Gully gratings on cycle tracks do not make the cycle track significantly narrower as cyclists ride at a safe distance from the kerb. On the other hand, depressions around gratings are a problem.

Car parking

On sections of road where there is a strong need for stopping and parking it is possible to establish a dividing island with a recommended width of 1.0 m between the carriageway/parking lane and the cycle track. It is not necessary to have a kerb between the island and the cycle track. The island should be paved differently from the cycle track.

The construction of cycle tracks leads to a big reduction in the number of accidents involving cyclists and parked vehicles. In Denmark stopping and parking on cycle tracks is illegal.

On roads with motor vehicles parked outside the cycle track,



PHOTO: Road Directorate

Boarding passengers at bus stops without bus-boarder may stand on the cycle track long before the bus arrives.



PHOTO: Road Directorate

Zebra crossings in line of the bus doors improve safety. The profiled marking gives a safer distance between cyclists and bus passengers.



PHOTO: Road Directorate

At bus-boarders pedestrians must give way for cyclists in Denmark.



PHOTO: Road Directorate

The cycle track is behind the waiting area etc.

islands between the cycle track and carriageway can improve pedestrian safety and help to prevent pedestrians from waiting on the cycle track. Another possibility is to remove some of the car parking and establish a pedestrian refuge.

Bus stops

The construction of cycle tracks can increase the number of accidents at bus stops unless special safety measures are introduced. Accidents with alighting passengers occur mainly at places where there is only a narrow or no bus-boarder, while accidents with passengers entering a bus occur at bus stops with a broad bus-boarder. Almost all accidents at bus stops where there is no bus-boarder involve alighting passengers and cyclists.

Studies of bus passengers and cyclists at bus stops without a bus-boarder have shown that the marking of zebra crossings reduces cyclist speeds in connection with stopping buses considerably, and that the number of serious conflicts between cyclists and bus passengers is reduced⁴⁵. The establishment of give-way markings, rumble devices and painted patterns at bus stops does not have the same positive impact as zebra crossings^{31, 32}.

At bus stops on roads where there are cycle tracks with extruded kerbs, it is a good idea to establish a section of ordinary cycle track with kerb height differences in respect of both the carriageway and footway.

On roads with cycle tracks bus stops should be placed at least 20 m before the junction, otherwise stopping buses will reduce cyclist safety and their visibility for other road users. The bus stop should never be placed immediately before the stop line at signalised junctions, as stopping cyclists will then block the way for boarding and alighting bus passengers.



PHOTO: Road Directorate

The cross kerb creates discomfort.



PHOTO: Road Directorate

Discomfort, danger and unlit.



PHOTO: Road Directorate

A smooth transition and a logical continuation of the track.

A bus-boarder should be at least 1.5 m wide and have a different pavement from that of the cycle track. At bus stops where there are many boarding and alighting passengers a width of 2.5 m can ensure that the bus-boarder is not overfilled, and that passengers with prams can board and alight in safety.

Boarding and alighting from buses are experienced as the next most dangerous situation by elderly pedestrians along Frederikssundsvej in Copenhagen. About half of the elderly experience problems with cyclists at bus stops very frequently⁶⁵.

Start and end designs

The design of the start and end of cycle tracks is an important part of the detailed design. The start and end of a cycle track should be formed as a smooth transition between road and track, as a direct continuation of the pavement of the track and without edges. It is an advantage for cyclists if existing cross kerbs are removed.

The conclusion of a cycle track in mixed traffic can be realised as a 15-20 long wedge-formed widening of the carriageway, with an edge line marked from the end of the cycle track to 15-20 m after the widening of the carriageway. The carriageway should not be narrowed if the cycle track is continued as a paved shoulder or cycle lane, and cyclists should be able to continue on their way without a lateral change of direction. If the cycle track ends abruptly, the attention of motorists can be drawn to this fact through signing and the establishment of an approx. 1 m wide build-out, which prevent rear-end collisions.

Cyclists have to walk across the zebra crossing to a cycle path close to a side road or use an entry to the cycle path to the right about 70 m before the zebra crossing. But cyclists behave differently!

PHOTO: Road Directorate





PHOTO: Road Directorate

Cycle paths

Two-way cycle paths are established through recreational areas, as short cuts between towns, as path systems in residential areas or along major roads with few junctions. Cycle paths often function as shared-use paths for pedestrians and cyclists. Cycle paths have an independent cross section, entirely separate from any nearby roads.

Cycle paths can be divided into two main types:

- 1) Cycle paths along roads, and
- 2) Cycle paths in a separate system through green areas, residential areas etc.

Cycle paths along roads

Cycle paths along roads should only be established after a safety assessment of this solution in relation to other solutions for vulnerable road users, and only as an exception. Two-way cycle paths mean a broader area for the individual cyclist, but are not as safe as one-way cycle tracks at junctions, private drives and driveways. Cycle paths are cheaper to construct than cycle tracks.

Cycle paths should not be established along roads where there are many side roads, driveways etc, across the path, eg in towns. Safety problems arise where a cycle path crosses side roads because it is often difficult for motorists to realise that cyclists can come from the “wrong” direction. The solution

Cycle path along a road.

here is one-way cycle tracks on both sides of the road.

Cycle paths can be established where there is a lot of motor traffic and there is plenty of space, eg along motorways or busy highways. From a road safety perspective it is usually best to place the cycle path on the side of the road that has the fewest side roads, driveways etc.

Paths in a separate layout

Paths through recreational or residential areas can offer short, more

attractive, safer routes with less perceived risk, where it is the cyclist's needs that are in focus. In residential areas the paths offer good conditions for bicycle traffic, especially for children and the elderly.

A path in a separate layout can be used by younger children without being accompanied by an adult as long as the path does not cross larger roads on the same level. At the same time the paths can be used to offer cyclists short cuts between important destinations such as schools, shopping etc. Paths in a separate layout can also be estab-



PHOTO: Road Directorate

Path in a separate layout.



PHOTO: Jens Erik Larsen

Every 10th tourist in Denmark cycles.



PHOTO: Road Directorate

This curve does not conceal cyclists!

lished with a view to cycle tourism and recreational purposes.

In some cases a path in a separate layout can mean detours for cyclists. Cyclists will often have to give way where the path crosses roads, which means delays for cyclists. The path may also have shorter curve radii in both horizontal and vertical curves than roads.

Cross section

Paths should be designed to allow two cyclists with trailers to pass one another. If there is also to be room for pedestrians, further width is needed. A two-way shared-use path should therefore be at least 3 m wide, and a two-way cycle path should be at least 2.5 m wide with a separate pedestrian area alongside. The breadth of the path is crucial for cyclist comfort and ease of travel. The recommended breadths per-

mit two people to cycle side by side and thus talk to one another on their cycle trip.

In urban areas the verge between the carriageway and the cycle path should be at least 1.0 m wide. Along highways the minimum width of the verge is 1.5 m⁷⁶. For main roads a dividing verge of 3 m in width is recommended. If these verges are narrower, or if the cycle path is closer than 15 m to a motorway or expressway, safety fences should be erected between path and road¹²¹.

Horizontal and vertical radii

To prevent dangerous situations between road users moving in opposite directions on paths with two-way traffic, curves must be designed so that there is double stopping sight. This also applies to curves in tunnels, at junctions with other paths etc. If there is mopeds on the path, the curve radii must be designed so that moped riders also have double stopping sight.

If it is not possible to obtain double stopping sight, opposing traffic must be separated by a central island, verge or the like. A cheap solution is to mark a central ghost island on the path.

It should be possible for both bicycles and mopeds to pass through

Long hill, but no visibility obstructions along the track and in tunnel.



PHOTO: Road Directorate

any curve at a speed of 30 kph. Where a horizontal curve coincides with a vertical curve, it may be necessary to design for higher speeds for both bicycles and mopeds so that cyclists do not lose control in the curve. On horizontal curves with radii of less than 50 m the path must have cross fall towards the centre of the curve.

As a minimum requirement there should be double stopping sight on vertical curves on cycle paths. If there is mopeds on the path, it should be designed for mopeds.

Gradients

As we all know, the energy needed to pedal the bicycle forward has to be produced by the cyclists themselves. For this reason the number of cyclists using a path will depend on the steepness of the gradients on the path. Furthermore, cyclist safety will depend on the steepness of the downhill sections of the path. It is therefore necessary to operate with maximum gradients on paths.

Gradient and energy consumption sets a limit on the length of uphill sections. For paths in a separate layout it is economically feasible to adapt vertical alignments, which are not a problem for cyclists. The steepest sections can with advantage be at the beginning of hills.

Gradient	Max. length
50 ‰	50 m
45 ‰	100 m
40 ‰	200 m
35 ‰	300 m
30 ‰	500 m

Cyclist safety declines if steep descents are combined with sharp horizontal curves. For a gradient of 50% the design speed should be 40 kph and for a gradient of 30% it should be 36 kph. It is therefore



PHOTO: Road Directorate

Path users have to give way.

towards the main path. As paths are established to improve conditions for bicycle traffic, traffic calming should be used only where there is a real problem.

Junctions with roads

At junctions of paths and roads and at the ends of paths conflicts arise between cyclists and motorists. It is particularly the party that has the obligation to give way that should recognise the problem. It is important to have uniformly good visibility conditions on both sides of the junction.

When it is motorists who have the obligation to give way, traffic calming or signal-control are required to make motorists aware and get them to accept that they do not have priority. If traffic calming or signals are not acceptable, the obligation to give way must be imposed on the cyclists for the sake of their own safety.

There are many solutions that can make cyclists aware of and accept the obligation to give way where paths cross roads. When cyclists have to yield priority, there should be at least 30-40 m between the path-road junction and other junc-



PHOTO: Road Directorate

important that there are good visibility conditions at path junctions so that cyclists and moped riders can obtain an overview of crossing traffic. It is also important to establish clear give-way conditions where there are many cyclists and it is not possible to obtain adequate visibility conditions.

If speeds are too high at path junctions – either because the junction is situated at the bottom of the hill or because cyclists ignore priority rules – traffic calming for cyclists can be a solution. This may be achieved through speed reducing exit constructions in the form of humps or undropped kerbs. The path with the obligation to give way can be formed with a rise up

Cyclists know all short cuts.

necessary to devote special consideration to the design of paths in connection with tunnels and bridges.

Path junctions

Path junctions have hitherto been a neglected problem in Denmark. It is

The cycle path crosses the road on a flat-topped road hump, where motorists must give way for cyclists.



PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate

The signal is activated by detectors below the path surface, so cyclists rarely have to stop.

tions. Stop signs or give-way markings can be used with other solutions. As at path junctions, humps, undropped kerbs and upward inclines can be established approaching the road – or one can establish speed reducing exit constructions as at side roads, where the footway or verge is formed as a raised surface with the help of flags, sett paving etc.

Finally, access barriers can be used to impose the obligation to give way on cyclists. This is an effective solution, but a lot of bother for path users. Sometimes access barriers are used to prevent motor vehicles from entering the path, but here bol-

lards with reflectors are just as good. Access barriers should therefore be used only rarely. They should be sited about 5-7 m from the edge of the road so that the cyclist is brought to a position with a good overview of the situation. The nearest barrier should always be on the right, and barriers and bollards should be lighted and visible from the path at a distance of at least 30 m.

Many cycle paths along highways end on the outskirts of a town. The termination can be combined with traffic calming measures at a town gateway. A central island will make it possible for cyclists to cross the



PHOTO: Road Directorate

Nice rock, but hard to see in the evening.

road in two stages. As it is important to avoid undesirable two-way bicycle traffic along one side of the road in a town, it should be relatively easy for cyclists to cross the road at the end of cycle paths. On very busy roads a tunnel may be the solution.

When paths in a separate layout end in a through-going road, motorists should not have to give way. The design is the same as when paths cross roads. It is a good idea to terminate paths in a separate layout at the end of cul-de-sacs – see how this can be done on page 98.

Many cyclists will try to avoid humps, undropped kerbs, access barriers etc. These attempts can most easily be prevented by laying kerbstones on both sides of the path with a height difference of 10-15 cm or by guard rails. Kerbs and guard rails should be placed so that cyclists have to cycle at least 20 m outside the path to avoid access barriers etc.

Other measures

Paths in a separate layout without lighting and paths in green areas are

The transition from two-way path to one-way cycle track is solved by access barriers, guard rails, central island and pinch point.



PHOTO: Road Directorate



PHOTO: Road Directorate

Accidents with cyclists in the “wrong” direction often occur at these junctions. Here path bridges/tunnels or a separate stage maybe with push-buttons for pedestrians and cyclists are good solutions.

very rarely used in the dark. Instead cyclists use the road system or desist from cycling. Bicycle lamps cannot illuminate the path. The lighting of paths in a separate layout should therefore light up the whole path, so that cyclists traveling at 25 kph can easily distinguish the path from its surroundings – otherwise the lighting is not worth much.

Safety

Paths in a separate layout give a high degree of safety and low perceived risk for cyclists, and severe accidents involving cyclists and motor vehicles do not occur on the path itself. The typical accidents on paths in a separate layout are single accidents and collisions with pedestrians, mopeds and other cyclists. A number of the accidents are due to slippery conditions, too high speeds, too sharp curves, poor visibility conditions and unclear priority situations at junctions. Remember that most accidents on paths in a separate layout – perhaps 95-99% - are not recorded by the police. In Denmark only 1 cyclist is killed annually at junctions between paths in a separate layout and roads ¹³⁵.

Cycle paths along roads give rise to far greater safety problems. In connection with paths along main roads the problem is mainly that motor

vehicles turning left from the main road and turning right from side roads do not see cyclists who are coming from the “wrong” direction. This causes accidents that are not infrequently very severe. Blue cycle crossings and signing rarely help much. Instead, flat-topped humps, roundabouts, separate signal stages and foot and cycle bridges/tunnels can be recommended – or give-way signs for cyclists.

Promotion of cycling

If paths in a separate layout are to be used to promote cycling, it is important to make it clear to oneself beforehand who one is constructing them for. In projects for the promotion of bicycle traffic the focus should be on the needs of cyclists, and therefore the obligation to give way must to a large extent be imposed on motorists. This means that cycle paths can function as short cuts for cyclists and be an enjoyable and worthwhile experience. In addition, cyclists must be ensured the possibility of cycling at high speeds – no sharp bends or too narrow passages, but a broad cross section and a good smooth pavement, please!

Priority junctions

There are two types of priority junction, namely junctions with priority

for traffic approaching from the right and junctions with an unconditional obligation to give way, where the road user on a side road must stop and wait for traffic passing on the major road. Junctions with priority for traffic approaching from the right are rare in Denmark but are to be found in residential areas and are common in a few Danish towns. The unconditional obligation to give way is preferable to priority for traffic approaching from the right, which leads to more accidents. Some road users do not notice their obligation to give priority to traffic approaching from the right, while others are in doubt about the rules. One possibility is to change the obligation to give priority to traffic approaching from the right to an unconditional obligation to give way or put up stop signs in all directions. In the following only junctions with an unconditional obligation to give way will be discussed.

About one third of the injury accidents with cyclists in Denmark occur at priority junctions

135

The most commonly occurring accidents at priority junctions are cross direction collisions and left-turn accidents. The serious accidents occur in particular when cyclists are crossing the major road.

Visibility and priority

It is important that priority conditions at a junction are clearly apparent. This can be achieved through signing, islands and conspicuous traffic calming measures such as speed reducing exit constructions.

Visibility conditions at a junction depend on bends, vegetation, lighting etc, and are of great importance for the safety of all road users. It is important that visibility conditions



PHOTO: Road Directorate

Parked cars conceal cyclists and obstruct visibility.

should be uniform in both directions, as otherwise road users will focus so much on traffic from the direction where visibility is obstructed that they forget to look in the other direction.

Motor vehicles parked close to a junction can obstruct the view for road users. This can be a problem for traffic on the side road and on the major road. Cyclists on the major road should be visible to traffic on the side road and turning motorists on the major road at least

20 m before the junction. For downhill slopes on the major road the distance should be greater, eg 24 m for a 20% gradient and 30 m for a 50% gradient.

It must be possible to recognise the junction early enough. Remember that buildings, vegetation and parked motor vehicles can often be perceived visually as an unbroken line along the road, which makes it difficult to recognise that there is a junction. The visibility of the junction can be improved by parking



PHOTO: Road Directorate

Motorists may have difficulty leaving side roads.

prohibitions, breaks in the vegetation and marking.

The dividing verge between the cycle track and the carriageway should end in good time before the junction, partly to make cyclists more visible, and partly to ensure optimal visibility conditions from the side road.

It is difficult to make left turns at big priority junctions, eg where the major road has 4 lanes. With the view of the traffic presented to the

There are many types of speed reducing exit constructions.



PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate

Harlequin pattern on continuous cycle track.



PHOTO: Road Directorate

Interrupted cycle track - the dividing verge should not be there.

motorist turning left it is relatively easy to overlook cyclists. Here markings can remind road users of the presence of cyclists, but there are also other solutions, eg roundabouts.

Continuous cycle track

At junctions with modest amounts of traffic the cycle track should be continued through the junction. Continuous cycle tracks have a traffic calming effect on vehicles entering and leaving the side road, since they have to pass across the cycle track and often also the footway. This speed reducing construction means that it is easier for traffic on the side road to register and understand the priority conditions and potential conflicts are avoided. Cyclists on the cycle track will presumably reduce the attention they give to the junction. A study of cyclist safety at minor priority junctions showed moreover that the establishment of speed reducing exit constructions in the form of continuous cycle tracks and/or footways led to a fall in the number of bicycle accidents of up to 50%⁴³.

To make the cycle track more visible through the junction the cycle track can be given a different pavement or it can be marked with bicy-

cle symbols or a harlequin pattern. Behavioural studies suggest that the reciprocal awareness of motorists and cyclists increase by the use of harlequin patterns through junctions⁸⁴.

Interrupted cycle track

At junctions with more traffic on the side road the cycle track can be interrupted at the junction. An interrupted cycle track is more dynamic, so turning road users do so at higher speeds. On the other hand, cyclists come level with motor vehicles at junctions, which may increase mutual awareness.

An interrupted cycle track can be supplemented with a cycle crossing through the junction to draw attention to the cyclists' traffic area. Where there is a high risk for cyclists and moped riders, the cycle crossing can be established as a blue cycle crossing.

At priority junctions on highways the cycle track should nearly always be interrupted. The establishment of right-turn lanes should be avoided because the motor vehicles turning right obstruct visibility from the side road. If, however, there is a large amount of traffic turning right, one can establish a right-turn lane with a large ghost island or island between the right-turn lane and the carriageway, but without a dividing verge between right-turn lane and cycle track. The separation of motor vehicles and bicycles can be carried out with extruded kerbs, thereby avoiding drainage costs and ensuring that right turns are performed at a very low speed. Truncated cycle tracks at priority junctions with right-turn lanes cannot be recommended. One should instead insure that motorists turn slowly.

Cycle lane

Where a cycle lane along a major



PHOTO: Road Directorate

Short corner radii may lower turning motorist speeds at interrupted cycle tracks.



PHOTO: Road Directorate

Cycle crossing and continuous footway.

road is continued up to a junction, a cycle crossing should be established through the junction. An accident analysis of bicycle accidents at priority T-junctions in urban areas showed that accidents were less severe in cases where existing cycle lanes and tracks were continued through the junction as a cycle crossing⁷². In order to avoid side by side collisions between cyclists and motorists the cycle lane can be formed as a profiled strip on the last section before the junction. A continuous footway will increase cyclist safety.

Recessed cycle track

At priority junctions on busy major, possibly 4-lane, roads it may be a good idea to lead the cycle track 5-7 m away from the road and lead it over the side road on a raised surface. This makes it easier for road users entering and exiting the side road to assess potential conflicts

with cyclists and at the same time gives them a good overview of the junction. The deviation should be 5-7 m to create room for an ordinary private car to wait without obstructing the rest of the traffic. The raised surface is necessary to make motorists respect their obligation to give way and to prevent them from stopping on the cycle track. Recessed cycle tracks should not be established when there are many trucks on the side road.

Mixed traffic

In mixed traffic it is a good idea to establish speed reducing exit constructions on side roads by continuing the footway without interruption through junctions⁴³. It is also advisable to keep corner radii relatively short.

Cycle paths

Cycle paths and priority junctions are a bad combination and give rise

to some safety problems that are difficult to solve if the path runs alongside the major road. If, instead, the path runs alongside the side road and crosses the major road, the problem is less pronounced.

Where it has been decided to establish cycle paths along major roads, it is important to make both cyclists and motorists aware of the conflict. Cycle paths should always be continued right up to the junction³⁴.

Where there is sufficient space, the cycle path can be recessed 5-7 m away from the major road and continued across the side road on a raised surface. The other possibility is to recess the path 30-40 m away from the major road and give the side road priority over the path. This means that cyclists will have to give way to traffic on the side road. This is not a cyclist-friendly solution, but may be necessary for safety reasons and out of consideration for the passage of motor vehicles. The 30-40 m recession is necessary, as at the junction cyclists cannot allow for traffic coming from all angles at one and the same time.

Traffic calming

It is also possible to raise the junction. It is, however, uncertain whether having raised junctions improves safety for cyclists. Raised junctions may mean unclear priority conditions. It is therefore important to indicate that there is an unconditional obligation to give way.

Speed reducing traffic islands can be a good initiative in rural areas to give road users on the side roads a better chance to catch sight of the junction.

Recessed cycle track - the design speed is 20 kph for cyclists.



PHOTO: Road Directorate

Signalised junctions

Signalised junctions are often established in expectation of a better traffic flow, road safety and lower perceived risk. The separation of crossing traffic flows in terms of time reduces the probability of cross direction collisions. Conversely, traffic signals will result in a concentration of conflicts between turning and straight-on traffic, which is normally not solved by signals⁶⁷.

About one out of six cyclist deaths and injuries occur at signalised junctions¹³⁵.

The most frequently occurring injury accidents involving cyclists at signalised junctions are accidents with motor vehicles turning left or right and cross direction collisions where the cyclist crosses against a red light¹³⁵.

The visibility of cyclists depends, eg on the geometrical and visual size of the junction. Parked motor vehicles and stopping buses near the junction may reduce the visibility of cyclists.

Right/left-turn stage for motorists

At junctions without a separate cyclist signal, the cyclists have to observe the signals for motor vehicles. Arrow signals apply to road users who wish to drive in the direction indicated by the arrow. However, cyclists are not allowed to use the left-turn arrow for motor vehicles, as according to the Danish Road Traffic Act they have to make left-turns in two stages. They first have to go to the opposite side of the junction before they make a left-turn when it can be done without inconvenience to other traffic, independently of whether the signal shows green or red¹³⁹.

Junctions with a left-turn stage for motorists reduce the number of



PHOTO: Road Directorate

Pre-green can reduce the number of accidents at the start of the green stage.



PHOTO: Road Directorate

Separate right-turn stage - conflict-free - channelisation of cyclists.

accidents between left-turning motor vehicles and oncoming cyclists at large junctions with many traffic lanes.

Cyclist signals

At junctions with cycle tracks or cycle lanes to the stop line, a separate cyclist signal may be established. Cyclists may thus have their own signal stage. Cyclist signals can be used to give cyclists a pre-green signal some seconds before motor vehicles. This means that cyclists who start from red get a

head start on motor vehicles, thus becoming more visible. The purpose is to reduce the number of accidents between motorists and cyclists.

Cyclist signals are also used to reduce green time for cyclists to facilitate the flow of turning motor traffic. At junctions with separate cyclist signals cyclists must always comply with these signals.

At junctions with two or more turning lanes in the same direction from

an entry road these turning lanes should have their own turning stage because it can be difficult to see the cyclists. Green time is thus reduced for cyclists riding straight on and turning left.

Detecting cyclists in vehicle-actuated operation

In vehicle-actuated operation, the duration of the green time is controlled by the traffic from the different directions. For motor vehicles loop detectors are milled into the road to report traffic to the signals. Bicycles can be detected through loop detectors or manually by push-buttons. In some places cyclists and pedestrians are detected by pushing the same button, while in other places they have separate posts.

The optimal way to detect cyclists is to establish a combination of loop detectors and a separate cyclist push-button placed on a low post at the stop line. When a cyclist has been detected, a control lamp lights up. If the control lamp does not light up as expected, the cyclist can activate the signal by pushing the button.

By inserting loop detectors in the cycle track/lane some way before



PHOTO: Road Directorate

Here left-turn loop detectors can be useful.

and up by the stop line cyclists can be detected sufficiently early for the signal to change from red to green or to extend the green time so that the cyclist does not have to stop.

At some junctions, cyclists turning left can be detected only by placing loop detectors in front of the stop line. In order to prevent crossing cyclists from activating the signal unnecessarily, the loop detector must be activated for at least two seconds.

The advantage of detecting cyclists via loop detectors is shorter waiting time and that they do not have to push a button. Manual detection also has the disadvantage that not

all cyclists are aware that they have to push a button, and that they become impatient and cross at red. The disadvantage of automatic detection of cyclists is that in order to be detected they have to stop or ride in a well-defined area. This area should therefore be marked or unavoidable.

Bypassing traffic signals

At signalised T-junctions with a cycle track up to and through the junction and with staggered stop lines, one can choose to let cyclists bypass the signals. This reduces the number of stops and gives greater ease of passage. The measure can be combined with a left-turn lane for cyclists. At the pedestrian cross-

Straight-on going cyclists bypass the signal, while left-turners have their own lane.



PHOTO: Danish Cyclists Federation

Right turning cyclists bypass the signal, but not the pedestrians.



PHOTO: Road Directorate

ing cyclists have to give way to crossing pedestrians. One possibility is to establish a pedestrian refuge between the cycle track and the carriageway to make the priority difference (signals versus pedestrian crossing) clear, and the island makes it possible to remove the pedestrian crossing from the cycle track.

At signalised junctions with enough room a right-turn lane can be established for cyclists before the signals. In this way cyclists turning right avoid having to stop at red lights.

Cycle track/lane to the stop line

At signalised junctions with a right-turn lane for cyclists and where cyclist speeds are low or normal, it is a good idea to continue the track/lane right up to the stop line and mark a cycle crossing through the junction. The cycle track/lane to the stop line has the advantage that it meets the cyclists' wish to have their own area and makes them feel safe.

At junctions with many trucks turning right a cycle track/lane to the stop line should be used with caution as truck drivers have difficulty in detecting cyclists on the right

side of the truck ⁷. Part of the safety problem with trucks can be solved by staggered stop lines.

Where the cycle lane is continued right up to the junction, side by side collisions between cyclists and motor vehicles can be avoided by separating the cycle lane from the traffic lane with a profiled stripe.

In order to make space for a right-turn lane and create a better interaction between motorists turning right and cyclists continuing straight-on, a broad cycle track/lane can be carried on in a narrow cycle lane the last 20-60 m up to the stop line.

This solution may eliminate bicycle accidents with motor vehicles turning right, but it reduces the capacity for bicycle traffic if not combined with an advanced stop line.

Truncated cycle track/lane

At signalised junctions with cyclists travelling at high speeds it is important to truncate the cycle track/lane for safety reasons. The result of truncating the cycle track at least 20-30 m before the junction (the length depends on the number of motor vehicles turning right) is that cyclists and motorists are at the same level, are physically closer to each other, and both are responsible



PHOTO: Danish Cyclists Federation

Truncated cycle track continued in a narrow cycle lane.

for obviating conflicts. In order to ensure sufficient space for motor vehicles as well as cyclists, the width of the right-turn lane should be 4 m wide or more. This is probably also a good solution where there are many mopeds. If truncation of a cycle track/lane is the only possibility of creating space for a right-turn lane, it is presumably also better from a road safety point of view to have a truncated cycle track rather than not having a right-turn lane.

At junctions with a truncated cycle track there should be no entries and exits on the 'truncated' section before the junction. Truncated cycle

A good profiled stripe. Staggered stop lines should have been established.



PHOTO: Road Directorate

Downhill – truncated cycle track.



PHOTO: Road Directorate



PHOTO: Road Directorate

Staggered stop lines do not reduce capacity.



PHOTO: Road Directorate

The blue carpet is rolled out.

tracks/lanes should not be used at junctions with many child cyclists as this solution creates a sense of perceived risk – and children cycle slowly.

Cycle lane between right-turn and straight-on traffic lanes

At large signalised junctions, a cycle lane can be introduced between the right-turn and the straight-on traffic lanes. The underlying idea is to replace the conflict between motor vehicles turning right and straight-on cyclists by having a less dangerous merging situation before the junction. At the same time straight-on riding cyclists are more visible for oncoming motorists turning left. This measure can be combined with a cycle crossing in the junction area. An accident study of this measure has not been able to document any safety impact ⁸⁵.

Mixed traffic

In entry roads to a signalised junction with mixed traffic a short cycle lane can be established over the last 20-50 m before the junction. Cyclists are then given their own area up to the junction which results in lower perceived risk and greater ease of passage. Furthermore, this makes it possible to mark a cycle crossing through the junction.

Cycle crossing

Cycle crossings can be established at junctions where it is considered necessary to draw attention to conflicts between straight-on going cyclists and turning motorists. Apart from making the conflict area clearer, the cycle crossing separates cyclists and motorists from each other visually and makes cyclists feel safer.

In Denmark there are four different types of cycle crossing. One is blue, while the others are marked by white broken 0.3 m wide edge lines. Bicycle symbols are always marked.

An accident study of cycle crossings at signalised junctions has shown that the marking of cycle crossings has led to a 36% reduction in the number of bicycle accidents and as much as 57% in the number of severely injured cyclists. The study showed, furthermore, that especially accidents between motor vehicles turning left and straight-on cyclists were reduced by introducing cycle crossings at large junctions. Motorists seem to have transferred some of their awareness from pedestrians to cyclists as there was an increase in pedestrian accidents ⁵⁵.

Mini cycle lane and blue cycle crossing at signalised junction.



PHOTO: Road Directorate

Staggered stop lines

At all signalised junctions it is recommended to recess the stop lines for motor vehicles by 5 m in all traffic lanes relative to the pedestrian crossing or the cyclists' stop line. Staggered stop lines make pedestrians and cyclists more visible in connection with a change of signal, and means that vulnerable road users enter the junction earlier so that many conflicts are avoided. An accident study showed a 35% reduction in the number of accidents between motor vehicles turning right and straight-on riding cyclists, and 50% in the number of injured cyclists in this type of accident ⁴⁵.

In fatal accidents where a bicycle/moped is hit by another

vehicle turning right, in 90% of cases the other party is a truck ⁷. Staggered stop lines make cyclists more visible to truck drivers.

Advanced stop lines

At signalised crossings advanced stop lines can be established with bicycle symbols in front of the stop lines for motor vehicles in the turning lanes. This makes it possible for cyclists who stop at a red light to keep in front of the motor vehicles. The advantage is that cyclists who stop at a red light become more visible for turning motor vehicles and that the cyclists enter the junction before the motor vehicles. Advanced stop lines in front of left-turn lanes must only be marked on side roads at signalised T-junctions. At present advanced stop lines

require special dispensation under the Road Standards and Guidelines in Denmark.

Channelisation of cyclists at junctions

At junctions with a high proportion of cyclists it can be a good idea to channel cyclists into a separate right-turn lane and a straight-on lane. The advantage is that cyclists thereby place themselves optimally before entering the junction. The lanes should be so broad that two cyclists can stop side by side, that is at least 1.85 m ¹²². Without channelisation there is a risk of cyclists stopping in front of the stop line, in the pedestrian crossing and in front of the motor vehicles – and they will cycle on the footway.

If there is a right turning stage cyclists should always be channelled. With many cyclists turning right a traffic island between right turning and straight-on cyclists may be a good idea. In both signalised and priority T-crossings it is a good idea to have a left-turn lane for cyclists.

Roundabouts

Roundabouts are often used to improve road safety in Denmark, in rural as well as in urban areas. Roundabouts can also be used to reduce speed. Roundabouts often improve the traffic flow where they are used as a substitute for signalised junctions. In roundabouts the risk of accidents is low because of left turns and cross direction collisions is eliminated. Roundabouts do not always reduce the number of bicycle accidents, but generally make them less severe. For people with impaired eyesight it is especially difficult to manoeuvre in roundabouts. The major part of bicycle accidents involves entering motor vehicles.



PHOTO: Road Directorate

Advanced stop line in front of a left-turn lane.



PHOTO: Road Directorate

Advanced stop line in front of a right-turn lane.



PHOTO: Road Directorate

The two-way cycle path should cross the road further away from the roundabout or be transformed into a one-way cycle track and placed closer to the circulating lane where motorists have to give way for cyclists.

Roundabouts can be designed with one or more circulating lanes and traffic lanes in entries and exits. With more than one lane in the circulatory carriageway or entry or exit, it is not advisable to allow bicycle traffic in the roundabout. Here bicycle traffic should be led round outside the roundabout. The 3 signalised roundabouts in Denmark do not provide basis for much experience.

Cycle paths close to the circulatory carriageway where motor vehicles have to give way will not be adequate safe as motorists tend to

believe that there is only one-way traffic in the roundabout.

In general, entry traffic lanes should not be broader than 3.5 m, but may be narrower for small and medium-sized roundabouts. Exit traffic lanes should not be broader than 4 m. Overrun areas with sett paving can make it easier for trucks and buses to get round.

Rural roundabouts

In the open landscape roundabouts are normally relatively dynamic, which means that circulating motor vehicles can drive relatively fast.

This is possible where there is a large central island of 20-40 m in diameter and triangular or trumpet islands in the branches of the roundabout.

In dynamic roundabouts, bicycles should not be permitted in the roundabout itself. Instead cyclists should be led onto a path about 30 m away from the circulatory carriageway and cross the road with an obligation to give way to traffic on the road. To prevent cyclists from having to make too big a detour a two-way cycle path may be a good solution. Another solution is to lead cyclists through a tunnel at a lower level than the roundabout. This can be recommended for very busy roads with 4 or 6 traffic lanes.

Less dynamic roundabouts with a central island of 10-20 m in diameter and parallel or small triangular islands in the branches of the roundabout may be used by cyclists. In these roundabouts it is important that cyclists are led round the roundabout on a one-way cycle track, and there should be cycle tracks on entry and exit roads.

Cars can drive fast in this roundabout.



PHOTO: Road Directorate

Cycle tracks and islands in less dynamic roundabouts should be designed to reduce speeds. The practice in Denmark is to establish cycle tracks next to the circulatory carriageway, and we have no experience of cycle tracks placed at a distance of 3-7 m from the circulatory carriageway. Experience from Sweden, Germany and Holland has shown that it is safer to have a shoulder of about 5 m between the cycle track and the circulatory carriageway. Bicycle traffic should be one-way and have priority over motor vehicles ^{12, 18, 19, 33, 136}.

Roundabouts in towns

In towns speeds are lower. Roundabouts in towns are, therefore, normally smaller than in rural areas, and have a greater speed reducing effect. There are more vulnerable road users in roundabouts in towns, and this should be a basic point of departure for their design.

Cycle lanes in roundabouts should be used with caution, as the establishment of a cycle lane means an increase in the circulatory carriageway, which motorists may use to increase speed. Furthermore, without physical separation there is a

risk that cyclists will be squeezed on entry and exit roads.

In roundabouts with not much traffic on roads with speed limits of 30-50 kph, cyclists should be mixed with motor vehicles in the 1-lane circulatory carriageway. Here the roundabout should have a strong speed reducing effect. The central island should have a diameter of only about 10 m, and no islands are necessary in the branches of the roundabouts. Another possibility is roundabouts on a raised surface.

In larger roundabouts with a central island of 15-20 m in diameter it may be an advantage to establish a cycle track, the best location of which is presumably 5 m from the 1-lane circulatory carriageway. If there is no space for a cycle track, and if the roundabout is used by less than about 8,000 motor vehicles per day, a possible alternative is to design the circulatory carriageway without a cycle facility or with a cycle lane and narrow circulating traffic lane. Where the traffic volume is larger, and there is not so much space – consider introducing a smaller central island or signalised junction.

In even larger roundabouts in towns with a central island of 20-30 m in diameter, traffic volumes and speeds are usually so high that bicycles should not be mixed with the motor traffic. In this case, roundabouts with one traffic lane in the circulatory carriageway and in entry and exit roads, a cycle track should be established 5-7 m from the circulatory carriageway. It may be a good idea to place this cycle track on a raised surface.

Mini-roundabouts

It is possible to drive over the central island in mini-roundabouts. The capacity for a mini-roundabout is about 15,000 motor vehicles per day. Mini-roundabouts are used where the speed limit is up to 50 kph. A mini-roundabout costs only about one tenth of an ordinary roundabout, and the inscribed circle diameter is only 15-25 m. Mini-roundabouts may with advantage be established as part of traffic calming of an area or a major road.

The priority situation must be clearly signed in the mini-roundabout. There may be road safety benefits from placing the mini-roundabout on a raised surface.

A large mini-roundabout, maybe the cycle lane brings bad luck.



PHOTO: Philip Rasmussens Tegnestue



PHOTO: Lars Bahi

Wheeling the bicycle is permitted.

idea to allow cyclists more access to pedestrian areas than is the case today.

Cyclists and pedestrian areas

Bicycle traffic is prohibited in some pedestrian areas. Where cycling is permitted in pedestrian areas, and where there is neither a cycle track nor a cycle lane, cyclists must always give way to pedestrians. Instead of totally prohibiting bicycle traffic in a pedestrian area, cycling can be permitted in certain periods, for instance, outside the opening hours of shops, when pedestrian traffic is often modest.

If there is enough room and a suitable number of pedestrians, a cycle track can be established. This reduces the number of conflicts between cyclists and pedestrians. The drawback of a cycle track is that it may be a barrier to crossing pedestrians. For mobility impaired people a cycle track is an extra barrier, while people with impaired eyesight find it easier to orientate themselves because of the separation from cyclists.

Where there is a cycle track in a pedestrian street, a change in pavement and level (2-7 cm) should make road users more aware of where they are.

In mini-roundabouts with low traffic volumes, cyclists should be mixed with the motor vehicles in the circulatory carriageway. In this case the mini-roundabout should have a very speed reducing effect. In mini-roundabouts with over 6,000-8,000 motor vehicles per day, a cycle track should be sited about 5 m from the circulatory carriageway.

Pedestrian areas and squares

In Denmark pedestrians, cyclists and motorists are often separated from each other so that each type of traffic has its own area. There are relatively few places where motor vehicles, bicycles and pedestrians share the same area. Motor vehicles and bicycles may use pedestrian streets if they show special attention and consideration to pedestrians - and always give way to them. Cyclists etc may be prohibited access to pedestrian streets by signing.

Many cyclists shop in town and are therefore cyclists as well as pedestrians. Therefore, it may be a good



PHOTO: Road Directorate

The pedestrian street is a 5-9 am short cut for cyclists.



PHOTO: Road Directorate

Two-way cycle track in a pedestrian street.



PHOTO: Lars Bahl

Do one's shopping.

Design of squares

The concept of squares covers many things – from large centrally situated squares and market places to intimate little open spaces. In connection with traffic calming there has been great interest in recreating the urban square as a meeting and market place.

Many squares have again been made wholly or partially car-free; parking spaces have been removed and new pavements and vegetation established. In most squares there are benches and possibly open air serving of food and drink, where one can sit down and have a well-deserved breather to the benefit of all.

Bicycle traffic in the square may be avoided by closing short cuts for cyclists, or making the pavement difficult to ride over, for instance,

by establishing cobblestones, stairs or guard rails. The police cannot enforce a prohibition against bicycle traffic if the square is a convenient shortcut for cyclists. Regardless of whether bicycle traffic is permitted or not, it is important to establish cycle racks, thereby avoiding randomly parked bicycles.



PHOTO: Lars Bahl

Shared-use roads

There are many good examples of a shared-use roads in Denmark. Here pedestrians, cyclists and motor vehicles share the street, but on the premises of the pedestrians. Shared-use roads have a very low speed limit and may be a one-way street. In Denmark there are many shared-



PHOTO: Road Directorate

use roads that are inspired by the Dutch 'woonerf'. In Denmark the carriageway and footway must not be separated, and there must not be any through-going difference of height in the cross section of the street. The part of the road, which is suited for motor traffic may be marked, for instance, by a change in pavement.

Speed reducers are necessary in some shared-use roads.

Bridges, tunnels, hills and stairs

Bridges

Especially for pedestrians, cyclists and trucks high guard rails/safety fences are necessary on bridges. Guard rails are recommended to be 1.2 m high. It must not be possible for the cyclist to slip under the guard rails.

On bridges with strong winds cyclists may derive benefit from windshields. Owing to lack of experience with windshields there are no recommended heights. Another possibility is to establish indoor cycle tracks.

Tunnels

Lighting in and outside tunnels is extremely important. Some tunnels should be lighted round the clock – it should be possible to see what is going on in the tunnel from the outside – and one should preferably be able to see through the tunnel.

Pedestrians and cyclists should always be separated in tunnels. Barriers, bollards and sharp bends should not occur inside or just outside tunnels.

Stairs

Wheeling ramps may be recommended on stairs – especially at stations, underground bicycle parking, bridges and tunnels. Almost all



PHOTO: Road Directorate

Dark, narrow, sharp bend – it brings bad luck!



PHOTO: Road Directorate

Combined wheeling ramp for cyclists and prams.

cyclists wheel their bicycles at their right side. Where space is narrow, it is most important to have an upward wheeling ramp. A ramp at both sides of the staircase is important so that it is easy to get up and down the staircase with the bicycle.

At stations etc, a broad double staircase with a rail in the middle is preferable. If prams etc, are also going to use the wheeling ramp, the design must be adapted to this purpose.

The wheeling ramp should be 0.3 m broad, and the rail be placed so high up that it is not in the way of people wheeling their bicycles. In places with many cycle tourists 0.5-0.6 m broad wheeling ramps may be desirable so that it will not be necessary to take off the panniers in order to use the ramp. But do not use broad wheeling ramps on stairs



PHOTO: Road Directorate

A well-designed tunnel, but the staircase lacks wheeling ramps.



PHOTO: Road Directorate

A long walk may be the result of missing wheeling ramps.

with a modest or moderate slope because cyclists will cycle down broad ramps, and this can be dangerous.

It is possible to insert a wheel groove in the ramp, which will make it easier to wheel the bicycle. The stairs should not have a gradient of above 25 degrees – otherwise the bicycle will be difficult to wheel upwards and to control on the way down.

Hills

Vertical curves have previously been dealt with on page 79. But a number of other possibilities will be described here of obviating the effect of steep hills, namely fewer cyclists.

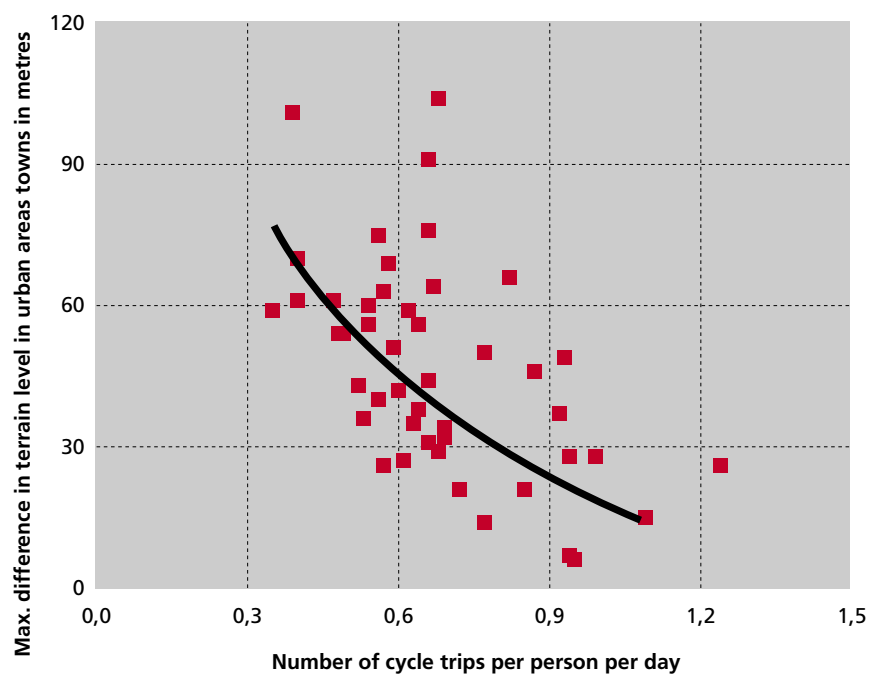
A small hill does not affect mode choice in a town, but ridges and higher hills of just 50 m have large impacts. When expanding the town, hilly areas should be avoided, and the town should be concentrated in flat areas.

Relation between configuration of the ground and mode choice in Danish towns with 10,000-70,000 inhabitants. In fact, the hills is the most important factor for the number of cyclists.



PHOTO: Jens Erik Larsen

Too steep to cycle.



With sensible planning of paths and roads even large hills can be avoided, although this will mean a minor detour. In the case of steep hills it may be sensible to sign alternative cycle routes or take refuge in expensive methods such as bicycle lifts, escalators or lifts.

One-way streets

The many traffic destinations at the centre of town make it important to be able to cycle in both directions in all streets. If only the street is sufficiently broad, two-way bicycle traffic can function in one-way streets without causing traffic flow or safety problems. Special attention should be paid to junction design.

One-way traffic in Denmark is primarily introduced in order to reduce traffic volumes by establishing one-way streets so that they meet one another or to make it possible to park. In contrast to, for instance Spain and the USA, no Danish towns have a network of one-way roads that can improve the traffic flow.

Cross section

With a special contra-flow area for cyclists, these cyclists will perhaps get to their destinations a little faster. A question still left to be answered is whether such separate areas improve the safety of cyclists as cyclists will be less alert whereas the one-way motor traffic will be more conscious of contra-flow cycling. In addition, motor vehicles passing parked vehicles may create problems for the contra-flow cycling.

In one-way streets with few cars it is not necessary to have a special area for contra-flow cyclists. In streets with more traffic, a cycle track or cycle lane may be established for contra-flow cyclists. The cycle track should be at least 1.7 m



broad, while the cycle lane should be 1.5 m broad. If there is car parking just outside the cycle facility, this should be at least 2.0 m broad. It is a good idea to give the cycle facility a different pavement.

With parking on the left side of the road, a cycle track or lane to the left of parked vehicles is important as motorists parked on the left side of the road have difficulty in seeing contra-flow cyclists on the right side of their vehicle.

In order to avoid illegal or undesirable parking the solution in narrow streets may be the setting up of bollards. There should be no kerbs in

these streets so that cyclists find it easier to get round vehicles obstructing their way. These streets may be signed to 15 kph.

In one-way local streets that are located next to arterials and boulevards contra-flow cycling is not desirable. Here speeds and/or traffic volumes are often high.

Junctions

Especially at junctions with speeds of 40 kph or more, traffic islands and footway widenings are sensible solutions to avoid parking close to junctions and to make cyclists moving in the “wrong” direction more visible. This makes it possible for

Wide contra-flow cycle lane.





PHOTO: Road Directorate

Motorists are informed about contra-flow cycling.

contra-flow bicycle traffic to enter and exit the one-way street safely.

At junctions with lower speeds, signing, change in pavement and bollards may be sufficient if this in itself can prevent parking close to junctions and thus create good visibility.

Safety

A German study concludes that contra-flow cycling is safer than

cycling in the direction of travelling in one-way streets ⁴⁹.

Promotion

Contra-flow cycling in one-way streets clearly awards cyclists preferential treatment by giving them a shorter route than motorists. At the same time contra-flow cycling, which takes place every day, irrespective of any prohibition, is legalised.

Traffic control measures

Permanent road closure

Road closures are carried out in Denmark primarily to avoid through-going motor traffic. Road closures are increasingly being used in order to reduce the total volume of motor traffic in town centres and to improve road safety. When urban areas are divided into zones by means of road closures, short car trips become less attractive.

Road closures are most often carried out in connection with junctions. Remember that motorists have a need to turn at one or both sides of the road closure, and this poses certain design requirements. To avoid irritating turning manoeuvres, the cul-de-sac sign should be visible.

It should be easy to cycle through a road closure as the purpose of road closures is only rarely to prevent cyclists from passing through. Cyclists ought to be able to pass through two openings, each 1.3-1.4 m broad. One idea may be to establish the cycle gaps just beside each other with a removable bollard as separation, thus making it easier to clean and maintain the area of the road closure. It is extremely important not to have parking in front of the cycle gap.

Planting vegetation, bollards or high kerbs without asphalt slopes emphasize the purpose of the road closure.

Intelligent/time-controlled road closure

In central urban areas the town environment would be considerably improved, if commuters did not enter the area by car, and through-going motor traffic was made impossible. With bollards that can be raised and lowered and access



PHOTO: Road Directorate

The traffic island prevents parking close to the junction.



PHOTO: Road Directorate

The street was fully reconstructed into playground and cycle-footway.



PHOTO: Road Directorate

Cyclists can easily passage this road closure.



PHOTO: Road Directorate

Bicycle racks is part of the road closure.

cards, unwanted motorists can be kept out from an urban area. Access cards may be given to residents, ambulances, police, refuse collection, shopkeepers etc.

By lowering the bollards for some hours every day, vehicles will be able to deliver goods to shops and companies. Conversely, the bollards may be raised during the periods when most people are on their way to work. Exits from the area should be designed so that it is always possible to leave by vehicle. Thus nobody are trapped, and it will be easier for vehicles to leave the area.

Bus gate

Just as in the case of road closures, the purpose of the bus gate is to reduce motor traffic and thereby give higher priority to pedestrian, bicycle and bus traffic. The bus gate can contribute to the bus plan being kept without delays. The bus gate can of course be made intelligent/time-controlled just like road closures.

The simple bus gate just signs the prohibition to enter for other motor traffic. Physical barriers to other traffic such as barriers, which can be raised/lowered by activating a transmitter in the bus, are often necessary. Another and often better possibility is a lane width obstruction, whereby only broad vehicles can pass at low speed. Bus gates should always be equipped with 1.3-1.4 m broad cycle gaps at both sides of the road.

Other gates, for instance, for trams, trucks etc, may also be established, but always remember the cycle gaps.

Regulating parking

In locations where there is a great need for stopping or parking, signs prohibiting stopping or parking are sometimes not sufficient.



PHOTO: Road Directorate

Lane width obstruction and cycle gates.



PHOTO: Road Directorate

This truck gate is difficult to pass for cyclists without illegally cycling on the footway.



PHOTO: Road Directorate

Cycle track with illegal chicanes.

Many motorists know that they must not park less than 10 m from a junction in Denmark, but they park illegally without realising it as the parking prohibition is rarely marked. Discreet but visible marking is preferable.

Parking is illegal on cycle tracks and cycle lanes and is at the same time regarded negatively by cyclists¹¹⁴. Parking on narrow roads with much traffic, double parking and parking on cycle tracks and lanes can make cycling very risky.

Double parking can be avoided by narrowing the street or introducing time-limited parking. Taxi stands at large hotels, traffic terminals, pedestrian streets and restaurants, cafes, night clubs and pubs etc, can in many cases be a good solution. Kiss-and-ride places at schools, traffic terminals etc, may also be necessary.

In shopping streets the argument of shopkeepers is often to allow parking since unloading of goods always is necessary. One possibility is to allow parking only for the unloading of goods outside relevant shops. Parking to unload goods should take place at specially prescribed places, which can otherwise be used as pedestrian areas.

20-25 cm high kerbs or bollards are a last resort to avoid illegal stopping and parking. Bollards and high kerbs can make cyclists feel unsafe and increase the risk of single accidents with fixed objects. Therefore, a good distance should be ensured – at least 30 cm – between bollards and cyclists, and road safety should be closely considered.

Direction signing and cycle maps

Planning for cyclists is not merely a matter of paths and roads. Direction signing and information are also important parameters. It is especially important that construction, direction signing and information are planned and implemented in a closely co-ordinated process.



Contents

Direction signing	102
Signing of cycle routes	102
Size and placing of signs	104
User studies	104
Signing in other countries	104
Service signing	104
Direction signing to bicycle parking	105
Cycle maps	105
Cycle maps of urban areas	105

Direction signing

Direction signing is what links cycle paths, cycle tracks, minor local roads, forest roads etc, together to form cycle routes. It was a huge improvement for cyclists when the new Road Standards and Guidelines for direction signing were introduced in Denmark in 1991. As a result the sporadically occurring local signs were replaced by a coherent signing system of cycle routes.

In 1999 the Road Standards and Guidelines appeared in a revised version, which incorporates the practical experience gained in connection with direction signing during the 1990s, including national cycle routes opened in 1993¹¹⁸. The new standards concern route signing, signing to and from routes and signing outside routes. There is also a section on information boards and cycle maps with a view to ensuring that the same colours and symbols are used in direction signing and maps.



PHOTO: Jens Erik Larsen

Direction signing for cyclists should be sufficiently clear without being an eyesore, and it should be of the same standard as signing for motorists, but at the same time clearly distinguishable so that there can be no doubt as to who the signs are for.

Signing of cycle routes

This direction signing has made possible the development of local, regional and national cycle routes. Today there are thousands of kilo-

metres of signed cycle routes. The Road Standards and Guidelines concerning direction signing from 1999 divide cycle routes into three categories with the numbers:

National routes 1-15
Regional routes 16-99
Local routes 100-999

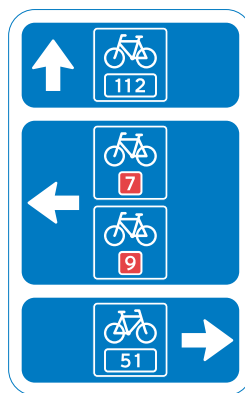
It is also permitted to use supplementary names. For local routes a name is sufficient, and logos may also be used, eg a pig for The Pig Track etc. The latter is due to the tourist industry's wish for a more vivid marking of local routes. However, the guidelines ensure uniformity of colour with a white logo on a blue background.

Route signing is also used in urban areas, where both national and regional routes pass through town centres, while local routes may be given names like "The Commuter Route", "The Centre Route" and, for instance, connect residential areas with city centres.

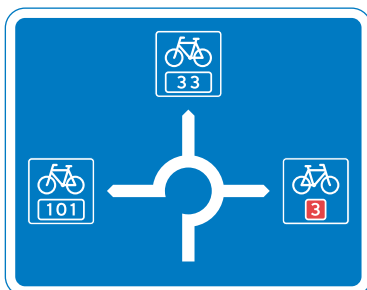
The most used direction signs are route signs, which are usually square, measuring 40x40, 30x30, 20x20 or even as little as 10x10 cm in woods and the like. This kind of sign is mainly used to confirm the route, but can also be found at minor crossroads, where the sign may be placed a short way down the route one is supposed to take.



Route signs for national, regional and local routes.



Arrow direction signs, stack-type direction signs and map-type direction signs.



The sign can also be supplemented with an arrow on a separate board below, and geographical destinations can also be shown on such boards.

The identification of the route consists of a bicycle symbol and the route number/name/logo. No arrows or other symbols may be placed within this identification frame. The identification of the route reappears on all types of sign, including arrow direction signs, stack-type direction signs and map-type direction signs.

Arrow direction signs are used at major junctions and when it is necessary to indicate a number of geographical destinations in connection with a change of direction in the

The sign changes in course of time.

route. Stack-type direction signs are used immediately before a junction when, for example, information about more than one route is required. Map-type direction signs can be used at very complex junctions and at roundabouts.

In a number of Danish town centres, cycle routes are marked by special concrete elements or paving slabs. It can be difficult to find one's way in the crooked streets and also to see signs, so that it may be an advantage to use marking on the road surface or cycle track.



PHOTO: Jens Erik Larsen

Size and placing of signs

It is very important that cyclists should realise that they need to look out for blue signs and that these signs are information for cyclists. It helps, however, if the signs are always placed on the same side of the road and at the same height. This makes it possible to keep the signs as small as possible while ensuring that they are seen by cyclists.

Most cyclists ride in a slightly bent forward position and with their eyes on the road surface in front of them, which means that signs must be low. However, not too low because of the risk of their being covered by grass etc, in summer and snow in winter. The most suitable placing is therefore about one meter above pavement level and on the right side of the road.

The size of the signs must be determined by vehicle speeds and the amount of information they contain. Reading distances and size of letters have been tested in practice. Further details concerning the choice and design of signs is to be found in Road standards and guidelines for direction signing on cycle and walking routes (in Danish) from the Road Directorate.

User studies

No detailed studies have been carried out of cyclists' understanding of and views on the direction signing of cycle routes. However, the Danish Tourist Board has carried out an interview survey of cycle tourists in Denmark and, among other things, asked about tourists' satisfaction with the national cycle routes and their signing. Germans gave the signing an average of 4.6 points out of a maximum of 5, while with 4.2 points Danes were slightly less enthusiastic but nevertheless quite well satisfied²³.



PHOTO: Jens Erik Larsen

Signing in Switzerland.

Signing in other countries

Taken as a whole, the signing of Danish cycle routes is coherent and consistent and of the same standard as signing for other road users, if it lives up to the requirement of the Road Standards. This is not the case in a number of other countries, where there is often relatively little signing, sometimes in the form of adhesive labels and the like. In recent years, however, some countries have introduced good signing systems.

This is the case, for example, in Switzerland, which has acquired a good signing system in connection with the establishment of a national system of cycle routes. One new idea here is that there is also room for logos on the national route signs, for instance, for international routes. An example of this is The Three Countries Route, which passes through Switzerland, France and Germany and has a green triangle as its logo. In addition, the signs indicate, where relevant, how much the route rises within the next kilometres, eg 630 m in the next 7.5 km. One sign indicates where one must wheel one's bicycle – not with respect to the steep mountain

climbs, but for short stretches in towns where the route passes through very narrow streets or pedestrian areas.

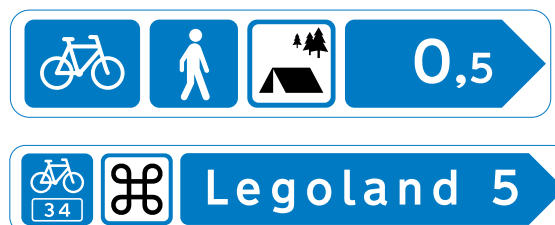
Service signing

Like other road users, cyclists also need directions for services. The Danish Road Standards and Guidelines describe how directions to tourist attractions, camping sites, beaches, stations, ferries etc, should be given in the form of signs.

In principle, all the normal service symbols can be used. A new symbol shows the routes to camping sites for cyclists etc. This symbol has, for example, already been used in a number of places along the national cycle routes.

For normal ordinary direction signing inverse colours are used, ie a blue text on a white background. Arrow direction signs have a white text on a blue background in order to keep the colour scheme simple. Service symbols are, however, black.

Special service direction signing is only used when cyclists have to use



Service signing.



Service signing to bicycle parking.

other routes than motorists. To date service direction signing has not been introduced to any great extent, but as a result of the increasing interest in cycle tourists Funen County is, for example, now planning to sign to local sights along cycle routes at places where there are at present no such signs.

Direction signing to bicycle parking

Especially in densely built-up areas, near stations etc, it is relevant to sign clearly to bicycle parking. Unfortunately it is more common to see signs saying No bicycle parking than directions to parking. There are, however, examples of service signing to bicycle parking.

Most frequently the sign consists of the bicycle symbol on a blue background with a P in one corner and possibly also an arrow. The Danish Standard bicycle symbol, black on white, is used by DSB. In other places one can see a broad range of signs. As yet, the Road Standards and Guidelines do not contain a specific proposal for this sign, except that "bicycle parking" can be written on a service arrow direction sign.

Cycle maps

Cycle maps can be used both for planning one's route and to find one's way, and for tourists the map can be a nice memento of the tour afterwards. Finally, cycle maps can contain practical information concerning services on the route like accommodation, eating places, shops, bicycle repairs etc.

The counties in Denmark have published good cycle maps – most of them with a scale of 1:100,000, which are excellent for cycling in rural areas. The signatures and formats of the maps have been harmonised on the basis of the Association of County Councils manual, which has been by and large followed by the individual counties⁵.

Local cycle maps have been published with a scale of 1:50,000 in certain tourist areas. In addition to the signed national and regional routes these maps show local routes and suggestions for tours. Good examples can be found in North Funen and on Langeland. The local population can also make good use of these maps for leisure activities.

Cycle maps of urban areas

Here there is a need for maps on a more detailed scale and of a handier format and scope. These maps usually contain a 1:100,000 key map, a 1:25,000 town map and a 1:10,000 town centre map. These are suitable scales because the cyclist needs to be able to compare with regional maps, and all major roads and preferably also all the streets in the centre should be named.

Furthermore, the most important destinations for both locals and tourists are included. The signature key should preferably be in Danish, English and German even though the maps are primarily intended for local use.



Cycle maps is easy accessible.

Cycle maps for urban areas are important for both established residents and people who have just moved to the town and are not acquainted with the system of cycle tracks and paths. The maps should both help people to find the way and also motivate them to cycle, thereby enhancing their quality of life. The maps can present ideas for trying out different routes, can be used for the Sunday cycle trip out of the town and can show where good locked or supervised bicycle parking is to be found, so that there is no cause to worry about theft while visiting the town.

Camping site to the left.



Bicycle parking

Bicycles are usually parked for 23 or more out of every 24 hours. With more than 1,500 bicycles per square km, parked bicycles are a common feature of the urban scene in Denmark.

Bicycles can be quickly, easily, stably under cover, in storeys, automatically, secured against theft and exclusively parked close to one's home or destination. Here are some examples of how.

Bicycle parking merits more attention, professionalism and new thinking. The one per cent of the urban space – indoors and outdoors – that is occupied by parked bicycles can be organised and arranged more practically and elegantly.



Contents

Planning	108
Placing	108
Capacity	109
Standard	111
Supervision and service	112
Recreational bicycle parking	114
The process	114
Construction projects	114
Finance	114
Maintenance	115

Planning

Good bicycle parking facilities can tidy up public and private spaces, prevent bicycle thefts and promote cycling.

By being visionary it is always possible to create space for sufficient bicycle parking facilities at the right place and of the right standard. Problem identification is important in order to improve the conditions in the right way.

A clear division of responsibilities between administrations, companies and citizens is essential. The responsibilities should coincide with ambitions, targets and funds.



PHOTO: Linda Hansen

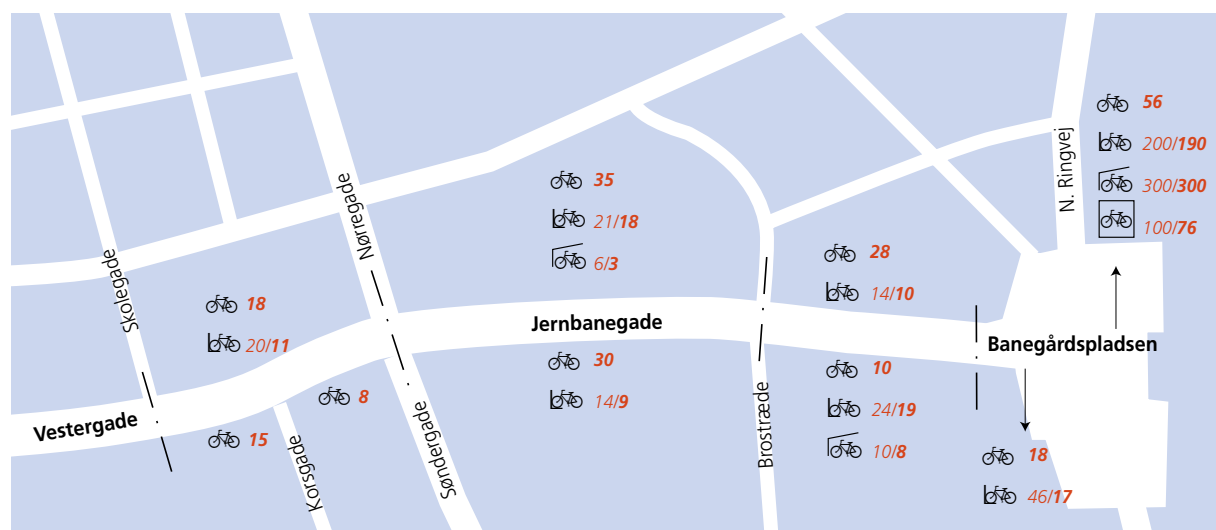
Lack of parking facilities creates a mesh in the streets.

Placing

The need for bicycle parking facilities can partly be calculated from the number of parked bicycles. It is a good idea to make a map showing the existing number of bicycle parking facilities supplemented with the number of parked bicycles both in and outside racks during peak periods.

In many places one sees bicycles parked outside a rack even though there are plenty of vacant spaces. This may be due to the fact that the bicycle parking facilities are awkwardly positioned, of the wrong standard or of poor quality.

Another important factor, which is often crucial for the appropriate choice of standard for a parking facility, is the duration of parking. At the same time cyclists will be willing to park further away from destinations, if the standard is high, eg locked and covered.



- No rack
- Rack
- Covered rack
- Locked, supervised and covered rack

Example of bicycle parking map of city centre. In a peak period the following is registered: Number of racks divided into 3 standards, ie rack, covered and locked/supervised, and peak load for 4 standards, ie no facilities, rack, covered, locked/supervised bicycle parking. The bold numbers refer to how many of the cycle stands that are used.

There should be sufficient parking facilities of the most appropriate standards at all major destinations:

- Workplaces
- Educational institutions
- Stations and major bus stops
- Town centres
- Shopping centres and department stores
- Places of entertainment and cultural institutions
- Stadiums and sports facilities
- Recreational destinations (woods, beaches etc)

Less important destinations are not so critical because it is easy to place a bicycle on its own kickstand or up against some object. Of course such destinations may prove to have a large need of bicycle parking, in which case they are promoted to “major destinations”.

One particularly important and critical aspect is bicycle parking for residents in large housing complexes. The bigger the complex, the more critical the problem because here the bicycle is out of sight and thus more exposed to vandalism and theft.

Bicycle parking in attractive sheds, cellars or the like, where the bicycles are locked up and at the same time protected from the weather should be standard and stipulated in

PHOTO: Linda Hansen



Good bicycle parking facility to employees.

the district plan. The cost is as a rule lower than for car parking, even though in Danish housing complexes with flats or rooms, the need for bicycle parking places is usually 2-12 times higher than the need for car parking. There is also a need for uncovered racks close to buildings for cycling visitors and short-term resident parking.

For detached and terrace houses and low-rise developments the problem is not normally so critical. The

bicycles of individual households can be placed inside garden gates under more or less organised and reasonably secure conditions.

Capacity

It can be difficult to determine what the actual need is. Often one will have to begin by establishing parking for the number of bicycles presently placed outside racks, and then successively develop the system as more and more bicycles come.

Experience has shown that at places where there are many bicycles, eg public transport terminals, fewer bicycles are parked if there are too few places. And, conversely, when the capacity is expanded, more bicycles appear.

Capacity should be estimated in terms of the need for short-term, hourly, all day and night parking, so that the needs for different standards of parking can be calculated.

Typical bicycle parking cellar in housing complex.



PHOTO: Linda Hansen



PHOTO: Road Directorate

Enlargement has begun – more parking facilities are still needed.

At the biggest destinations, eg stations, department stores, major workplaces in town centres etc, there will often be a lack of space. Here there are in principle two possibilities to choose between:

Reallocate space in favour of bicycle parking, eg by taking car parking space for bicycle parking either in parking lots, where sizeable areas can be appropriated, or from curbside parking, which will typically provide 8-10 bicycle spaces for each car space.

Compression of bicycle parking by:

- more efficient design
- establishment of two-storey bicycle parking
- establishment of multi-storey bicycle parks
- automated bicycle parks

Supervision

Establish on-going day and night registration of utilisation of individual bicycle parking facilities, so that overcrowding can be detected in good time and extra capacity provided.

Overcrowding is registered as the number of bicycles outside the



PHOTO: Road Directorate

Two-storey bicycle parking.

racks. Overcrowding can, in fact, occur even though the parking facility is not entirely full, eg if some of the places are regarded by users as being too far away, while the nearest spots are jammed with bicycles. A good idea is to place the covered racks furthest away from the main entrance in order to spread the parked bicycles.

Day-time utilisation is best registered between 10 a.m. and 12 noon, and night-time utilisation between 9 pm and 6 am. Outside shops, Friday afternoon and Saturday morning are often peak periods, while for places of entertainment and sports facilities peak loads occur in connection with major public attractions.

Parking ban for cars, eg at junctions, can be an advantage for cyclists.



PHOTO: Linda Hansen



PHOTO: Bike Parking Systems AG

An automated bicycle park.

Standard

In principle, there are 4 standards for bicycle parking conditions: no rack, rack, covered rack, locked/supervised and covered rack. The criteria for choosing the relevant standard might be as follows:

- For short-term parking under 30 minutes it should be possible to place the bicycle on its kickstand or in a rack right next to the main entrance, but it is not necessary to be able to lock the bicycle to the rack.
- For parking by the hour up to 4 hours it should be possible to chain the front wheel and the frame to the rack, and cover of the rack should be considered.
- All-day parking at workplaces, schools, places of education and terminals should be covered, and it should be possible to lock the bicycle to the rack; the need for a supervised/locked room should be considered in relation to the fear of theft.
- All-night parking for homes and terminals should be in a covered, locked room.

Basic design requirements

There are many types of bicycle parking facilities. One of the basic problems with some of these well-intentioned facilities is that not only do they function badly, but they also offend against Danish architecture and design.

It is important that the design should be striking, attractive, streamlined and functional. It should signal innovation - not only when new but also after a year's use. For example paintwork gets worn where it is in contact with the bicycles. Furthermore, design and materials should also take into account what the facility looks like when there are no bicycles in it.

Like the bicycle itself, the ideal bicycle parking facility is a simple

machine that is straightforward to use. This means that it must be easy and quick to place and remove one's bicycle and that the facility is to get to and from. It should be easy to use the rack and the locking mechanism.

Many bicycles carry baskets, which means that a width of 70 cm is necessary both in front for the handlebars and behind for panniers and other baskets. Carrier cycles and cycle trailers may necessitate an area for free-standing larger bicycles.

If the design is good, bicycle parking facilities can fit in with their surroundings. Bicycle parking should not dominate the scene and must under no circumstance be alarming or ugly. The design should actually contribute to embellishing the physical surroundings. It is generally advisable to aim at ensuring that the total impression is fairly calm and to avoid too many different kinds of solution.

Placing and design should provide a sense of security. Social safety while parking is important as the cyclist is considerably more vulnerable to violence than while cycling.

This poses demands of lighting and transparency and means that it should be easy for passers-by or people who have other business at the spot, such as taxi drivers, shopkeepers etc, to see what is happening in the facility. Bicycle parking can be placed where it is natural for people to pass by, and it should not constitute a hindrance for pedestrians or disabled people.

Depending on the need, bicycle parking must be effectively secured against theft and vandalism. This can be ensured by providing lock-up parking or supervision or by making it easy for bicycles to be locked to the rack.

User-friendliness can be checked through observations of user behaviour or by asking users or by tests. It is a good idea to let representative users test a prototype or specimens of a rack before setting up the whole facility. In this way the construction, space conditions and access can be tested in practice.

Differences in user-friendliness of racks that respectively support the bicycle's wheel, saddle, frame and handlebar have not yet been studied. The pavement should slant



PHOTO: Linda Hansen

down towards the bicycle wheel rack, so bicycles do not fall out of the rack.

Bicycle parking should be easy to find and easy to take in at a glance. Where necessary, clear signs should be set up to show where one can find different types of parking.

The routes to and from bicycle parking should be secure, safe and convenient. Bicycle parking should be properly linked to the cycle network. There should be sufficient room for cyclists to brake and get off or on their bicycles safely.

Requirements for attractive bicycle parking – check list:

Here is a check list with the requirements presented more or less in the same order as that in which studies and experience show that cyclists prioritise their requirements and wishes 28, 103, 125. Not all bicycle parking facilities need to fulfil all the requirements, but it is a good idea to tick off each point to be sure that one has considered them all.

Bicycle parking should ...

- be very close to the destination
- have enough racks and stands
- be easy to use
- have a simple layout and be secure
- be easy to locate
- be safe and secure when coming to and leaving
- support the bicycle without damaging it
- be locked up or afford the possibility of locking the bicycle securely
- be attractive, fit in with its surroundings and, preferably, enhance its surroundings
- protect the bicycle – especially the saddle – from rain and snow
- be solid and easy to maintain and clean

Supervision and service

Supervision of bicycles was common during and just after the war at many railway stations, where the local bicycle repairer had a shop right next to the station. In these cycle centres the bicycle repairer could look after the bicycles and offer service and repairs while his customers were at work.

Today there are cycle centres at, for instance, the Main Station in Copenhagen and at Østerport Station. In Holland there are more than 100 of them. At Danish cycle centres the model is that the bicycle repairer leases the premises, ie pays a certain portion of his income in rent.

It should be possible to rethink supervision today, linking bicycle parking with other functions such as ticket sales, a bicycle shop, café, grill bar, other shops and car parking etc. In Germany “cycle stations” are being introduced under a scheme by which cycle centres are established as employment projects at previously unmanned stations.

Human supervision can be supplemented and possibly replaced by video surveillance, which has in course of time become a common, accepted and effective means of prevention against theft and vandalism.

Video surveillance at Østerport station.



PHOTO: Linda Hansen

Secure, transparent bicycle parking.



PHOTO: Road Directorate

There are many ways to park a bicycle –
mentioned below with the simple and primitive types first followed by the more sophisticated



PHOTO: Lars Bahl

Hopeless coupling



PHOTO: Lars Bahl

Against a stone



PHOTO: Road Directorate

Against a wall



PHOTO: Lars Bahl

On its own kickstand



PHOTO: Linda Hansen

In loose racks



PHOTO: Linda Hansen

In racks on walls



PHOTO: Lars Bahl

At the pedestrian street



PHOTO: Linda Hansen

At the edge of the footway



PHOTO: Road Directorate

In the dividing verge



PHOTO: Road Directorate

On former car parking bays



PHOTO: Linda Hansen

In sheds



PHOTO: Linda Hansen

In bicycle cellars



PHOTO: Road Directorate

In covered racks



PHOTO: Lars Bahl

Two-storey and locked



PHOTO: Crow

In a lockable box



PHOTO: Bike Parking Systems AG

In an automatic machine



PHOTO: Lars Bahl

Is the bike still in place after the swim?

needs in connection with a pedestrian street, an educational institution, a local area, an urban districts, a town, a municipality or county – in the same way as for car parking.

Formulate some clear general objectives and some clear operational goals together with success criteria for investments and projects.

Arrange meetings at which there are opportunities for various interested parties to express their ideas. Let this be a creative process, because there is a need for creativity and combinatory thinking when one encounters a major need for bicycle parking and a lack of space. Take pains to ensure good communication and co-operation with the local population and relevant authorities, interested parties and enterprises.

A bicycle parking policy and plan is a good idea. But a “little by little” approach is also good, where one can develop and improve bicycle parking conditions in a town step by step and site by site. No matter which method is used, an detailed analysis of problems and needs is useful.

Recreational bicycle parking

So far we have been focusing on the weekday cyclist. But we should also remember the recreational cyclist, including the cycle tourist.

Here we have to do with popular leisure-time destinations, such as a beach, a museum, a rock concert. In such places mobile bicycle racks can be an advantage. On a holiday it can be very important for a family with five loaded bicycles to be able to leave their bicycles and luggage in a secure place, while they visit the town on foot.

It may be necessary to think creatively and link solutions with other possibilities, eg a harbour house with bicycle parking together with toilet and washing facilities. There could also be parking for cyclists in connection with the tourist office.

The process

Make a bicycle parking plan – or at least an analysis of problems and

Construction projects

There is a fundamental and inescapable need to think bicycle parking into new construction projects – physically, functionally and economically. It is necessary to work purposefully with norms, standards, building regulations, local plans etc.

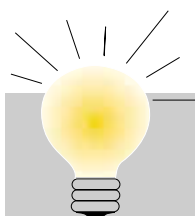
At present, parking norms for cars and bicycles are not specified in Danish building regulations. For car parking there is a tendency for the old rules to be used because many people are in doubt as to what they should do instead.

Finance

In addition to establishing a clearer distribution of responsibility among the state, county, municipality, public transport operators and private persons regarding the financing of bicycle parking and anchormen/project managers in individual organisations, it is important to consider other possible sources of financing.

Bicycle parking funds

The use of money from car parking funds for developing bicycle parking is not possible. An idea like a bicycle parking fund cannot be compared with car parking funds as bicycle parking is established by the main entrance. New construction



PROPOSAL FOR BICYCLE PARKING NORM

based on Dutch experience ⁷⁹

Shopping streets and centres	4-8 places per 100 m ² shop or storage area
Offices	1-4 places per 100 m ² office or storage area
Educational institutions	30-80 places per 100 pupils/students
Sports facilities, cinemas, theatres etc.	20-40 places per 100 users/visitors
Hospitals	20-50 places per 100 beds
Parks, beaches, amusements parks	10-35 places per 100 users/visitors

should contain bicycle parking facilities from the start, and it should not be possible to avoid this by contributing to a fund. Bicycle parking funds can offer the possibility of private and public co-financing of bicycle parking facilities in city centres.

Financing from advertising

In recent years wind shelters and passenger information boards financed by advertising have made their appearance at bus stops, where the standard has been raised considerably, and it must be correspondingly possible to establish more attractive bicycle parking facilities financed by advertising.

Another possibility is to motivate firms, institutions, shops, chambers of commerce, cultural institutions, places of entertainment, public transport operators etc, to sponsor bicycle parking facilities. The sponsorship may also include advertising in connection with various events.

User payment

Experience from abroad and a few studies indicate that there is a certain readiness among cyclists to pay for secure bicycle parking closer to destinations.

User payment has been practised in Denmark for some years. At cycle centres users pay DKK 5 per day, DKK 60 per month or DKK 500 per year. This is for indoor bicycle parking with personal service and supervision, which, however, functions as lock-up parking during the evening/night/weekend.

For lock-up bicycle parking facilities at Danish rail-stations users pay a certain sum per year for a key or a key card. The price varies from free to DKK 200 per year. At most stations it is DKK 100-200 per year. Here it may be a matter of locked,



PHOTO: Lars Bahl

Locked, user paid bicycle parking.

covered bicycle parking, outdoor parking or even cellar parking.

There are on the market a few bicycle racks that function as parking meters. Payment by coin or card releases a hoop with which one can lock the bicycle to the rack. These devices can be placed singly on pavements or squares, but this has not yet been done in Denmark.

Maintenance

It is important that bicycle parking facilities should signal status, rather than ugliness and decay, throughout their lifetime.

Locked, user paid bicycle parking.



PHOTO: Road Directorate

The possibility of regular cleaning and maintenance should therefore be an essential element in the requirements made of their design and materials. It cannot be accepted that it is impossible to remove withered leaves or paper trash. It must also be possible to remove graffiti, as graffiti signal decay and insecurity. A final point to bear in mind is that the construction should be resistant towards vandalism and easy to repair once the damage has been done.

Road maintenance

The maintenance quality of the traffic areas used by cyclists is an important factor in people's desire to cycle. Poor pavement may distract one's attention from other cyclists and in some cases cause serious accidents. Furthermore, poor road maintenance can help to preserve the image of cycling as a low status mode of transport.

It is therefore a good idea to improve the quality. A practical way to start the process is to carry out an annual inspection by bicycle.



Contents

Prioritisation of road maintenance resources	118
Road capital versus level	
of service for cyclists	118
Smoothness and quality of paths and tracks	119
Winter road maintenance	121
Sweeping	123
From construction to maintenance	123
Poor road maintenance produces	
bicycle accidents	124



PHOTO: Lars Bahl

Trærødder under ujævn asfalt.

tion of Danes cycle in many situations, strong political pressure arises for these problems to be solved. At the same time it is often cheaper to improve the quality of paths and tracks than of carriageways. It might therefore be a good idea to choose a higher maintenance quality on paths and tracks than on carriageways.

It is very important for cyclists that there should be no holes or unpleasant unevenness on cycle tracks and other traffic areas on which they ride. The more uneven the pavement, the more uncomfortable it is to cycle, and the more one's baggage is liable to fall off the bicycle. Furthermore, it requires more energy to cycle on an uneven surface⁷³. Finally, permanent damage can be done to the bicycle, especially to spokes, tyres and rims.

Uneven pavements reduce cyclist safety, as there is a risk of falling off, which often leads to injuries. If the cyclist wobbles, he risks running into the kerb, pedestrians or other cyclists. In certain cases the cyclist may come out in front of a car, which can result in a serious accident.

Prioritisation of road maintenance resources

The prioritisation of road maintenance resources is determined by various technical and political considerations. In order to define principles for a prioritisation of these considerations it is necessary to give careful thought to how they should be weighted.

Cyclists are sensitive to the quality of maintenance. As a large propor-

Unevenness is mainly caused by poor resurfacing after roadworks, from patches of asphalt, ramps, manhole covers and tree roots. One's own and external contractors should therefore be clearly instructed as to the necessity of carrying out asphalt repairs correctly without significant edges or deviations from the level of the existing asphalt. One possibility is to move cables etc, from beneath the areas used by cyclists to the ground beneath the footways.

Repairs of cycle tracks should be carried out with a hot-mixed asphalt of soft and small stones (< 16 mm) in a layer of less than 3 cm. Finish with this asphalt when asphalt of gravel and hard bitumen is used as base. The hot-mixed asphalt must not contain flint – use granite instead.

When possible, the asphalt should be poured from machines, among other things for lengthwise surface repairs and for larger areas. Transverse repairs usually have to be carried out manually. The methods of repair are described in the Road Directorate's "Konstruktion og vedligehold af veje og stier – Hæfte 4 – Vedligehold af færdselsarealet" [Construction and Maintenance of Roads and Paths – Booklet 4 – Maintenance of Traffic Areas].

When the damage has been caused by tree roots, repairs will as a rule have only a temporary effect as the continued growth of the tree will lift the asphalt and kerbstones once more. Sometimes it proves necessary to remove some roots by cutting them off and digging them up from under the traffic area. As this is a serious intervention for the tree, it should be done only with specialist guidance.

A smile despite unevenness.



PHOTO: Road Directorate

More serious problems occur where the tree has been planted in too narrow a verge with poor growth conditions for the roots. Depending on the age and type of the tree, felling and replanting may be considered as a solution. Problems can be preempted by good growth conditions – typically 30 cm of humus on top of 80 cm of well drained, non-compressed raw soil on top of loosened earth. As the spread of the roots normally corresponds to the extent of the tree crown, the bed should be as large as possible. An alternative solution is to cut the crown regularly, thus limiting the spread of the roots.

The decision to phase out the use of pesticides in public spaces in Denmark has rendered the maintenance of roads and paths more expensive. Unless more resources are allocated, this will make things more uncomfortable for cyclists. Sometimes maintenance using heavy vehicles produces cracks along the thin surfaces of the paths, in which weeds can grow. Once weeds take hold, the surface breaks up faster. The ban on pesticides therefore requires stronger surfaces, the use of light vehicles for maintenance and inspection of cycle tracks.

Road capital versus level of service for cyclists

Over the years, large sums have been invested in roads, and the major part of this investment is concealed beneath the wearing courses of carriageways and cycle tracks. This investment can only be preserved through on-going maintenance or resurfacing of the protective wearing courses as they are gradually but inevitably worn down.

There is as a rule close correspondence between annual expenditure on resurfacing and annual expenditure on repairs. The lower the



PHOTO: Lars Bahl

Resurfaced cycle track.

expenditure on resurfacing, the higher the expenditure on repairs and vice-versa.

The optimal economic policy for road maintenance is to ensure that the total sum of expenditure on resurfacing and repairs is as low as possible. The secret is to resurface at the precise moment when this will in the long term be cheaper than continuing to carry out repairs.

Road with many patches (repairs).



PHOTO: Linda Hansen

As cyclists are sensitive to unevenness caused by, for example, repairs, resurfacing of cycle tracks should receive higher priority, even though it might be more economical to carry out repairs. This prioritisation can only take place at the expense of resurfacing of minor roads with little bicycle traffic.

Smoothness and quality of paths and tracks

Quality goals

Quality assessments can be based on subjective or objective registrations. A subjective registration could, for instance, be an assessment of road conditions by road maintenance personnel in individual districts. Such an assessment is entirely person-dependent and mainly based on observations from daily inspection, but also on feedback from users. This on-going inspection, which is not systematic, is normally carried out by car, but there are also advantages to be derived from inspection by bicycle.

Experience from the municipality of Odense indicates that inspection by bicycle is a time-consuming task, one that will at first encounter resistance from inspectors. In the



PHOTO: Jens Erik Larsen

Remember the maintenance of pavements without asphalt.

long term, however, the inspectors involved will obtain greater insight into, for instance, the effect of minor unevenness for cyclists, so that one can expect a greater number of repairs to be initiated than after inspection by car. A final and not negligible gain is that the inspectors involved will achieve a greater understanding of traffic conditions for cyclists.

A systematic registration of deterioration should be carried out once a year each spring in a main inspection. As part of the main inspection of paths and cycle tracks, all routes should be cycled over by a inspector. Holes, patches, depressions, crack formation etc, and the extent of roadworks necessary to resurfacing should be registered. These data should then be processed in a pavement management system that iden-

tifies road sections for technical assessment. The computer programme then writes out prioritised resurfacing and repairs lists taking due account of budgetary parameters. The measurement of unevenness with a comfortmeter bicycle will give a correct objective registration.

The municipality of Copenhagen has cycled over its entire system of cycle tracks and paths and registered each section in one of three categories for pavement quality. This is a sufficient number of categories in connection with subjective inspection.

After the possibility of using a cycle track, pavement quality is the factor that exercises the greatest influence on the choice of cycle route in Germany¹³.

Road inspector and his bicycle for main inspection of cycle tracks and paths.



PHOTO: Municipality of Odense

For cyclists the impact of unevenness depends on the width of paths and tracks, ie the possibility of avoiding holes, cracks, depressions etc.

Repaving

For some poor quality cycle tracks and paths the best solution is to carry out repaving, which is expensive as it is necessary to replace the base and draining construction, to reset the kerbstones and to relay the footway. Some repaving can be carried out in connection with laying or maintenance of mains, cables etc.

The possibility of financing repaving via the construction account may be considered, since it is easier to find resources for maintenance when other forms of road or path improvement are carried out at the same time.

In connection with all repaving projects, efforts should be made to improve safety and level of service for cyclists, thereby achieving optimal use of all available resources. The secret is to find ways of integrating plans for better roads, paths, cycle tracks and bicycle parking in the operating and maintenance budget. One way is cycle audits of all repaving projects.

Roads without cycle tracks

Higher priority can also be given to repairs that improve conditions for cyclists on roads without cycle tracks. Such types of repair could be the replacement of wrongly oriented gully gratings and the repair of old, unevenly surfaced main and cable excavations, especially transverse runnels and asphalt patches.

Gully gratings and manhole covers

Some gully gratings are troublesome for cyclists because of their placing, level or design. The height of these gratings can be regulated so

that they are flush with the pavement or they can be moved right into the kerb. Gratings with bars parallel to the kerb should be turned 90 degrees or replaced with a more bicycle-friendly type.

The older type of manhole cover, which rests permanently on the rim of the hole, will often present a difference of height in relation to the wearing course that is unacceptable for cyclists, and they should therefore be replaced with floating covers. They should be paid for by the owner of the sewers. Inappropriately placed sewer manholes are often expensive and difficult to move.

On traffic areas with manhole covers and gratings, cyclists will often try not to ride over them and thereby be tempted to make dangerous changes of direction. This behaviour is due to a fear of jolts and bumps, even though there is in fact no unevenness. This problem can be obviated by building the grating into the kerb, so that there is a lateral entrance to the drain. This type of drain has been used only in a few places in Denmark, and no experience of its effect has as yet been gathered.

Dialogue with the public

The Danish Cyclists Federation and other cyclists will be able to contribute well-qualified ideas for road maintenance and, possibly, proposals for other measures. A "hot line" from the Federation for the reporting of minor deterioration etc, may

be useful, as this will reduce the need for resource-demanding administration and inspection. This direct contact can also promote mutual understanding. A reporting corps of cyclists can contribute to a cheap but co-ordinated monitoring of road maintenance quality.

Time lag after new construction
In connection with repaving and new construction of roads the normal practice is to postpone surfacing until the year after the road base has been completed. This time gap is observed in order to avoid most of the and consolidation inflict the evenness of the wearing course. Painting "Temporary pavement" on the base may lead to fewer complaints and fewer irritated cyclists.

Danes believe that better maintenance of cyclists' traffic areas is the factor that can do most to promote bicycle traffic ⁶³.

Winter road maintenance

Purpose and scope

Modern urban society can only function optimally if roads and paths are easy and safe to travel on irrespective of the season and weather conditions. It is therefore necessary to take effective steps to counteract the problems that snow and ice cause on traffic areas. The "Act on winter maintenance and clearing of roads" stipulates that road administrations must provide snow-clearing and take measures

PHOTO: Road Directorate



PHOTO: Road Directorate



PHOTO: Road Directorate



Three bicycle-friendly gratings.



A Swedish questionnaire study demonstrated that winter cycling can be increased by 13-58% by better winter road maintenance ⁸.

Help us find

The worst cycle track in town and win a bicycle holiday for two in Provence

against slippery and icy conditions on public roads and paths.

Priorities and service objectives

As both roads and paths can be divided into different categories of importance, it would seem reasonable to treat them accordingly. This gives an optimal use of resources with an acceptable weighting of traffic-related, environmental and economic factors.

In practice, roads and paths can be divided into 3 categories – A, B and C – according to their importance for the economy. In order to promote cycling, also in the six winter months, it is important that cycle tracks should be given high priority.

The most used paths and cycle tracks are placed in category A. It is important that these paths and tracks have a high service level, as snow and ice will here create problems for many cyclists. Cyclists must not be tempted to use the road instead of the track. These sections are so important for bicycle traffic – for society – that the goal should be to keep them clear of serious obstacles 24 hours a day 7 days a week.

School routes and distributor cycle tracks and paths are placed in category B. Snow-clearing, salting etc are only carried out in the daytime but 7 days a week.

Category C contains short and little used cycle tracks and paths. Snow-clearing, salting etc will not normally be carried out here.

Recreational paths with, for example, gravel surfaces do not usually receive winter maintenance.

Salting, snow-clearing etc

Icy conditions on cycle tracks and paths are treated with traditional salting, gravelling or, as an alternative, with NaCl brine.

PHOTO: Municipality of Odense



PHOTO: Road Directorate



PHOTO: Road Directorate



Traditional salting on cycle tracks and paths involves a very heavy environmental load, as the concentration of salt must for technical reasons be far higher than on carriageways.

Gravelling is also accompanied by environmental costs and increases the risk of punctures and skids. Furthermore, gravel is not particularly effective for clearing ice and snow. The gravel has to be regularly removed from sewers, and because of the admixture of dangerous substances the remainder – what is left on roads and paths – has to be deposited at controlled landfills. There is a special charge for this in Denmark. Finally, gravel is a more limited resource than salt.

When performed correctly, the spreading of brine containing 22% NaCl reduces the consumption of salt by 80% in relation to traditional salting. Using brine costs roughly the same as traditional salting but only 2/3 the expense of gravelling. Spreading brine has, however, proved to be less effective for heavy snow falls and thick layers of ice ⁷⁴.

In order to deal with icy conditions effectively, it is first necessary to clear away snow that may be lying on the cycle track or path. In Denmark these two tasks can as a rule easily be carried out by the same vehicle. Powerful tractors are required in order to ensure a high level of service in all snow situations, so that the snow can be cleared from traffic areas quickly

The sweeper can not sweep every spot!

and effectively. Normally the snow is pushed into windrows over the kerbstones between the cycle track and the footway and the cycle track and the carriageway, but on narrow cycle tracks and roads the snow must be removed and driven away. Snow-removal is very costly and can only be carried out in the most necessary spots.

Sweeping

There must also be a high service level with respect to the sweeping of cycle tracks and paths. According to the importance, systematic sweeping is performed from twice monthly to once every second month.

In addition, extra sweeping is required in autumn when the leaves fall. A standby service must be available to remove objects that are dangerous for traffic and broken glass. This is especially relevant for Saturday and Sunday mornings when the nightlife leaves a lot of broken glass on roads and paths.

From construction to maintenance

In order for maintenance personnel to acquire the required knowledge concerning the purpose of the construction project and to be able to influence the construction project with their maintenance experience, it is important that maintenance per-



PHOTO: Linda Hansen



PHOTO: Road Directorate

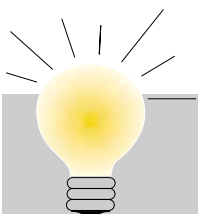
sonnel should be involved in the design process. It is also an advantage if the maintenance department is given an opportunity of inspecting the construction before the contractor finishes the project.

The following are some of the most commonest problems that one detects after delivery of a construction project: wrongly oriented gully gratings, non-functioning drain con-

Just resurfaced, still the old puddle.



PHOTO: Road Directorate



PROPOSAL FOR MAINTENANCE VEHICLES

Use operating machinery of the right size – since heavy vehicles on paths can cause cracks etc – but construct new paths so that they can withstand the pressure of the vehicles it is intended to use and of illegally parked vehicles.



PHOTO: Linda Hansen

structions and unevenness. During the making-good period the construction department must ensure that the contractor remedies these deficiencies.

Elements that are expensive to maintain

If cobblestones, sett paving and the like have been laid for aesthetic reasons, one should be aware that these forms of surface are more difficult and expensive to maintain and sweep than asphalt. Furthermore, uneven surfaces are often criticised by cyclists.

The blue cycle crossings are also expensive to maintain, since the price is almost double that of ordinary thermoplastic. Painted marking costs 3/4 of the price for thermoplastic, but has only 1/10 of its lifetime on cycle tracks.

The Danish Road Standards and Guidelines permit cycle tracks to be signed with a sign for cycle tracks or marked with a bicycle symbol in thermoplastic. It is cheapest to choose bicycle symbols. Cycle tracks are not normally signed in urban areas.

Luggage can cause single accidents.

Poor road maintenance produces bicycle accidents

Cyclists risk being involved in traffic accidents as a consequence of poor road maintenance, including inadequate winter maintenance. A good number of accidents are related to the standard of maintenance. It is not always possible to identify the actual cause of an accident. Often it is a matter of interrelated factors, which cannot be clearly separated from one another. In single accidents there are usually fewer causative factors than in collisions.

The Accident Analysis Group at Odense University Hospital has made a study of single bicycle accidents. In this connection it is interesting that only 2% of these accidents are recorded by the police as against 26% of multi-party accidents. In approximately 70% of the single accidents studied there were no defects or deficiencies on the road that could have caused the accident. In 10-15% of the accidents loose objects (branches, small stones etc) were a contributory factor, while 3-4% were due to holes in the road. Factors like asphaltramps,

roadworks, gully gratings and train rails were all insignificant⁶⁹.

It would appear that accidents could be obviated through more frequent sweeping of roads and paths and quicker repairs of holes in cycle tracks and carriageways. Roads with a poor surface quality present a serious risk of single bicycle accidents. Finally, snow-clearing should be maintained, both to reduce the risk for cyclists but primarily to increase cycling in winter.

42% of Swedish cyclists state that road surface quality is a contributory factor in accidents where slippery and icy conditions are a problem. The frequency of single accidents among Swedish cyclists rises sharply as a function of poor road surface quality⁸⁷.

It is important to salt road surfaces before they become slippery or icy. With the temperature around zero on cycle tracks there is a strong risk of ice and cyclists cannot immediately detect how slippery it is. Warning systems against slippery and icy conditions are an indispensable tool for avoiding these situations.

Most cyclists ride round holes.



PHOTO: Linda Hansen

Roadworks

It is often assumed – consciously or unconsciously – that traffic finds out on its own how to get around roadworks. At roadworks it is a good idea to pay special regard to cyclists who are more sensitive to uneven pavements and diversions than motorists. Clear marking and barriers can prevent bicycle accidents. At times car traffic must be controlled out of regard for the safety, comfort and passage of cyclists. 2-3% of single bicycle accidents is due to roadworks.

The road administration can make more stringent requirements of the way roadworks in cyclists' traffic areas are carried out, and not least to improve supervision and control. It must be assumed to be in the interest of the road administration that the traffic area is restored to at least as good a condition as it was in before being dug up.



Contents

General	126
Information to the public	126
Guidance at roadworks	127
Barrier devices	127
Guidance with blinkers	128
Cover plates and the like	128
Speed reduction	128
Placing of cyclists	129
Accident risk	129

General

Roadworks are often a nuisance and risk for road users. Cyclists need an even road pavement, so that for them the nuisance is often especially great. Regardless of whether it is a road administration or a cable owner or others who decided to have the work performed, and no matter whether it is carried out by themselves or by a contractor, the safety, ease of passage and comfort of cyclists should be ensured.

Roadworks are often of short duration and will not cause inconvenience to cyclists. However, the needs of cyclists can be taken into account in various ways. In some cases it is necessary to exclude road users from the work area. If so, the best possible alternative route must be offered.

In connection with many excavations, cyclists may share the area with pedestrians instead of with motorists. Depending on the space and number of pedestrians, it may in certain cases be safer to let cyclists and pedestrians use the same area.

Cyclists should not have to force high kerbs and the like or get off the bicycle because of roadworks. In exceptional cases, high kerbs and wheeling one's bicycle may be acceptable, but only in the case of roadworks lasting for less than one day and outside rush hours.

Information to the public

Not all excavations are announced in advance as there are many of them. Only in the case of roadworks where passage is wholly or partially obstructed, and where road users face considerable delays is prior announcement required.

The announcements can typically be made through the local paper or



PHOTO: Linda Hansen

Short-term roadwork – cyclists ride on footway or carriageway.



PHOTO: Municipality of Odense

Poster about resurfacing in Odense.

a weekly paper distributed to all households or as news in the local radio. In addition, large signs at the roadworks can inform road users about the roadworks and their duration. This can with advantage be turned into positive information for cyclists, for instance, when resurfacing is being carried out.

Guidance at roadworks

Signing and marking must be easily understandable. It may be necessary to give a warning well ahead, so that cyclists become more aware and so that they have time to choose another route.

It is often difficult for cyclists to adapt their speed to conditions at roadworks as there is seldom warning of, for instance, sharp curves and high kerbs and edges. In the case of roadworks where the cyclist has to reduce speed, this should appear from the signing. Sometimes clear marking on the path or road can direct the cyclist to the right track.

As certain roadworks are initiated at short notice, incorrect or unneces-



PHOTO: Lars Bahl

A warning about these holes is necessary.

PHOTO: Road Directorate



The yellow snake – a good longitudinal guiding barrier.

sarily restrictive signing may occur. Typically, no entry signs are seen where a prohibition against motor traffic would be sufficient. Prohibition against cycling should be avoided when it is possible and safe.

In the case of roadworks extending from one house wall to another or from hedge to hedge it may be necessary to redirect cyclists. It is important that cyclists are warned about the diversion early enough and that they respect it. Diversions cause more inconvenience for cyclists than for motorists. The longer the duration of the roadworks the greater the impact of the inconvenience.

One often sees unfortunate examples of the placing of temporary signs. Traffic signs are typically put up on a low post with a rubber base, often standing at the edge of the road or on the cycle track. Cyclists cannot pass under the low post, and with a certain safety margin the sign occupies at least 1 meter of the cyclists' area. In bad weather this is especially problematic as cyclists tend to lower their heads more. And in the dark a normal bicycle lamp will cast very little light on the sign.

Barrier devices

It is very important that roadworks are provided with correct barrier devices, especially in the case of deeper excavations that may constitute a serious risk to cyclists. Precautions must be taken that the



PHOTO: Road Directorate



PHOTO: Road Directorate

Signs may make the cycle track useless.



PHOTO: Lars Bahl

Thick wooden plates, wire fences and the like are better than strings.

saddle or reduce speed. In the case of excavations over longer periods, asphalt ramps should be established for all plates with a high edge.

Where mains, cables etc. run across the road, a board is often placed on either side of them. In these cases there is also an edge of several centimetres, which may inconvenience cyclists and in certain cases make them fall.

cyclist cannot fall over or under the barrier. Furthermore, cyclists must not be pressed too close to the barrier by other traffic.

Traffic closure across cycle tracks can be established by means of a bar, wire fence etc, and must be provided with not less than two yellow danger lamps unless the marking is sufficiently lighted, which is rarely the case ¹²⁰.

Wire fences in full height instead of just a bar can prevent the cyclist from falling into an excavation. Regardless of the type of barrier, it should be continuously checked as in the worst case a defect may be fatal to the cyclist.

Guidance with blinkers

Normally, guidance with blinkers is only required where skips or similar objects are placed on the road. As a bicycle lamp rarely provides sufficient light on roads and paths, the establishment of blinkers in dark spots and close to dangerous excavations should be considered for the protection of cyclists.

On traffic closures across cycle paths there must not be more than 2

m between each blinker and on longitudinal barriers not more than 10 m.

Cover plates and the like

When excavations are covered with plates or the like, this is done in order to enable traffic to pass. Such covers are normally thick iron plates with a high vertical edge. If possible, rounded edges should be used to protect cyclists' tyres and rims. It is difficult for cyclists to see whether the edge is a serious obstacle, and they therefore execute a "jump", raise themselves from the

Speed reduction

A considerable problem for the safety of cyclists in connection with roadworks is when motorists try to overtake cyclists on road sections with narrow lanes in mixed traffic ²⁵. Where there is little space, possibly combined with the risk of running into an excavation, it may be necessary to reduce the speed of cars in the interests of roadworkers and road safety.

Speed may be reduced by means of mandatory signs with a lower speed limit. In individual cases it may be expedient to mount temporary phys-

A good asphalt ramp is unfortunately a rarity.



PHOTO: Road Directorate

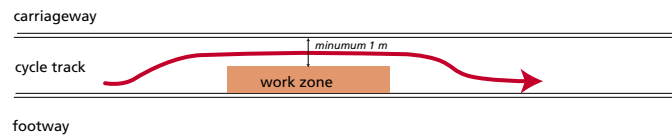
ical speed-reducing measures in the form of staggering, guiding humps of loose asphalt or of rubber modules that are screwed into the pavement. In a few cases it should be considered whether a reduction of cyclist speed will be necessary. This can be achieved by, for example, establishing staggering for cyclists.

Placing of cyclists

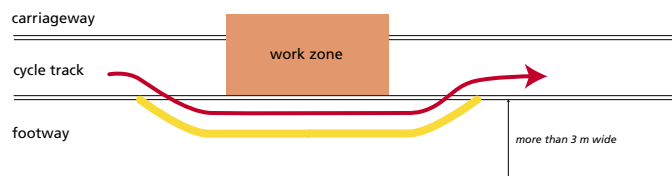
The following is a short, illustrated instruction on placing of cyclists at stationary work zones.

Roadworks on roads with cycle tracks

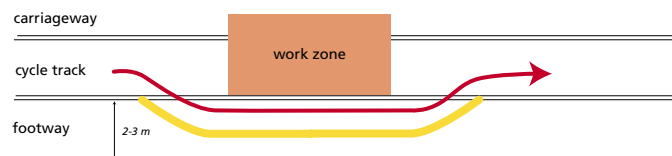
1. If 1 m of the cycle track is still free of the work zone, then cyclists ride on the cycle track.
2. If the footway is 3 m or wider outside the work zone, then cyclists must ride on a temporary cycle track on the footway by using longitudinal barriers.
3. If the footway is 2-3 m wide outside the work zone, then consider cyclists to ride on the footway maybe by using longitudinal barriers.
4. If cyclists are not placed on footway, then establish a temporary cycle track of at least 1.2 m width on the carriageway by using longitudinal barriers.
5. If a temporary cycle track on the carriageway is not wanted, then consider speed reduction of motor vehicles.
6. Establish a good alternative route for cyclists or good asphalt ramps from the cycle track to the carriageway.



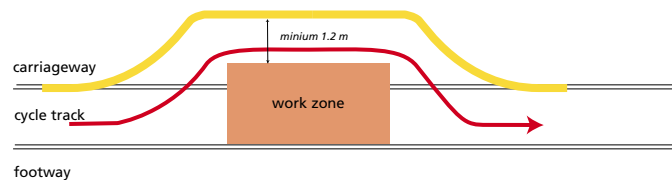
1.



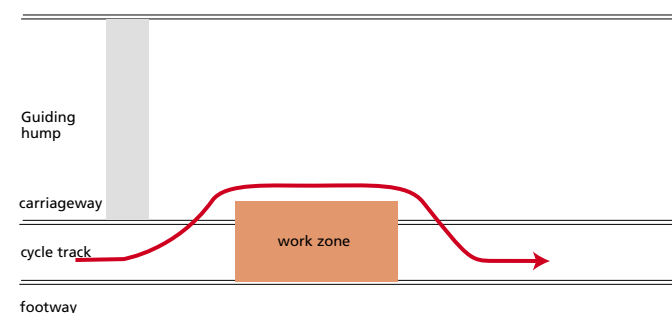
2.



3.



4.



5.

Roadworks on roads with cycle tracks

Roadworks on roads with mixed traffic, paved shoulders or cycle lanes

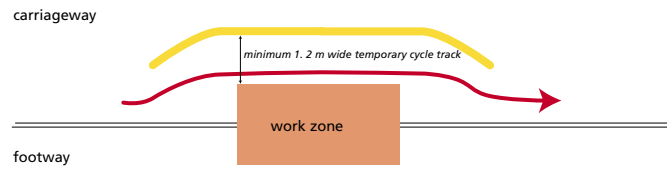
1. Consider to establish a at least 1.2 m wide temporary cycle track on the carriageway by using longitudinal barriers.
2. If the footway is more then 2 m wide, then consider temporary cycling on the footway maybe by using longitudinal barriers.
3. Consider temporary speed reduction on the carriageway.
4. Establish a good alternative route for cyclists.

Accident risk

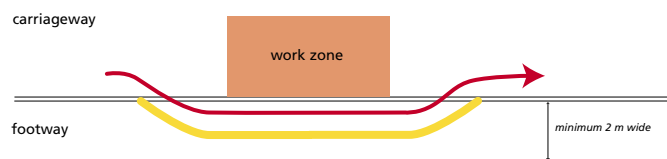
More than 70% of the injured cyclists have been involved in single accidents. The Accident Analysis Group at Odense University Hospital has studied cyclists' single accidents. A questionnaire survey showed that roadworks were in progress at 2.4% of accidents. The cyclists reported that work zone barriers caused 1.8% of the single accidents. Bars and barriers were mentioned in 2.7% of cyclists' collision with fixed objects. Adult cyclists were more often involved in roadwork single accidents than child cyclists ⁶⁹.

Generally speaking, roadworks are not a major factor in single bicycle accidents. The reason is that roadworks do not occur that often after all and that cyclists normally are more careful at roadworks.

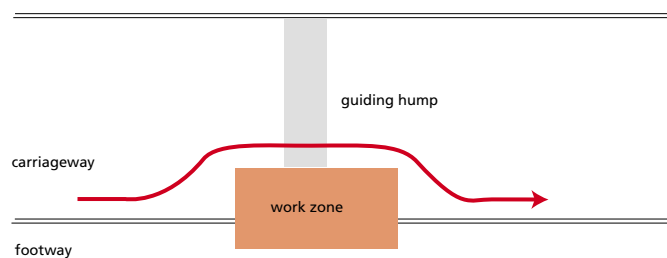
There has not been found studies of bicycle accident frequency at roadworks. However, there is reason to believe that a good design of work zones will prevent bicycle accidents.



1.



2.



3.

Roadworks on roads with mixed traffic, paved sholders or cycle lanes

Collection of examples

Since 1995, the Danish Folketing has allocated money to the Ministry of Transport's Traffic Pool. This money has been spent on initiating and supporting demonstration projects that can make traffic safer and less harmful to the environment.

The knowhow and experience deriving from 8 demonstration projects under the theme Safer Bicycle Traffic have been described. The projects show that road safety for cyclists can be improved and car trips changed into cycle trips.



Contents

Introduction	6
Næstved	6
Karlebo	8
Aalborg	8
Præstø	8
Herning	8
Odense	8
Randers	8
Svendborg	8

Introduction

The projects share the two overall goals of changing car trips into cycle trips and of improving road safety for cyclists. As indicated in the examples, more specific goals have been set up for the individual projects. If you wish to know more, further information is available at the Road Directorate's website www.vd.dk under Trafikpuljen [Traffic Pool].

Examples of bicycle traffic are to be found in a number of other publications. *Flere på cykel* [More cyclists] written by the Danish Cyclists Federation and published in the year

2000 is an excellent supplement to this collection of examples.

The Traffic Pool was established to support the Government's policy in the field of transport. During the period 1995-1999 a total of ca. DKK 350 million was distributed in support of projects relating to public transport, limitation of the environmental load caused by traffic and the improvement of road safety and conditions for pedestrians and cyclists. A major part of the money was used to promote safer bicycle traffic. An annual sum of DKK 50 million has been set aside for the

Traffic Pool in the period 2000-2003.

The projects presented all show new ways of promoting bicycle traffic and/or making it safer. One direct impression is that the work on campaigns, bicycle parking, company bikes etc, is interesting and exciting, and quite different from the establishment of cycle tracks. The Traffic Pool also supported projects in the municipalities of Næskov, Copenhagen, Frederiksberg, Århus, Nykøbing F and Frederikshavn under the theme: safe bicycle traffic.



PHOTO: Municipality of Herning

Employee bikes is an effective measure to get more people to cycle.

Project	Project period	Budget DKK million	Contact person in the municipality
Næstved bridges, bicycle and train	1997-2001	27.44	Anders G. Petersen
Cycling town 1999 – Karlebo	1998-1999	0.35	Kjeld Gammelgaard
The ABC-project in Aalborg	1995-1999	10.80	Henrik Nystrup
Shopping bikes in Præstø	1997-2001	1.40	Bo Vilberg Nielsen
Safe cycling in Herning	1996-2000	8.80	Martin Pape
Odense – Denmark's National Cyclecity	1999-2003	20.00	Troels Andersen
Safer Cykling in Randers	1995-1999	2.13	Birgit Berggrein
Svendborg Safe Cyclecity	1995-1999	12.00	Klaus Johannesen

Næstved bridges the gap between bicycle and train

Town and background

With well over 46,000 inhabitants in the municipality, Næstved is the regional centre of southern Zealand. Many people commute from Næstved and the surrounding area to Copenhagen – and many take the train. The town is good for cycling, but it can become even better. One in five trips in Næstved is made by bicycle.

In Markkvarteret there is a concentration of traffic problems, such as accidents, barriers, perceived risk, noise and a visually poor environment. Especially cyclists have difficult conditions.

Planning

An architectural competition for a combined foot and cycle bridge across the railway at Næstved Station was won by the architects Andersen & Sigurdsson. The wish to have a foot and cycle bridge is due to the fact that the existing connections from the 1920s are badly designed and unsafe. At the same time the foot and cycle bridge will reduce the effect of the railway ter-



PHOTO: Road Directorate

Cramped space on the old bridge over the railway in Næstved.

rain as a barrier, which is broadest in the very centre of town.

In order to strengthen the work to make bicycle traffic safer and to get more people to use a bicycle for trips in Næstved, the municipality drew up a cycle action plan in close

co-operation with representatives from local organisations and other authorities. The intention of the plan is to contribute to improving the urban environment and public health.

Foot and cycle bridge

The foot and cycle bridge connects the 9,000 inhabitants of Markkvarteret with the station and the centre of town. At the same time the bridge improves access from the station to the platforms, especially for the disabled. The winning project became too expensive, and a number of changes were therefore carried out in co-operation with the architects.

Approaching Markkvarteret, the cycle and pedestrian parts diverge, so that cyclists are led along a circular slip path while pedestrians are led to a stairway. The cycle ramp is 2.5 m broad and about 130 m long with a slope of 1:15.

Cyclists feel unsafe in the viaduct under the railway.



PHOTO: Road Directorate



PHOTO: Municipality of Næstved

Computer-visualised foot and cycle bridge.



PHOTO: Municipality of Næstved

Existing bicycle parking conditions at Næstved rail station.

A number of different features have been established on the bridge to give the traveller various experiences. Thus, the bridge changes appearance along the route. At the platforms there are covered stairways and lifts. The bridge is 4.5 m broad with 2.5 m for cyclists and 2 m for pedestrians, who are separated from the cyclists by an extruded kerb and a differently coloured pavement.

Multi-storey bicycle park

At the station apron the bridge ends at a multi-storey bicycle park with

space for 500 bicycles. Here bicycles can be parked on three floors. The bicycle park will be manned so that the bicycles on the two lower floors will be supervised. Bicycles can be repaired in the park while the travellers are at work. It is planned to try out a scheme with bicycle hire, commuter bikes etc, in the bicycle park.

There are already 1,169 bicycle stands on the station apron. During peak loads these are more than full. There are all standards of bicycle parking available, from wheel

stands in the open air to underground lock-up bicycle parking.

The foot and cycle bridge will improve access to the station by bicycle and will thus increase the pressure on the parking situation. There is therefore a great need for further parking facilities, especially of the type where commuters can safely leave their bicycles.

Cycle action plan

The local authorities in Næstved have drawn up a cycle action plan as part of the work to improve traf-



SKETCH: Andersen & Sigurdsson

Sketch of the multi-storey bicycle park.

fic conditions in the town while at the same time complying with national transport targets. An analysis to identify bicycle traffic problems has ascertained that ...

- accident figures are unacceptably high,
- there is insufficient accessibility due to few fast and safe cycle routes between the different parts of the town,
- the parking conditions, especially in the town centre and at the station, is unacceptable,
- private car traffic is extensive, resulting in congestion and pollution.

The goals of the cycle action plan are to increase the number of cycle trips by 30% over the period 1998-2009, and at the same time to reduce the number of cyclists killed and injured by at least 15%.

These goals are being pursued by systematising the work on a number of important themes. Within each theme, projects are being carried out, and effects are assessed and priorities set up according to a phased plan. The themes are:

- Main cycle routes
- Bicycle parking
- Safety
- Delivery of goods
- Driving pupils to school
- Co-operation with companies
- Cycle audit in planning, construction and maintenance
- Communication strategy

With the theme *Delivery of goods* the idea is to give Næstved's inhabitants better possibilities for large-scale shopping by bicycle. Trips to and from work by car take up much space in the town of Næstved. In *Co-operation with companies* the municipality therefore wishes to suggest target-oriented initiatives



for making car drivers shift to cycling.

Cyclists are more affected than other road users by details in the design of roads and paths. Therefore, the municipality is going to draw up some practical and easy-to-remember rules that will ensure a greater focus on the needs of cyclists in local planning, building and construction projects and the maintenance of roads and paths. The *Communication strategy* is intended to strengthen the impact of

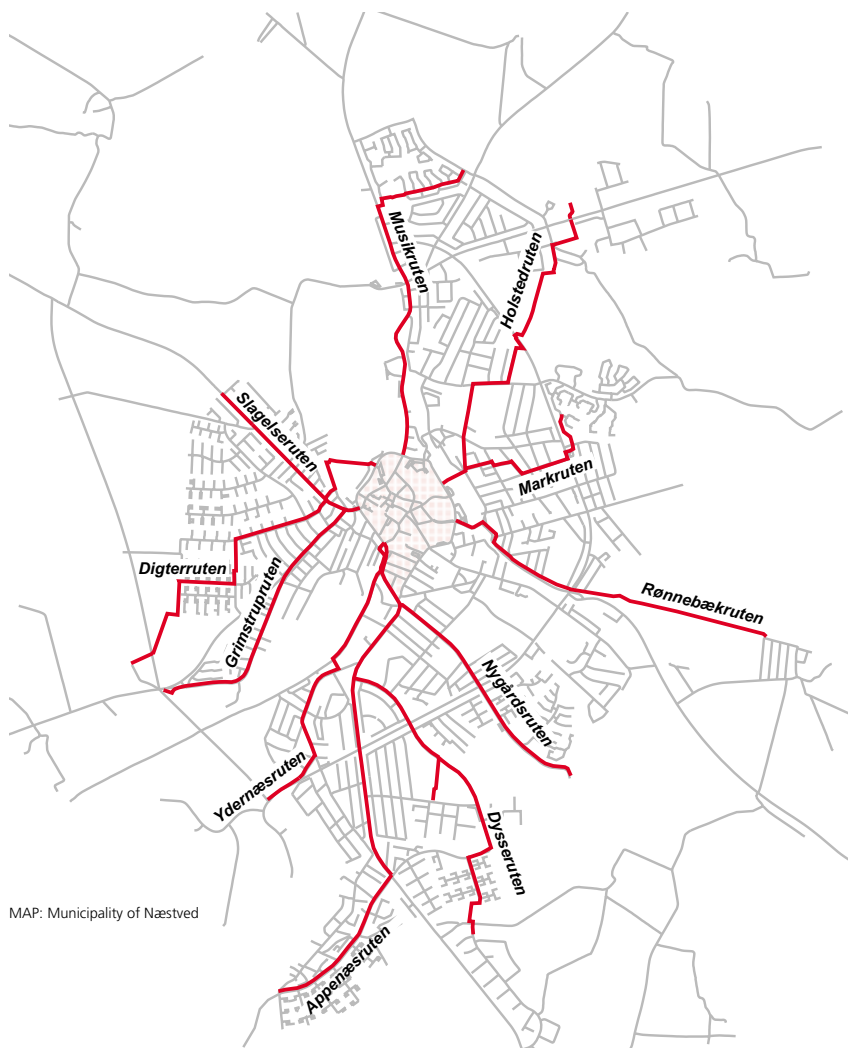
the other initiatives, and information and campaigns will be organised to influence road user behaviour.

Main cycle routes

The expression main cycle route is used about a route where a special effort has been made to enable cyclists to travel between urban districts in a fast, direct and safe manner. Together with other cycle routes the main cycle routes form a coherent network for the whole of the municipality.

Based on a number of design principles a quality lift is planned for 11 main cycle routes. The quality is improved by establishing cycle tracks, raised junctions, path lighting and signing. The strategy is to offer cyclists a uniform network of high-quality main cycle routes.

Future structure of main cycle routes in Næstved.



MAP: Municipality of Næstved



PHOTO: Road Directorate

Bicycle parking

Counts have shown that there are insufficient parking facilities for cyclists at a number of locations in the town centre, and that the quality of certain racks is poor. As a consequence of these two factors bicycles are parked outside the racks to the inconvenience of other road users.

A bicycle parking policy should especially consider the purpose of the parking and should draw up and implement guidelines for parking for different purposes. The table below presents a rough overview, which the municipality will plan its efforts.

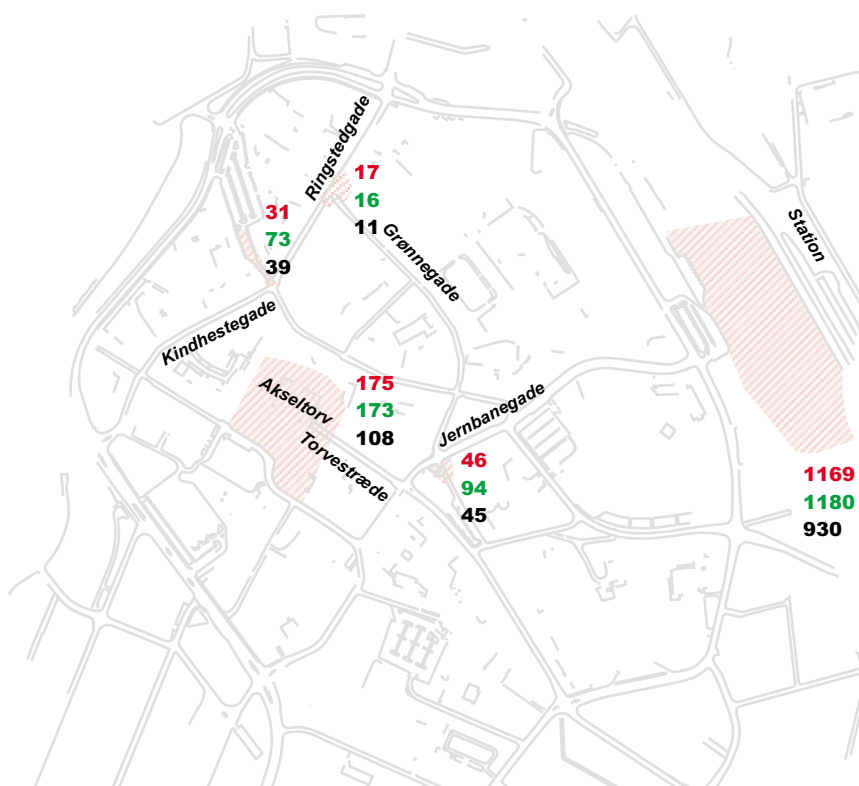
Destination	Parking space wishes
Workplaces and institutions	Bicycle racks, covered and lockable
Public buildings, visitors	Bicycle racks, preferred covered
Traffic terminals	Bicycle racks, covered, lockable, service at the station
Sport and other leisure activities	Bicycle racks, preferred covered, possibly lockable and possibly supervised in connection with special events
Shops and minor shopping centers	Bicycle racks, preferred covered
Næstved town center	All kinds: Bicycle stands/racks, lockable spaces, covered spaces, on the basis of an overall assessment
„Nightlife“ locations	Specially locked/supervised bicycle parking
Special events	Temporary bicycle racks, possibly supervised

A number of measures have been planned, for instance, more bicycle parking places at bus stops and in the town centre. In addition, a design policy for bicycle parking is to be formulated specifying requirements for appearance and function depending on the location and purpose of the parking.

Safety

The municipality of Næstved has a long tradition for working systematically on accident prevention. This theme is intended to strengthen that work and will focus on accidents involving cyclists.

Analyses of bicycle accidents show that by far the major part of the accidents involve cars. The accidents are spread over many locations and only in a relatively few locations are there so many accidents that reconstruction of the road and possibly new signal systems can be expected to reduce the accident figures.



MAP: Municipality of Næstved

- 1169** Antal pladser i stativer
- 1180** Maksimal talt belægning
- 930** Gennemsnitlig talt belægning

Bicycle parking in the centre of Næstved.



7 bicycle accidents with turning motor vehicles have occurred during 5 years at this driveway to a petrol station. The turning motorists have difficulties in seeing the quick cyclists riding downhill because of the bend and the bus stop. A truncation of the cycle track before the driveway is expected to prevent half of the bicycle accidents.

The work to promote greater safety for cyclists therefore focused both on the prevention of accidents in places with many bicycle accidents and on measures, such as campaigns and traffic signing, directed against certain types of accident.

7 black bicycle spots have been identified in Næstved. The estimated savings from the lower number of accidents and injured persons indicate that the black spot method is an appropriate way of bicycle accident reduction. Thus, the

expected first year returns on investments are all over 75%.

Driving pupils to school

In May 1998 the municipality carried out a questionnaire study of the travel patterns of children at three schools in Næstved. The results show that a little less than one out of every five children from pre-school grade up to 5th grade is brought to school by car. The parents state perceived risk as the reason for about 40% of this car driving, whereas 25% is due to time pressure or convenience.

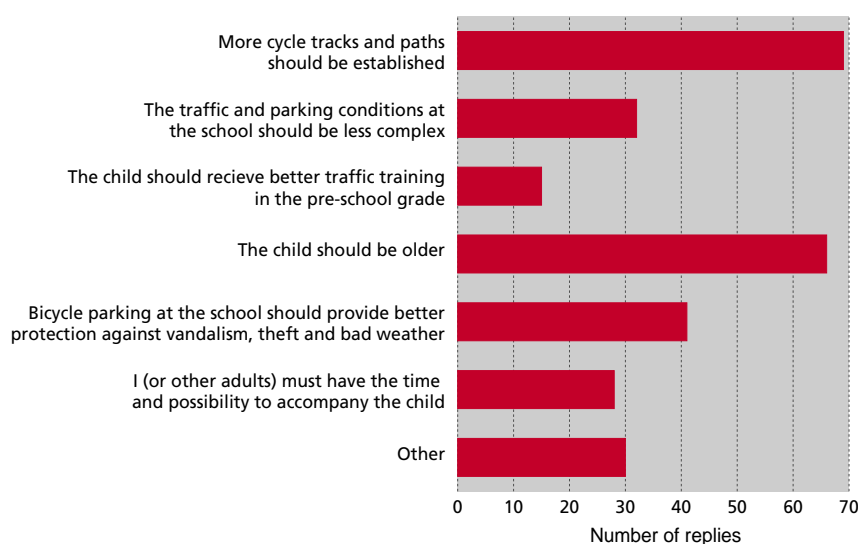
On the basis of replies from the parents the municipality is contemplating launching campaigns directed towards parents and improving conditions for cyclists near schools and school routes to get more children to cycle to school.

The future

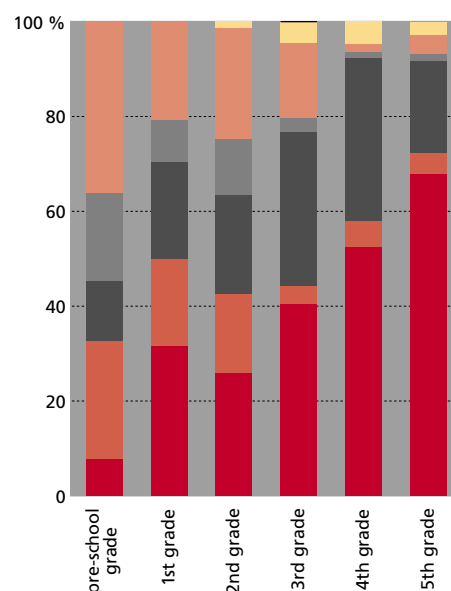
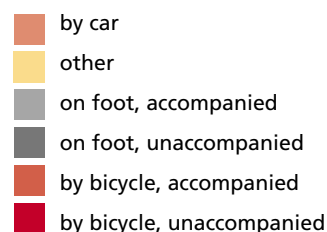
It is the intention to continue the foot and cycle bridge across the railway terrain towards the centre of town so that cyclists avoid slip paths and hills.

The cycle action plan up to the year 2010 has a budget of about DKK 16 million. Almost 60% of the expenses have been set aside for a quality lift of the main cycle routes.

Results of questionnaire survey at 3 schools in Næstved



What conditions should be changed in order that your child will more frequently walk or cycle to school?



Travel patterns of children to and from school

Cycling town 1999 – the municipality of Karlebo

Town and background

The municipality of Karlebo is a suburb in the Metropolitan Region with close on 20,000 inhabitants. In and around the urban districts of Kokkedal and Nivå there is an independent network of cycle paths. According to a analysis carried out by the municipality, it is a problem for users that it is difficult to find one's way around in the network. Similarly, safety conditions for cyclists can be improved along the roads that cyclists use anyway and at junctions between paths and roads.

Planning

The goal of the project was to promote cycling in the municipality especially with respect to short car trips and at the same time to improve signing on the cycle path network in order to increase its user friendliness. All in all, the intention is to reduce the emission of CO₂ and improve cyclist safety.

A campaign consisting of a variety of events and elements was carried out over a period of 5 weeks. The campaign was directed towards cer-

Campaign activity	Date
Get your bike ready	28 April – 7 May
Opening event- cycle trip with the town council	8 May
Cycle far competition	8 May – 12 June
Cycle to the baker's	15 May – 16 May
Can you use the cycle network?	8 May – 31 May
Tresure hunt - use the cycle network	19 May – 31 May
Accompany your child to school	2 May – 4 June
Conclusion - presentation of prizes	12 July

tain target groups among the public. The first phase was to ensure that as many people as possible would become aware of the campaign. Then to arouse their curiosity and build up a positive impression and expectations that would make as many people as possible participate in the events. Competitions/draws formed part of all activities. The campaign received intensive coverage in the local press.

Get your cycle ready

As a prelude to Cycling town 1999 two bicycle dealers offered to check bicycles for free and to oil them and pump them up. At the same time customers were given a special

offer on any recommended repairs. The first two hundred customers received a set of reflectors and a puncture kit. Far more than 200 came to have their bicycles checked, and a lot of repairs were carried out as well.

Opening event – cycle trip with the Town Council

The official opening was formed as a communal cycle trip on which about 100 persons together with the town council cycled around in the municipality. Before starting there was breakfast for all laid out, and after the trip, there was a herring and salad lunch in Nivå centre, where booths had been set up. All

A cycle booth at the opening event.



PHOTO: Municipality of Karlebo



PHOTO: Municipality of Karlebo

Breakfast was part of the opening event.



in all, it was a really good day in which about 250 people participated. The Danish Cyclists Federation and Karlebo Touring Cyclists did much of the practical work.

Cycle far competition

Companies, institutions, associations, individuals etc, were invited to take part in a competition to cycle the greatest number of kilometres in the period 8 May – 12 June. In order to participate, bicycles had to be equipped with a cycle computer. The participants were mainly individual persons, and that there were only 40 participants was disappointing.

Cycle to the baker's

"Why not take your bike when you're going to the baker's? If it's not more than 1-3 km to the baker's, it's probably quicker than driving." This was part of the message to persuade people to avoid unnecessary short car trips. Two local bakers handed out 2,100 "bicycle buns" to about 320 persons who either cycled or walked to their shops. Considerable practical support was afforded by the local Agenda 21 group and The Danish Society for the Conservation of Nature.

Talking before the final of the cycle far competition.

Treasure hunt on the cycle network

A treasure hunt route was marked on a map of the cycle network. The route map was obtainable at municipal offices and in a number of shops. On the reverse side of the map one could write the answers to questions on local history at 6 posts along the route. Lots were drawn among the correct answers for a prize of DKK 1,000. There was also space to express one's opinion of the cycle network. Cyclists had a 2-week period in which to participate, and even experienced cyclists discovered new shortcuts thanks to the treasure hunt.

A total of 110 people completed the treasure hunt, and many good proposals and views, such as are not normally encountered in approaches from the public, were submitted. The proposals will be incorporated in the work on future cycle route planning for, among other things, new paths and signing.

Accompany your child to school

About 1,200 pupils from pre-school

grade to 3rd grade took part in a competition to collect the greatest number of accompanied-to-school points. The class at each of the municipal schools that gained most points received DKK 1,000. Information material on the competition was distributed to class teachers and to all the children/parents. The children fought hard not to be driven to school and put pressure on their parents to cycle. The children were very involved in the competition and actually began to mob children who didn't cycle. A drawing competition was held as a supplement.

Conclusion – presentation of prizes

Unfortunately the event attracted only 50 participants. The day marked the conclusion of the Cycle far competition and offered, in addition, musical entertainment, presentation of prizes, booths and grill food. There was also a cycle triathlon in cycling slowly, slalom cycling and track cycling. The day was a success but had deserved a greater number of participants.



PHOTO: Municipality of Karlebo

The ABC project in Aalborg (*Aalborg - Bicycle - Commute*)



Cycle routes on busy main roads (green), cycle routes on paths and traffic-calmed residential streets (blue) and participating workplaces (red).

concentrated within a 12-km corridor between Skalborg and the airport.

In the first phase of the project a users' panel was established with representatives from, among other things, interest organisations and workplaces. The panel was quite active and assisted in developing the project. It also contributed to a useful exchange of information.

New and better cycle routes

A number of missing links in the cycle network have been filled in with the construction of cycle tracks on Vestergade, Vesterbrogade and Thistedvej in Nørresundby and on Vesterbro in Aalborg. The new routes have given the network greater cohesion, a greater sense of comfort and lower perceived risk for cyclists on routes with direct access to the centre of town. The routes have speed reducing exit constructions at side roads and signal regulation or roundabouts at major junctions. Some side roads have been closed.

Town and background

With its 160,000 inhabitants Aalborg is the fourth largest town in Denmark. The town on the Liim Fiord is situated on 4 hills, which can make cycling fairly demanding. The Liim Fiord Bridge is the only cycle connection across the fiord, so north-south bicycle traffic is concentrated on very busy roads. The university and the town's function as a regional centre mean that there

are both many bicycles and many cars.

Planning

The goal of the ABC Project is to get more people to cycle and to improve road safety. A package of measures for more and better cycle routes, company bikes and activity plans at workplaces together with various campaigns were implemented in 1995-98. The measures were

Vesterbro – A lot of space here.



PHOTO: Road Directorate

Vesterbro – Cramped space there.



PHOTO: Road Directorate



PHOTO: Road Directorate

Vesterbrogade – Not all parking bays were abolished.

The new cycle tracks reduced parking possibilities and ease of passage for motorists, but at the same time gave calmer driving conditions and fewer lane changes.

Parallel with the new and existing cycle tracks along busy roads, cycle routes were established on paths on traffic calmed residential streets. These cycle routes were carefully inspected for holes, problematic gully gratings and other nuisance factors for cyclists.

Foot and cycle bridge across the Lindholm Stream.



PHOTO: Road Directorate



PHOTO: Municipality of Aalborg

A new slip path on one of the cycle routes offers new possibilities.

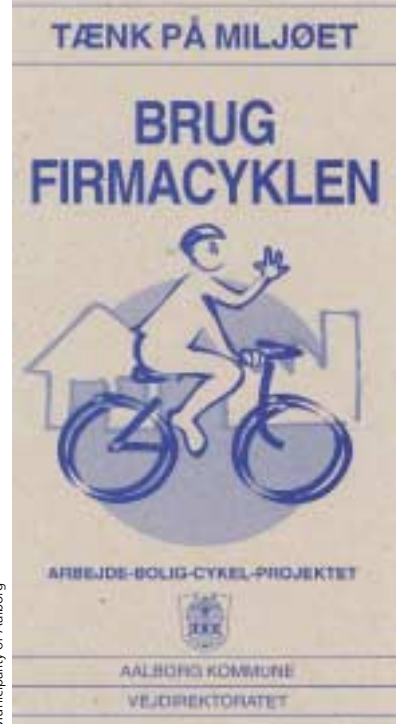
A new path connection on the north shore of the Liim Fiord gives improved access to commercial and recreational areas. A 50 m long foot and cycle bridge was established here.

On the basis of bicycle counts, an increase of 5-20% in bicycle traffic has been registered. Whether this is due to the construction of cycle routes or to the protracted bridge and tunnel works on the Liim Fjord links is an open question. On the south shore there are several alternative cycle routes to those that form part of the ABC Project, which makes it difficult to assess the development of bicycle traffic.

A couple of practical things could have gone better. For example, it is not a good idea to hold the official inauguration of cycle routes in winter, and for a couple of months the cycle routes lay without a smooth wearing course of asphalt, which gave rise to complaints. These complaints could have been avoided with a little information and signing, or if the wearing course had been laid with less delay.

Company bikes and activity plans

In the autumn of 1995 the municipality of Aalborg sent a letter to the managements at a number of workplaces in order to involve them in the project. The letter described the



Municipality of Aalborg

Use the company bike – a folder to employees.

PARTICIPATING WORKPLACES

- Berner Ltd
- Rambøll Ltd
- College of Handicraft and Design
- Technical School Skole
- Aalborg Hospital
- Aalborg Post Office
- Central Administration, Municipality of Aalborg
- Technical Administration, Municipality of Aalborg
- Social and Health Administration, Municipality of Aalborg

project and invited the workplaces to participate and to appoint an enthusiastic contact person. The workplaces could expect a good deal of media coverage, a green image, better health and a greater sense of wellbeing among their employees. As a trial project the workplaces drew up activity plans for bicycle traffic with the help of a handbook. The plans described activities that could motivate employees to use bicycles at work and to cycle to and from work.

In May 1996, 35 company bikes were handed over to the workplaces at an official presentation of the tri-



PHOTO: Anders Bach

al project. After the trial period the workplaces were allowed to take over the bikes without any charge provided that at least 300 km had been ridden on each bike.

Kilometres ridden were documented in a travel diary. All in all, the 35 bikes covered a total of almost 22,000 km in the 6-month period. For the most part, the cycle trips replaced trips by private car, taxi and company car (57% in all) and bus (21%). Almost half the trips were between home and work. Each company bike had on average saved the company DKK 600 in taxi expenses alone. Since the expiry of

the trial period the 9 workplaces have financed a further 40 company bikes themselves.

A questionnaire study showed that 9% of the employees have changed travel patterns by cycling more to work and generally cycling more.

"The absence due to illness has dropped in the trial period ... We have established a cycle shed ... We do not need more investments in car parking."

Economy Director Morten Boldvik, Berner Ltd

The company bikes were spectacularly presented from the start.

30% more parked bicycles were counted at Aalborg Hospital. These are significant changes in relation to the relatively small number of company bikes among 12,000 employees, of whom just under half had cycled to work prior to the trial. Only every fourth employee has tried using a company bike. Nevertheless almost all employees think that company bikes and activity plans are a good idea.

Company bikes have led to changes at the workplaces. For example, Berner Ltd has joined the Danish Federation of Company Sport, and Aalborg Hospital has started a cycling club. The contact persons found it fun and different to take part in the project. It has been fun even though the process has led to the production of many internal notices, letters etc, at the workplaces. All in all, the company bikes have contributed to a greater sense of solidarity at the workplaces, and company bikers have formed the habit of greeting one another.

Company bikes are not taxed, even though transport between home and work is in principle taxable for the user of a company vehicle. The explanation is that the bicycles are placed at the disposal of the entire staff, and any employee is entitled to use them. Company bikes can therefore be compared with general human resources management of an insignificant economic value – just like the provision of free coffee at work.

The trial with company bikes has been a visible element of the urban scene, and at the same time it has been followed with great interest by the press. A number of other workplaces have contacted the municipality concerning the possibility of



Aalborg Stiftstidende

Company bikes are tax-free as well as company coffee in Denmark.



MAP: Municipality of Aalborg

Cycle route maps were posted to all households.

While it was running, the project received a lot of column space in various newspapers and local radio and TV have also brought spots.

Commuter bikes

A trial project introducing commuter bikes at Aalborg station and at the bus terminal was started in May 1999. For those arriving by regional bus or train, a commuter bike is an ideal solution if the bus or train do not stop close by their workplaces or educational institutions. At the same time the bicycle can be used at work.

obtaining company bikes, and the municipality has made 12 more bikes available outside the project.

Information and campaigns

In the spring of 1997 a bicycle newspaper and a route map presenting the ABC Project and current traffic policy were sent to all 75,000 households in the municipality of Aalborg. The motivation parameters for cycling were health, exercise and the environment together with the fact that it is easy to get around on the relatively well developed cycle network. At the same time

some good advice concerning cyclist safety was given.

The bicycle newspaper contained a general invitation to the inauguration of the new cycle routes. More than 500 people came to an event in Lindholm Strandpark, where the then Minister of Transport Bjørn Westh cut the ribbon. Caps, t-shirts and reflectors with the project logo were distributed at the various events. In addition, the contact persons at the workplaces received gifts in recognition of their efforts.

Commuter bikes are hired out for DKK 100 per month or DKK 1,000 per year. The hire charge covers a bicycle in a smart, anonymous design and a service guarantee, so that there is always a ready-to-go bicycle waiting.

The bicycles are parked in a locked basement less than 50 m from the station and coach and bus terminal. Here the commuter can access the bicycle with a magnetic card. The goal is to hire out 50-60 commuter bikes throughout the year.

Inauguration of the cycle route 7 June 1997.



PHOTO: Municipality of Aalborg

Reserved space for commuter bike.



PHOTO: Road Directorate

Shopping bikes in Præstø



PHOTO: Road Directorate

Adelgade, shopping street in Præstø.

Town and background

The municipality of Præstø has almost 7,500 inhabitants. Præstø's shopping street was reconstructed as an attractive shared-use street with sett paving. The bicycle stands look good – but do not function well.

Planning

The goal of the project is to get more people to shop by bicycle in Præstø by initiating a number of activities, eg a delivery scheme, making baggage equipment for bicycles available, road construction and campaigns.

A pilot study showed that 85% of the municipality's inhabitants shopped primarily in the town of Præstø. 25-30% of the customers came on foot, while 15-20% came by bicycle and 55-60% by car. This was so despite the fact that 60% of the catchment area is within 3 km of the shops, and 93% of the cus-

tomers came directly from their homes and returned home immediately after shopping. Of the vulnerable road users 37% were not content with traffic conditions, while

only 6% of motorists were dissatisfied with parking conditions. It seemed therefore that there was a considerable potential for improving conditions for cyclists, possibly at the expense of motorists.

Test pilots – baggage equipment

The subproject of making baggage equipment available was divided into two phases, a first phase in which test pilots tested different types of equipment, and a second phase in which the best equipment was made available to a larger number of people.

Through advertisements in the local press a total of 20 test pilots were found to try out 4 types of bicycle trailer and 1 type of collapsible bicycle basket. The equipment was tested for 4 months from August 1999. Free fitting of equipment and

Test pilots fit trailers to their bicycles.



PHOTO: Municipality of Præstø

repairs, if necessary, by the local bicycle dealer formed part of the subproject.

Experience was exchanged at a series of dialogue meetings. The colour and appearance of the equipment had a certain influence on whether the test pilots wished to use it. The “Donkey” bicycle trailer from Winther got high marks, and a Burley bicycle trailer also passed muster. The collapsible bicycle baskets functioned well. The test pilots were pleased with the equipment, and for some it has become almost indispensable.

The test pilots felt safer in traffic with a bicycle trailer, because motorists attentively. The test pilots functioned at the same time as a reporting corps who reported unsatisfying and unsafe conditions for cyclists.

In the spring of 2000 a further 50 test pilots will be given the baggage equipment that the first test pilots have indicated as being the best for a period of one year. In this way the equipment will be spread to a



PHOTO: Municipality of Præstø

Test pilot with groceries.

greater number of cyclists. Test pilots are selected only from among people who previously habitually shopped by car.

Delivery scheme

A delivery scheme was started in November 1999. The idea is that cycling customers can have their purchases delivered to their homes. With participation by the Præstø Chamber of Commerce the scheme

has been ensured a large customer base. To date 8 shops have joined the scheme. The customer fills in a form saying where and when the purchases are to be delivered. The form is sent to the delivery centre, which is run by the municipality's transportation manager, who arranges and co-ordinates the trips made by the delivery personnel.

In 1999 deliveries under the scheme have been free - as a come-on. The price is at present DKK 20 per delivery, and at a later date may come to depend on the amount delivered. Two school pupils have been hired to deliver the purchases between 3 and 7 p.m. three days a week.

The future

Besides continuing its activities with baggage equipment for bicycles and the delivery scheme, the municipality of Præstø plans to improve parking conditions for cyclists and at the same time to improve road conditions at spots where conditions are perceived as unsafe by cyclists.

Do you want your purchases delivered?



PHOTO: Municipality of Præstø

Safe cycling in Herning

Town and background

The municipality of Herning has close to 58,000 inhabitants. Founded a century ago, Herning is a relatively new town. It is dominated by its textile industry and is the largest trade fair centre in Scandinavia. In the years prior to the project, traffic counts showed a fall in bicycle traffic while car traffic had increased significantly. At the same time the accident frequency for vulnerable road users had begun to increase. Today there are major congestion problems during rush hours.

Planning

The point of departure was the high frequency of accidents involving vulnerable road users and the heavy pollution from motor traffic. The municipality of Herning therefore set itself the goals of raising moral standards in traffic and reducing average car speeds on three roads. Other goals were to shift 5% of the trips between home and work from cars to bicycles for selected firms and to move 4% of passenger kilo-

metres from cars to bicycles, for instance, in order to reduce CO₂ emission. CO₂ problems received extensive press coverage at the start of the project.

The project was divided into two phases. First, cycle tracks were established to fill in missing links in the cycle network, thereby making it more coherent. The second phase was to get inveterate car drivers to shift to cycling, so that more people would use the cycle tracks.

Logo competition

To start the project, a logo competition was arranged. The logo helps to make the project visible and easily recognisable. The competition helped to boost media coverage, and the project received mention at the same time as the name of the winner, Michael Møllegaard, was published.

New and better cycle routes

The cohesion of the cycle network has been improved by the establishment of 3 new cycle tracks in an industrial, a residential and an educational area, a total of 7,2 km of cycle tracks. The cycle tracks were inaugurated at an evnet where over 80 people cycled through the trough the routes at a sedate speed. A number of main and cable works were carried out at the same time as the cycle tracks were established.

Birk Centerpark became a beautiful road. Later a train station was established at the end of the road with a link to the town bus system. Despite a relatively large volume of pedestrian traffic the road was not provided with a footway.

A diving verge was preferred instead of a footway.



PHOTO: Road Directorate



PHOTO: Road Directorate

Good friends accompany each other on H. C. Ørstedvej.



PHOTO: Road Directorate

The dividing island prevents accidents with open car doors on H. C. Ørstedvej.

At H.C. Ørstedvej, several raised surfaces were established at junctions, which contributed to a marked fall in car speeds. A dividing island has been established between the parking bay and the cycle track so that car doors can be opened more safely. The cycle track is designed as a separated cycle-footway without a kerb. At bus stops, a bus-boarder ensures safer boarding and alighting.

New and better cycle routes

The cohesion of the cycle network has been improved by the establishment of 3 new cycle tracks in an industrial, a residential and an educational area, a total of 7.2 km of cycle tracks. The cycle tracks were inaugurated at an event where over 80 people cycled through the routes at a sedate speed. A number of main and cable works were carried out at the same time as the cycle tracks were established.

The cycle tracks along Vesterholmvej have been interrupted at the side roads so that, among other things, the many trucks in the industrial area find it easier to turn. The dividing verge makes cyclists feel more secure on this road section, where speeds are quite high. Average car speeds have not changed on Vesterholmvej.

Cyclist morals in traffic

10-15% of cyclists violate the Road Traffic Act at a normal signalised junction. Herning Police have carried out ongoing control of car speeds and traffic violations by cyclists. Neither the establishment of cycle tracks or police checks have resulted in changes in the number cyclists violating the Road Traffic Act.

Roller-skating in western Jutland – on Vesterholmvej.

PHOTO: Road Directorate





KØN?

☐ Kvinde ☐ Mand

ÅLDER?

☐ Under 25 år ☐ 25 - 40 år
☐ 40 - 50 år ☐ 50 - 60 år
☐ Over 60 år

AFSTAND FRA BOPÆL TIL Herning Kongrescenter

Ca. _____ km.

HVILKET TRANSPORTMIDDEL BENYTTES DU OFTEST TIL OG FRA ARBEJDE?

☐ Bil ☐ Tog
☐ Bus ☐ Motorcykel
☐ Knallert ☐ Cykel
☐ Gang

ÅRSAG TIL AT VÆLGE BIL FREM FOR CYKEL FOR AT KOMME PÅ ARBEJDE?
 Du må gerne sætte flere krydser.

☐ Jeg synes, at der er for langt at cykle.

☐ Jeg sparer tid ved at bruge bilen.
☐ Jeg har gjort det til en vane at køre i bil.
☐ Jeg mener, at det er for farligt at cykle.
☐ Jeg synes, at det er for upraktisk at cykle.
☐ Jeg er bange for, at min cykel bliver stjålet.
☐ Jeg skal bruge bilen til at bringe mit barn/mine børn i børnehaven
☐ Jeg bruger bilen til indkøb, når jeg kører fra arbejde.
☐ Jeg synes, at det er umuligt at parkere min cykel tæt ved min arbejdsplads.
☐ Andet _____

ER DU INTERESSERET I AT CYKLE TIL ARBEJDE, HVIS DER BLIVER STILLET EN FIRMACYKEL TIL RÅDGIVNING?

☐ Ja
☐ Nej
☐ Måske

Questionnaire to the employees.

Employee bikes

171 inveterate car drivers in Herning have chosen to leave the car at home and borrow an employee bike when travelling to and from work. Employee bikes have been introduced in 7 firms in Herning. The concept for introducing employee bikes was largely formulated by the Municipality of Herning and Herning Central Hospital, which was

the first workplace to introduce employee bikes.

To begin with, an agreement was concluded with the workplace about how many bicycles they wanted to buy. The project and the workplace each paid half the price of the bicycles. These are 5-gear city bikes painted in the colours of the logo of the workplace.

Employees who wish to use an employee bike are found on the basis of a questionnaire. Typically, the firm's internal newsletter or paper publishes a notice about the questionnaire, which brings the response percentage to over 50%. In order to borrow a bicycle the employee must be a car driver and have between 2 and 8 km to work.

5-20% of the car drivers was interested in an employee bike, and men and women are equally interested. If there are more employees interested than there are bicycles, lots are drawn. The employee can buy the bicycle for DKK 500 after one year. If it turns out that an employee only uses the bicycle rarely, it will be given to another employee.

A service agreement means that the employee almost always has a bicycle ready for use. After repair, the bicycle shop normally returns the bicycle to the firm on the same day. Service under the agreement is paid for by the firm.

Employee bikes at Customs & Tax.



PHOTO: Municipality of Herning



Interview of employee cyclist.

The handing over of employee bikes to the staff takes place with the greatest possible media coverage to give the participating firms and institutions a green and healthy image. At the same time this gives the local authorities an opportunity to tell the citizens that they are making an effort to reduce pollution from car traffic. A number of press conferences have been held and press statements issued. And the press has, in fact, published a lot of articles, interviews etc, about employee bikes.

Leisure cycling among employee cyclists has tripled. If employee bikes were introduced in all firms

and institutions in Herning, this initiative alone would almost fulfil the goal of shifting 4% of passenger kilometres from cars to bicycles.

Experience from Herning Central Hospital shows that an increasing number of employees wish to have bicycles. The experiment has thus proved to have started a positive development. A brochure about the results from Herning Central Hospital and Job Training Centre has been given to all employees at workplaces in Herning with a staff of more than 50 employees. This got another 4 workplaces to join the project.

It takes about one and a half months from the first contact with the workplace until the employees have started to use the bicycles. Employee bikes must be considered as a cost-efficient measure. At the beginning of the project an attempt was made to get the workplaces to formulate transport action plans, but this was rejected by workplaces as too time-consuming.

Firm	No. of employee bikes	New bicycle km/day	Transferred car traffic
Herning Central Hospital	100	1,119	4%
Job Training Center	11	78	6%
Trade Fair Center	13	145	8%
Cimbria Herning Ltd.	11	55	6%
Erik Roug Ltd.	16	160	6%
Customs & Tax	10	138	9%
Herning Congress Center	10	–	–

Odense – Denmark's National Cyclecity

Town and background

With its 185,000 inhabitants the municipality of Odense has a long tradition of planning for cyclists. More than one in every four trips in Odense is by bicycle. The main cycle network is well developed and comprises more than 350 km of cycle tracks and paths. In addition, there are internal paths in residential areas and minor recreational paths.

Together with the increasing number of cyclists, the road safety of the individual cyclist in Odense has been significantly improved over the last 10 years.

Planning

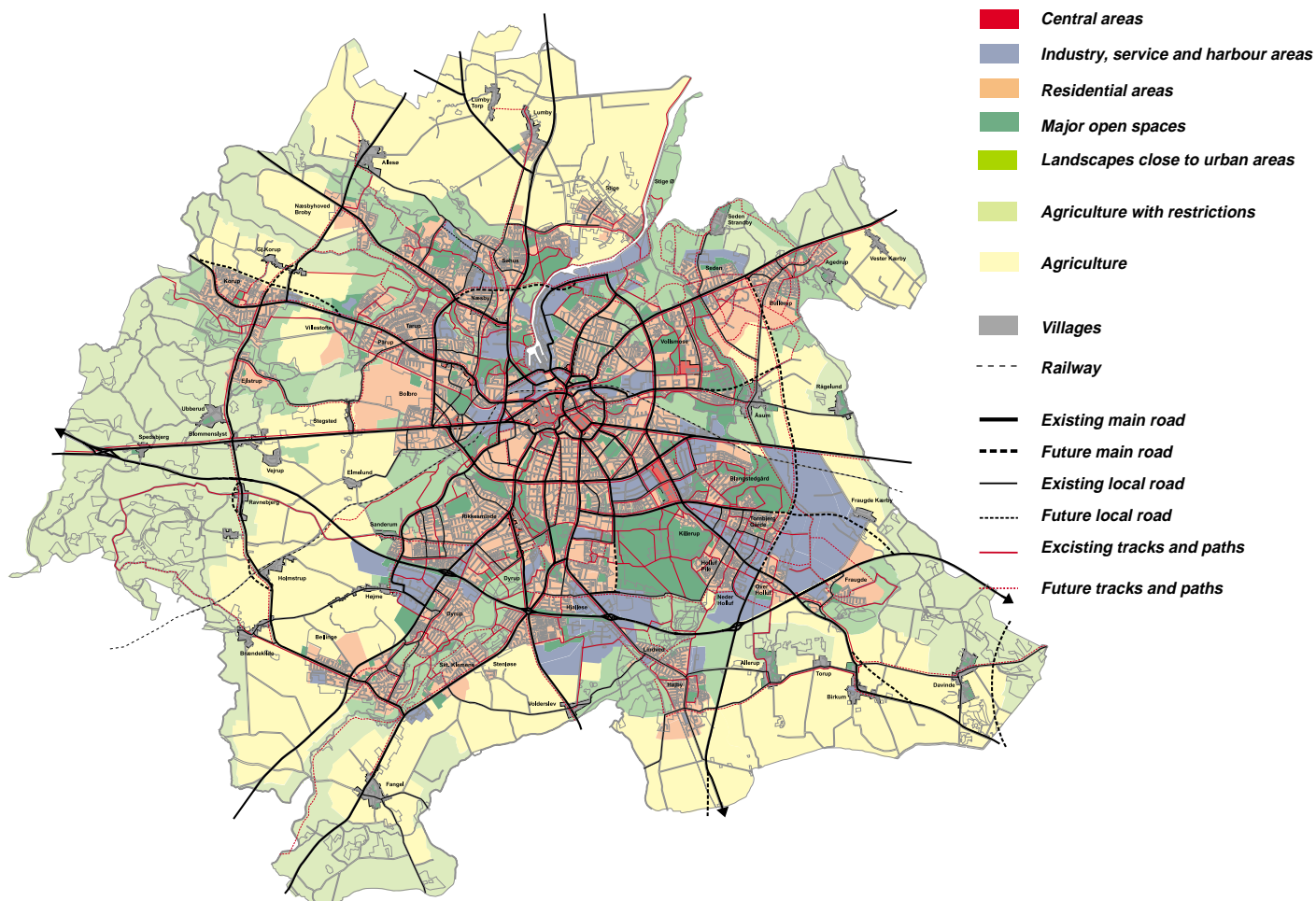
The well-developed cycle network means that further investments in cycle track and paths etc, will yield only limited results. The role of the traffic planner has therefore changed from providing a good infrastructure to a broad portfolio of tasks, including campaigns, co-ordination, schemes etc.

By bringing together experiments on how to influence choice of transport, accumulate knowledge about choice of transport, road safety and testing new initiatives in one city – a National Cyclecity – a shop window for bicycle traffic has been

established. The project takes its point of departure in the fact that it is the individual who chooses his/her transport mode.

In Odense, the idea is that 5 factors influence the distribution between bicycle and car traffic:

- **The house** in which people live
- **The man**, the individual and his social relations
- **The horse**, transport mode, the bicycle
- **The road**, the infrastructure, roads and paths
- **The field**, destinations, eg work and shopping



MAP: Municipality of Odense

Cycle network plan, Municipality of Odense, 1997



Poster – Ride bike, Odense is ready.

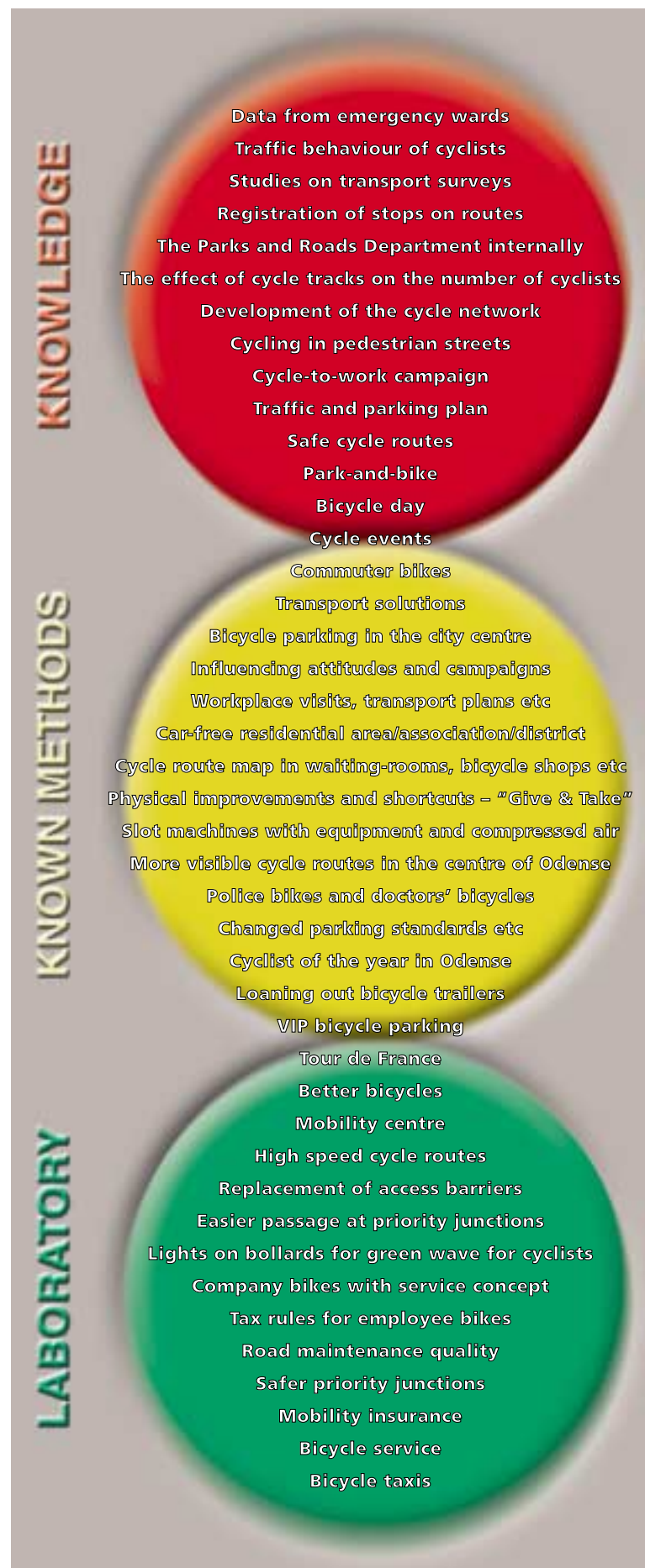
The cyclecity is founded on about 50 subprojects, each of which has a certain weight in relation to 3 development stages, namely *knowledge*, *known methods* and *laboratory*.

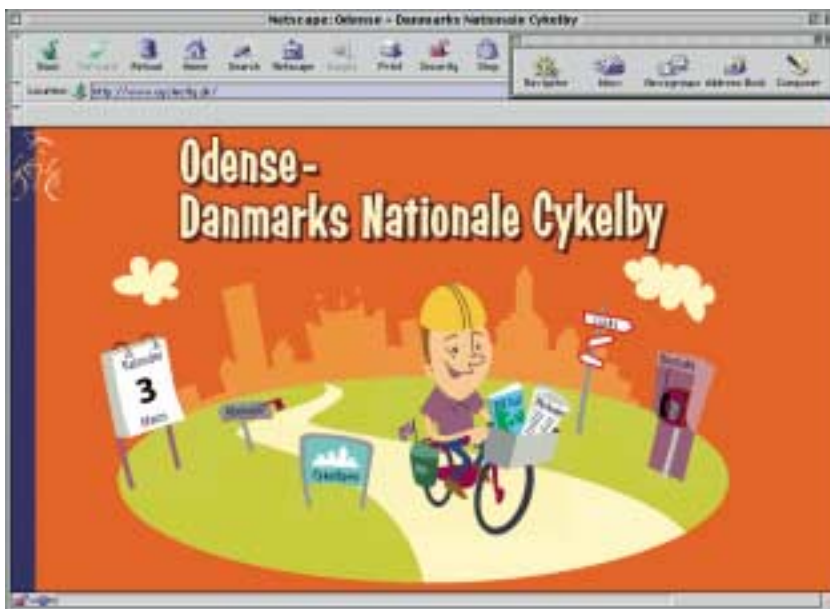
Knowledge covers the collection, analysis and processing of information with a view to improving the knowledge basis for the other projects.

Known methods cover wholly or partly tested and evaluated initiatives, which are incorporated in new contexts.

The *laboratory* covers initiatives that have never, or only to a limited extent, been tested.

Not all subprojects are necessarily implemented. New subprojects may be added and implemented. The major part of the subprojects takes place in the laboratory. 6 subprojects will be described in more detail in the following.





Information strategy

Extensive communication to and from the project via the internet, TV, radio, newspapers, magazines, newsletters and lectures is in itself an effective way of putting bicycle traffic on the agenda. The general public, journalists, traffic planners etc. are continuously fed with new stories and information.

Bicycle parking in the city centre

Parking facilities for cyclists in the centre of Odense are being developed step by step. In 1999, for instance, a square at Asylgade was converted from car parking to bicycle parking, creating an attractive, beautifully designed urban environment. The square is located close to the newly established ring of cycle routes in the city centre.

A module system of automated bicycle parks will be established at several sites in the city centre, although its financing through user payment and advertisements may raise problems for the scheme.



Sketch of the square at Asylgade.

SKETCH: Municipality of Odense



Plates on cycle route.

Making cycle routes more visible

On the main cycle routes in the centre of Odense, plates bearing a bicycle route symbol have been inlaid in the pavement at all junctions. The plates are intended to promote bicycle traffic and make it easier for cyclists to find their way around in the central streets of the city.



PHOTO: Anders Brohus

The fascinating Trial show on the bicycle day in Odense 1999.

Bicycle day

On a rainy day in June, the annual bicycle day was held with an exhibition of both conventional bicycles and less conventional bicycles, such as electric bicycles, half bicycles, carrier bicycles and of bicycle trailers. One of the main attractions was the Trial show by Martin Mikkelsen and the European champion Henrik Rivold.

In a fun draw, with children acting as goddesses of fortune, eight lucky participants won a bicycle in the day's competition. The bicycles were donated by the exhibitors. At least 450 people visited the event.

Mobility centre

The mobility centre opened on 1

October 1999. Its purpose is to promote pro-environmental transport behaviour. One of the main tasks is to promote car-sharing, while another is to establish a regional centre to co-ordinate and harmonise commuting and commercial passenger transport.

The centre will also be a publicly accessible service function which informs and gives advice on less environmentally burdensome forms of transport. The various transport proposals are to be made more individually oriented so that the individual road user/customer is offered a personal package solution.

Experiments at priority junctions

In close co-operation with the Road

Directorate, experiments are being carried out at priority T-junctions on roads with mixed traffic. 5 junctions will be converted into mini-roundabouts. At 15 junctions, a cycle lane is to be established over the last 20-40 m before the junction and 10 m after the junction, while the junction area is provided with a harlequin pattern.

Behavioural studies before and after reconstruction of the junctions will form the basis for an evaluation of the safety effect.

The future

The goal for Odense is to be the best cyclecity in Europe. Hopefully, the many projects will make more people use their bicycles and lead to a reduction in the incidence of bicycle accidents. The inhabitants of Odense, according to what they themselves say, are experiencing their city as a better place for cycling, and this gives them a greater sense of well-being and satisfaction.

In order to strengthen the evaluation of the project, a Ph.d. student has been attached to the project. With its many new initiatives for promoting more and safer bicycle traffic, the project will contribute much valuable new knowledge.

Is Odense going to be the best cyclecity in Europe?



PHOTO: Municipality of Odense

Safer cycling in Randers



Randersbro in the centre of Randers.

ject places a focus on the “meeting” between cyclists and other road users. In 1995-97, 120 bus stops, 18 signalised junctions and 115 priority junctions were marked. As a result of this very comprehensive project a reduction in the total number of accidents involving cyclists may be expected.

Signalised junctions

Stop lines for cars in all traffic lanes have been recessed 5 m in relation to the stop line for cyclists, enabling motorists to keep a better eye on cyclists from the beginning of the green phase. This has made it possible for an extra car to turn left in each yellow/red phase when clearing the junction during peak hours.

Town and background

The municipality of Randers has a population of some 62,000 inhabitants. The town on Randers Fiord and the river Gudenåen has two links across the water for cyclists and one for motorists, which means that traffic is concentrated on a few roads near the centre. On the steep hills, cyclists can be seen moving at high speeds. People in Randers use their bicycles for one out of every five trips. The police have recorded approx. 120 injured persons in traffic per year in the municipality of Randers, about 30 of whom are cyclists.

Planning

The project was a large-scale experiment with certain forms of marking at bus stops and at junctions. Prior to the project the markings had been tested in a few places at other locations in Denmark. The project was carried out in co-operation with

the Road Directorate, Århus County, Randers Police, the Danish Cyclists Federation and the municipality of Randers. The marking pro-

PHOTO: Road Directorate



Truncated cycle track continued in a cycle lane.



PHOTO: Road Directorate

Busy traffic at priority junction with interrupted cycle track.

er. Then the rumble strips make cyclists keep to the right side of the cycle track, thus increasing their distance from cars turning right. An international cycle crossing is marked in the junction area.

Owing to detectors for controlling the traffic lights, the stop line has in some places been recessed only 3 m. It takes two men 5-6 hours to mark an entry and costs DKK 3,500, excluding milling the existing marking and removing the detectors. It costs DKK 4-5,000 to move detectors in an entry.

Behavioural studies show that speeds have been reduced by 11% among cyclists who do not have to stop at red. It must be expected that these reduced speeds will make cyclists more visible for motorists. No changes in the behaviour of motorists have been recorded. They were thus just as bad/good at paying consideration to cyclists before as after the new marking.

Priority junctions

In continuation of the cycle track, bicycle symbols and international cycle crossings have been marked at

side roads without speed-reducing exits. Just as at signalised junctions a slalom lane of rumble strips has been marked. This first takes the cyclist close to cars – then further away. It takes two men 5-6 hours to traffic sign at a side road and costs DKK 3,500, excluding milling, which costs DKK 500. Behavioural studies show a clear improvement in motorist behaviour - they are much better at observing their duty to give way and more rarely drive through the junction without a reaction.

On side roads with speed-reducing exits, for instance, a continuous cycle track, harlequin patterns are used instead of cycle crossings and bicycle symbols. The pattern is a further warning of conflict between cyclists and motorists. Experience has shown that the harlequin pattern marked with 4 mm of thermoplastic is exposed to wear by motor vehicles so that after six months it does not feel uncomfortable for cyclists to cross it, but complaints may be expected initially. On side roads with less than 300-500 cars per day,



PHOTO: Road Directorate

The Harlequin pattern is very visible.



PHOTO: Randers Amtsaavis

Zebra crossings guide bus passengers across the cycle track and accentuate give-way conditions.

it is sufficient to paint the harlequin pattern. 3M tape is destroyed by large vehicles and should not be used for the harlequin pattern. It takes 5-6 hours for two men to mark with thermoplastic and costs DKK 4,000. The harlequin pattern can be easily seen in the dark and clearly shows the location of the side road.

Bus stops

At all bus stops in the town of Randers where there is a cycle track but no bus-boarder, the cycle tracks were marked with zebra crossings and rumble strips in thermoplastic. Three zebra crossings at the doors of the bus steer the bus passengers to and from the footway. The rumble strips make cyclists keep to the right and thereby increase the distance to boarding and alighting bus passengers. A stop line reminds the cyclists that they have a duty to give way.

It takes about 2 hours to mark a bus stop and costs DKK 2,000. If the strips are laid out in frosty weather,

there is a risk of condensation under the marking compound, which will therefore come loose in the spring. Winter maintenance should be handled with a sweeping machine. A snow plough could otherwise easily remove all the rumble strips.

Information was given about the project in the local newspapers. Road posters were also displayed.

Posters showing the markings at bus stops were distributed to schools together with leaflets illustrating the 4 types of markings at bus stops and junctions. Sign boards with information about markings at bus stops were hung up in buses.

Almost 500 stop interviews with bus passengers and cyclists showed that the markings gave 42% a

Two men for two hours and the marking of a bus stop is finished.



PHOTO: Municipality of Randers



PHOTO: Municipality of Randers

Questionnaire study

All 30,000 households in the municipality of Randers received a leaflet about the project in October 1996. The leaflet contained a questionnaire, which was answered by 1,847 persons. The low percentage of replies means that they should be interpreted with some caution.

Almost all the respondents had noticed one or more of the markings. 70% believed that both they and their fellow road users have changed their behaviour at places with markings. 9 out of 10 found that they improve road safety, and 94% thought that they should be introduced in other towns. In order to increase the percentage of replies, the respondents had the opportunity to participate in a competition for a bicycle and accessories.

The future

A study of road safety will be carried out in the year 2001, when accident statistics for 3 years after the new markings will be available.

Students performed the stop interviews.

greater sense of security. 60% had noticed the campaign about new markings at bus stops. 3 out of 4 knew that cyclists had to give way to boarding and alighting bus passengers. Only 23% of the road users believed that the markings had changed their behaviour at bus stops, while only 13% had noticed a change in the behaviour of other road users. Most pedestrians and cyclists prefer bus stops with a bus-boarder.

PHOTO: Municipality of Randers



The winner of the competition won a bicycle and a bicycle helmet.



Inauguration of the new cycle path and bridge.

and a high perception of risk by cyclists. Despite the fact that cyclists have been given low priority for many years, bicycles are extensively used. The goals for the project were thus to improve the safety of cyclists by reducing the number of injuries by 5% per year, to increase bicycle traffic by 10% over 3 years and to give cyclists a greater sense of security in traffic.

The project was realised in the form of an improvement of the cycle route between Svendborg and Thurø, which had been perceived as very unsafe and exposed to accidents. In addition, a number of campaign activities were arranged.

Cyclist studies

Questionnaire studies concerning, for instance, choice of transport, choice of cycle route, the identification of places where there was a high perception of risk and reasons for this perception, and proposals for improvements for cyclists were

PHOTO: Lars Bahl

Svendborg Safe Cycle Town

Town and background

The municipality of Svendborg has about 42,000 inhabitants. Svendborg is the retail trade centre of south Funen and is situated in a beautiful hilly landscape on Svendborg Sound. Prior to the project "Safe Cycle Town", several of the town's central squares and streets were redesigned, which has reduced car traffic in the town centre. In Svendborg more than one out of every four trips is by bicycle.

Planning

The point of departure was an unacceptably low level of road safety, poor road maintenance and paths

Identification of cyclists' perceived risk in Svendborg 1999.

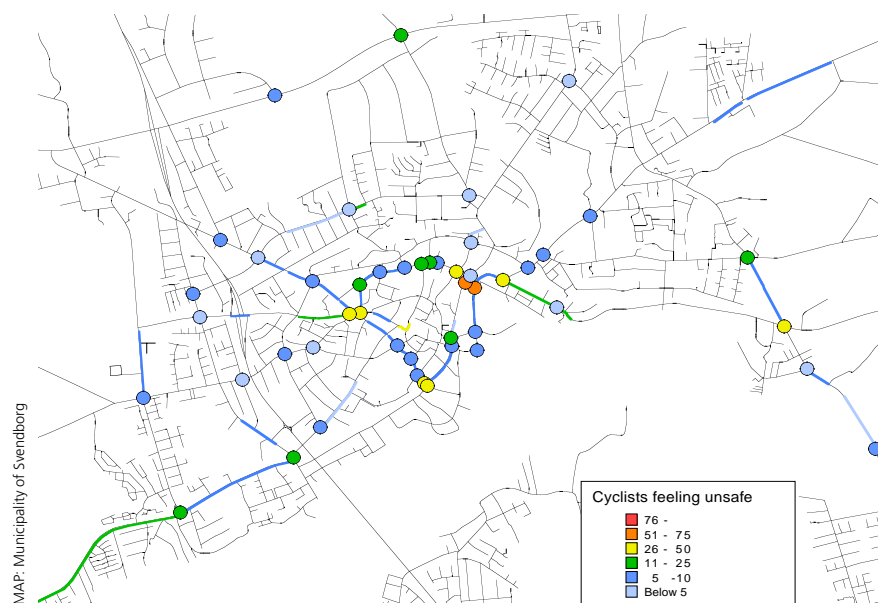




PHOTO: Road Directorate

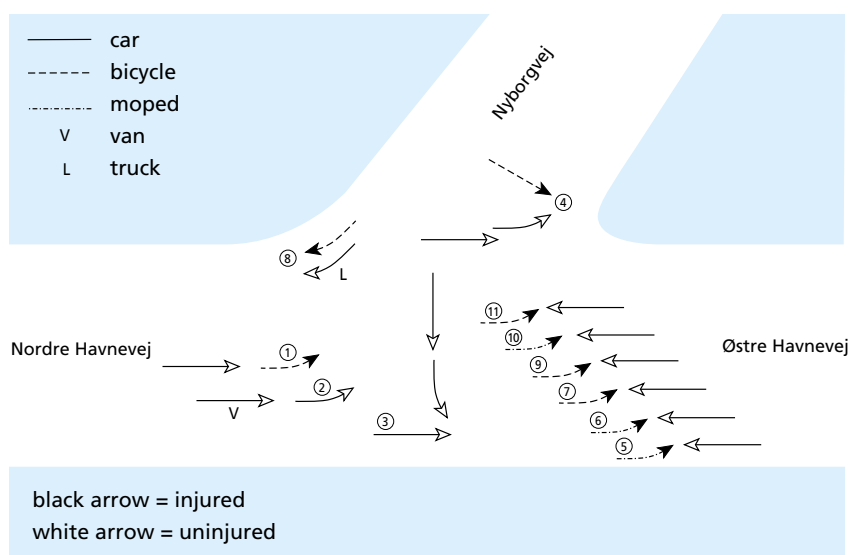
New signs and more secure cyclists.

There is great coincidence between cyclist route choices on trips to and from school/work and trips in their leisure time. Despite this, the background for the choice of route is different inasmuch as the shortest route has first priority when it comes to trips to work whereas the most beautiful route is chosen for cycle trips during leisure time.

Risk perception among cyclists is primarily caused by high car speeds and heavy traffic. Poor pavements on roads and paths and many trucks also have a strong impact on cyclists' sense of security. Both in 1994 and in 1999 cyclists especially wanted more cycle tracks and paths, and they believed that such facilities are the most important factor in improving road safety.

Svendborg-Thurø cycle route

The cycle route between Svendborg and Thurø posed four special problems. Cyclists were mixed with cars on the causeway and bridge to Thurø. This was remedied by the



Collision diagram for junction before reconstruction.

carried out in 1994 and 1999. The questionnaire was each time answered by about 1,000 members of the Danish Society for the Conservation of Nature and the Danish Cyclists Federation.

On the basis of the replies in 1994, cyclist route choices were recorded on digital maps. The traffic figures that emerged can be used to make a comparative analysis of the various routes chosen. By comparing a few bicycle counts with the digital map, traffic volumes on all roads and paths can be described. The study can also be used to predict the use of new cycle routes.

Some cyclists still – illegally – turn using the left-turn lane at the junction of Nordre Havnevej with Nyborgvej and Østre Havnevej.

PHOTO: Road Directorate





PHOTO: Road Directorate



PHOTO: Road Directorate

The path in the harbour and through the forest is a delightful experience on bicycle.

building of a foot and cycle bridge and by widening the causeway. At the same time the dilapidated old bridge was renovated.

Another problem was the junction of Nordre Havnevej with Nyborgvej and Østre Havnevej, where cyclists felt at risk and where many bicycle accidents occurred, especially with cyclists turning to the left. This was remedied by establishing cyclist signals and a short cycle track. However, the cycle track was too short so that some of the cyclists

still used the carriageway and the traffic lights for cars.

The third problem was that cars and bicycles on Østre Havnevej were not separated. After some disputes with the harbour committee a next-best solution was arrived at, namely cycle lanes.

On the path in the harbour and through the forest the route had a gravel pavement and no lighting. The new asphalt pavement and the lighting of the path made it possible to use the route in all weathers and

at all hours – under far more comfortable conditions. A section of the cycle route passes along one of the best beaches of southern Funen. A comparison between the cyclist studies from 1994 and 1999 shows a significant fall in the number of cyclists who feel at risk on the cycle route, especially on the bridge to Thurø, at the dangerous junction and on Østre Havnevej. Telephone interviews before and after establishment of the route showed that the number of cyclists was unchanged. Even though the cycle route has not made people change mode of transport, the route has attracted cyclists from other roads and paths. Therefore more people cycle on the route.

Cyclists received a warm welcome outside the baker.



PHOTO: Municipality of Svendborg

Com a puter on your bike

In May 1996 the Com en' puter on your bike campaign, targeting people over 18 in the municipality was carried out. The idea was to motivate people by giving them a cycle computer if they cycled not less than 250 km in the month of May. The Danish Cyclists Federation and the Danish Society for the Conservation of Nature arranged several cycle trips in support of the campaign. The press coverage was good, as the regional newspaper



PHOTO: Lars Bahl

The winner of Com a puter on your bike.

Fyns Amtsavis followed five of the participants.

Despite bad weather, 446 Svendborgians participated, and 373 received a free computer. The total number of kilometres cycled was equivalent to three times round the earth. The 67-year-old winner cycled 2,363 km.

Mobile without a car

The Mobile without a car campaign was held on a September weekend in 1999. About 400 people came to the Centre Square, where several activities and competitions were arranged, eg cycling at the ring, banana cycling, HPVs etc. The production folk high school served delicacies from Funen and thus set focus on the transport advantages of using local products. A wall newspaper in which citizens could express their views on traffic in Svendborg worked well. The event also dealt with the topics of animals killed in traffic and exhaust gases from cars.

In addition, the campaign included free ferry trips and free rides on town buses and trains. On Sunday

about 600 cyclists and pedestrians were given free rolls, and folders on the pro-environmental use of cars were handed out to car drivers outside 4 of the town's baker's shops. As the bakers did not wish to discriminate between people, the rolls and folders were distributed outside the shops.

Company and employee bikes

In connection with the We cycle to work campaign the local authorities distributed a folder in 1999 to the

200 largest workplaces in the municipality of Svendborg, offering company and employee bikes at half price. A member of staff was employed on the project for a week to telephone the firms and awaken their interest. Nevertheless only 12 workplaces reacted positively, buying a total of 51 bicycles.

Among the good arguments in the folder for company and employee bikes were happy and healthy employees, environmental and economic benefits, speedy transport in town and a green image. For instance, reference was made to a study from Saab-Scania where non-physically active employees had 30 days lost through sickness per year while those physically active only had 8 days annually.

Car commuters who cycled to and from work 4 out of 5 days a week were given a free employee bike. The company bike was transferred to the firm at half price if it had been used for at least 350 km within 12 weeks.

The municipality of Svendborg spent a total of about 150 hours on the company and employee bikes project.

51 new company and employee bikes ready for use.

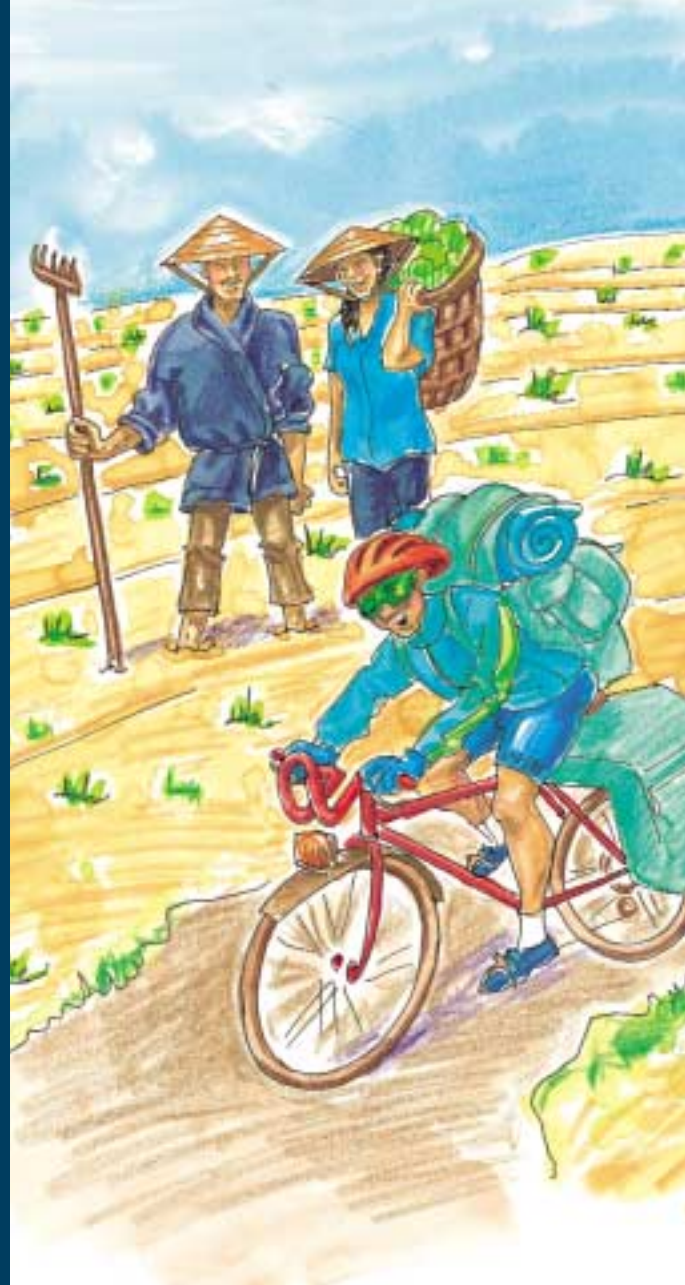


PHOTO: Municipality of Svendborg

From past to future

If you understand the past and the present, you have a good chance of foreseeing possible future developments.

This chapter reviews the historical conditions for cyclists and proposes some ideas about what the future may have in store. One of the goals is to show that “Rome was not built in a day”, that cycle tracks are culturally rooted, and that promoting more and safer cycling takes time.



Contents

1900-1945	164
1945-1975	164
1975-2000	166
Future	170



PHOTO: The Royal Library

Bridle path along Nørre Søgade 1910.

The bridle paths probably formed the model for the Danish cycle track, which later became so popular among cyclists. The curb and planks that were originally intended to keep the loose surface in place later proved to be a good way of separating cyclists from other road users.

More and more vehicles

In the period prior to World War II the bicycle became more and more common with an almost 30% increase in bicycle traffic from 1934 to 1939⁸⁸. Cars also became common and their numbers increased even more rapidly. The cycle tracks in towns were established both to provide better surfaces for cyclists and to separate them from the rest of the traffic. Bicycles were a conspicuous feature of the urban scene and they impeded motorised traffic.

During the Occupation 1940-45 the bicycle was an important mode of transport, as it did not need fuel. The lack of spare parts was a problem, but many imaginative solutions were found. A bicycle was such a great asset that bicycle theft became a significant problem.

1945-1975

The post-war boom initially led to a further increase in the number of bicycles and of bicycle traffic, but

1900-1945

On cobbles among horses

Around the year 1900 few people could afford a bicycle, which was a mode of transport and toy for the wealthy. It offered a wider radius of activity and greater speed than walking, the most common way of getting from one place to another. There were very few cars. Horses, trains and ships were used for goods transport and long trips.

In its day the bicycle meant a revolutionary change in travel patterns and in society. This came to expression at an extraordinary general meeting of the Plumbers Trade Union in 1902. Some of the journeymen had bicycles, which they naturally used when sent out to a job by their employer. As this was solely to the employer's benefit, the union forbade its members to cycle unless they were doing piecework

⁵¹.

The bicycle made new demands of road surfaces. The cobbled paving was uncomfortable and unsafe to cycle on. Even before the turn of

the century a start had been made on improving the traffic areas for cyclists by laying down flagstones. Nails from horseshoes and the like along the roadside posed a constant threat of punctures. This was also a problem cyclists wanted the authorities to do something about.

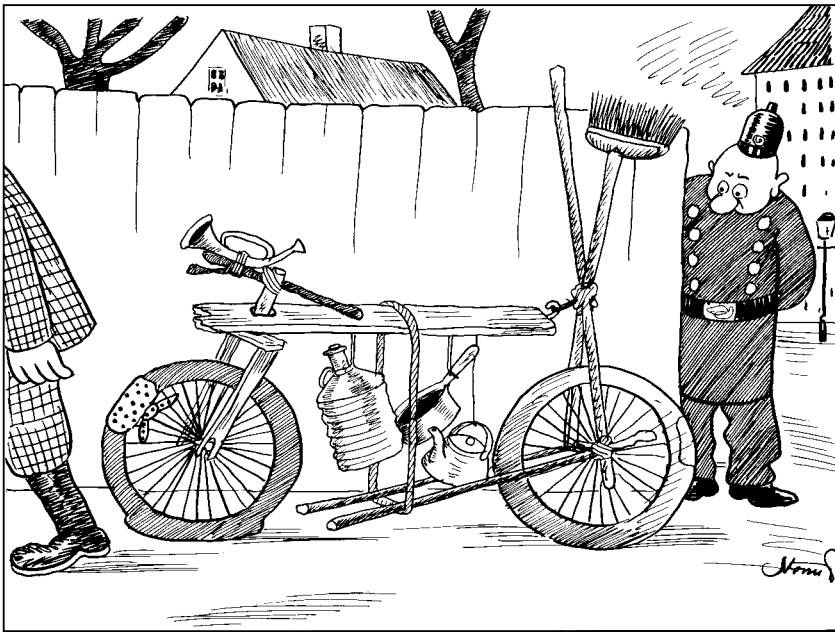
Bridle paths as an example

Around 1910 cyclists obtained acceptance of their demand that the bridle paths paved with loose stones along the Lakes in Copenhagen could instead be used by cyclists, and that the paving could be left smooth and not be loosened at regular intervals.

Many bicycles and few cars in Copenhagen at the end of the 1930s.



PHOTO: The Royal Library



© STORM P. MUSEUM

Storm P.'s Trick Bike to prevent bicycle thefts during World War II.

Albertslund – complete separation – good if paths are used.



PHOTO: Municipality of Albertslund



PHOTO: Municipality of Albertslund

around 1950 this trend changed. There was a sharp rise in car traffic at the same time as people began moving out of the densely populated towns to find air and light in the more sparsely populated and hilly suburbs.

However, there were still many cyclists, and cycle tracks were established. Road inspectors cycled round to check on roads and paths.

Cycle tracks discontinued

At the end of the 1950s, in the 1960s and in the beginning of the 1970s the road system underwent considerable expansion. Cycle tracks were appropriated to create

room for the many new cars. Many buildings had to be demolished to allow streets to continue through towns, and the new roads and streets were often constructed without cycle tracks. In these years there was a strong belief in the car as the solution to all transport problems. Despite the fact that there were still many cyclists, they were regarded as a “dying race”, and bicycle traffic had very low status.

Belief in traffic separation

Among planners a complete separation of types of traffic was regarded as the ideal solution, and new housing developments were established with path networks that were large-

Police recorded road fatalities and injuries in Denmark 1930-1998 ²¹.

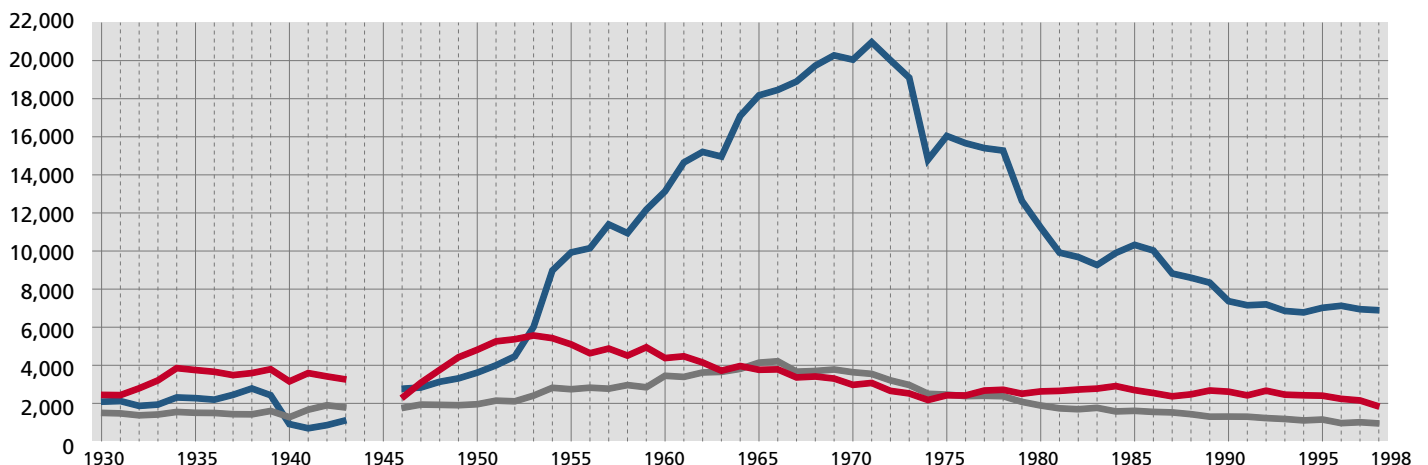




PHOTO: PoFoto



PHOTO: Tage Christensen



PHOTO: Jacob Maarbjerg



PHOTO: Ebbe Andersen

Cyclists about 1960.

ly independent of motor roads. In 1976 the Swedes gave a detailed description of these principles for traffic separation in their SCAFT project. In Denmark the SCAFT philosophy was much used in the planning of new residential areas right through the 1970s.

1975-2000

In the middle of the 1970s and the beginning of the 1980s many changes took place. The simultaneous occurrence of energy crises, the introduction of speed limits and increasing environmental consciousness led to a rise in bicycle

traffic in the late 1970s and even to a decline in motor traffic.

Much manual labour had been taken over by machines, and sport and exercise therefore became popular. Jogging was especially widespread in the 1970s and 1980s, but ordinary cycling was not thought to give a healthier life – something more strenuous was required.

Changing attitudes to cycling

In the 1950s most people cycled for economic reasons. They couldn't afford a car, but cycling was quicker than walking.

Around 1980 many people were still cycling of necessity – not everyone could afford a car. But exercise and concern for the environment were increasingly important motives for cycling. Today we



PHOTO: Ebbe Andersen

Up to 40,000 demonstrated for better conditions for cyclists on the annual bicycle day at the end of the 1970s and the beginning of the 1980s in Copenhagen.



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen



PHOTO: Linda Hansen

Cyclists in the year 1999.

cycle because the bicycle fulfils our need for transport in towns, and we choose to cycle for the exercise, for our health and because we enjoy it. Economic considerations and concern for the environment play a somewhat less important role.

In 1996 the U.S. Department of Health published a ground-breaking report on exercise and health¹¹². The report asserted that physical activity such as cycling is of great importance for our physical and mental health. Dancing, gardening, cycling etc, give a longer life, a more positive frame of mind and fewer depressions. At the end of the 1990s the issue of public health is even more strongly involved when decision-makers try to balance the



PHOTO: Road Directorate

Legal road hump.



PHOTO: Road Directorate

Traffic calming on a main road.



PHOTO: Road Directorate

Traffic calming with flower bowls.

conflicting demands of traffic and the environment.

Stability in cycling

The development of bicycle traffic changed in the mid-1970s. Except for a few fluctuations the number of people using bicycles in Denmark has remained stable from 1975 to today.

There was an increasing understanding of the need to protect vulnerable road users, the term for people who travel by virtue of their muscle power or on mopeds. The widespread public interest in obtaining better conditions for cycling and the safety of cyclists and moped users were important arguments for establishing new cycle tracks along roads.

Traffic calming

There were also other areas in which doubts were raised regarding the one-sided favourisation of motor traffic in road building. Section 40 of the 1976 Road Traffic Act made it possible to construct low-speed road areas. Report no. 827 from 1978 "Section 40 of the Road Traffic Act - New Types of Traffic Calming" introduced physical speed reducing measures for the first time in Denmark⁵⁷.

A large variety of more or less successful experiments were made with staggering, narrowing, changes in the pavement, flower bowls and circular concrete elements. It was often felt that the traffic calming cost too much. In retrospect it is surprising that humps were seen as a secondary instrument, but humps were considered dangerous to drive over because they distracted the driver's attention from other road users.

In practice, relatively few streets underwent traffic calming in the first half of the 1980s. Slowly but surely a consensus emerged that car speeds needed to be reduced in residential and shopping streets. The arguments were that there were considerable gains to be made with



PHOTO: Peter Marling/Bio Foto

Cyclists on the West Coast Route.

respect to security, safety, the urban environment and quality of life.

It was only when humps began to be used that traffic calming began to be effective. The explanation was simple: staggering and narrowing were too expensive and flower bowls too ugly. Many humps were wrongly constructed, so that bus drivers developed back trouble. Today humps are required to fulfil certain criteria to be legal.

Humps are not suitable everywhere. On very busy roads and roads, where there is a special focus on creating a better urban environment, it can be an advantage to put together a concept composed of various traffic calming measures. Roundabouts, pedestrian refuges, narrowings and raised areas, mini-roundabouts, central reserves and the like can form a stretch of road that is both visually attractive and safe. Many such composite concepts have been introduced with success in all parts of Denmark.

National cycle routes

In 1993 Denmark acquired a national network of cycle routes. This was a system of maps and signs that connects existing sections of minor secondary roads, forest roads and

paths and also cycle paths established on closed railroads. Prior to this each of the counties had created its own system of regional routes.

In many cases the routes run through beautiful landscapes and are suited for cycling holidays. The routes are slower and less direct than the road system, but that is scarcely a problem for recreational purposes. Their amenity value has received a very positive assessment, in fact almost top marks with 4.5 points out of a possible 5. Their technical quality lay somewhat lower with 4.1 points. The most popular cycle route was the West Coast Route from the Skaw in the north to the German border in the south ²³.

State funds for cyclists

It was primarily the municipalities and to a certain degree the counties that financed the development of cycle tracks along roads. But the State also played an active role. The National Road Directorate has built hundreds of kilometres of cycle tracks along the national roads.

Cycle tracks first figured in the Finance Act in 1983, and State-supported experiments with cycle routes in towns were initiated, starting in Århus, Odense, Herning and

Elsinore in 1983, and later in Nakskov and Odder in 1988. A lot of money has been distributed to municipalities via the Ministry of Transport's Traffic Fund from 1995 in support of demonstration projects for the promotion of more and safer bicycle traffic.

In 1999 the Minister of Transport designated Odense as Denmark's National Cyclecity, a testing ground for full-scale experiments with campaigns, infrastructure and so on. The purpose of the trials is to get more people to cycle and to make cycling safer.

Cycle tracks are quite safe

Various studies in the 1980s raised doubts as to road safety on cycle tracks. Later experience has shown that some problems can be solved by adapted design and marking of bicycle areas at junctions. Measures such as blue cycle crossings, staggered stop lines and truncated cycle tracks can enhance cyclist safety. In rural areas cycle tracks are a safety benefit.

In 1997 38% of the Danish municipalities built new cycle tracks, while measures against excessive speeds and bicycle accidents were introduced by 72% and 44% respectively ²⁴.

New studies have shown that bicycle accidents are less serious on roads that have cycle tracks than on roads that have paved shoulders or mixed traffic on road sections where there is fast-moving motor traffic ⁵².

Total separation abandoned as the only solution

The 1990s saw an erosion of the belief that a network of paths was the answer. In practice it has only been possible to realise the principle of separate road and path networks in new residential develop-



ments. But even there problems have arisen, since many people feel insecure on empty and separate paths during the evening hours.

Another point is that paths often follow a rather indirect route, which means that cyclists can save time by using the roads and do so. In urban districts with path networks the roads were not built for cyclists, so that from the very start safety and service for cyclists were of a low standard. Roads were reconstructed in a number of urban districts with separate road and path networks in the 1990s, so that cyclists now enjoy good conditions in both networks. In this way a new strategy has been implemented with the result that the total network of cycle routes covers a number of different needs.

From competitor to partner

At the end of the 1990s there was a change of attitude in the public transport companies. Today the bicycle is more seen as a partner than as a competitor. The idea of increasing the customer catchment area for trains and buses by getting more people to cycle to train stations and bus stops has persuaded the companies to invest in better bicycle parking and commuter bikes.

Danish bicycle policy 1999.

The future

National bicycle policy

In *By Bicycle in the 21st Century* the Ministry of Transport, the National Association of Local Authorities and the Association of County Councils in Denmark set out their political goals for better towns and healthier Danes. The three bodies propose to work for more cycle trips, greater road safety and fewer car trips, thus presenting a political vision of what the future should look like ¹⁰⁹.

The strategy *Promotion of more and safer cycling* by the Ministry of Transport points out themes where efforts should be made. The strategy combines physical measures for the benefit of all cyclists with campaigns targeted towards certain groups, for instance, children and youth and also firms. The physical measures are eg:

"The bicycle offers a unique combination of exercise and mobility. An increased use of the bicycle for short trips will give us healthier and fitter Danes".

"For us it is a great challenge to make Denmark one of the leading countries in the world with respect to creating functional, safe and sustainable urban communities. An increased focus on the qualities and potential of the bicycle can be a significant factor in realising such communities."

From: *By Bicycle in the 21st Century*

- Environmental zones and other restrictions in urban areas.
- More and better cycle routes.
- Better maintenance of cyclists' traffic areas.
- Improved bicycle parking conditions.
- Lesser attractive car parking ¹²⁶.

Will elderly people cycle more in the future?



Scenarios for the future

The following pages describe some possible scenarios. It is not a clear-cut scenario but rather a selection of present-day trends that may make themselves felt in the future with a greater or lesser impact.

Different vehicles

For many years now bicycles have been getting faster and faster. Gears, lighter materials etc, have meant considerably higher cycle speeds in the late 1990s than in the 1980s. This development is not beneficial to cyclist safety, since the set-up with cycle tracks along urban roads functions best when cyclists travel at relatively low speeds. But cyclists will continue to travel faster and faster, as they too are interested in higher speeds.



Will new types of bicycles gain ground?



Will electric cars be a part of a sustainable society?

Bicycles will perhaps become more variegated. Some people need a bicycle with many functions, others a simple and smart design.

A sustainable development will demand engines that are different from those in today's cars. Hybrid cars, electric cars and cars that drive 100 km on 3 litres have already seen the light of day. Very quiet engines may cause safety problems for pedestrians and cyclists, who partially rely on their ears to orientate themselves in traffic.

With cheaper communication and electronics cars will be filled with new technology. In order to get motorists to comply more strictly with the Road Traffic Act and to obtain greater road safety, better environments and utilisation of road capacity, this new technology will be developed in a co-operation among the authorities, car manufacturers and the electronics industry. The car of the future may have a speed limiter, road-pricing and parking guidance and enforcement as standard equipment.



Will future cars be equipped with speed limiter, road-pricing and route guidance?

New travel patterns

Still more holiday trips, more international relations and cheaper flights have resulted in a steep growth in airline passengers. The

growth in long trips will presumably continue, primarily in trains and planes. The car will maybe be considered a poor alternative for

long trips in the future. Forecasts for North America show, that car traffic volumes will stagnate in 2010 and then start to decrease, because mobility growth will take place in faster transport means than the car¹²⁷. The natural stagnation in car traffic will occur in Denmark much later.

The incipient trends towards more road closures and area-wide traffic calming that have appeared in the 1990s will be strengthened. In a few years it will still be easy to get in and out of towns by car, but it will be difficult to get around in towns or to drive right into the centre. For this reasons trips within towns will rarely be by car. Its primary use will be to get from one town to another at a regional level.

Inside the smaller and medium-sized towns people will mainly move around on foot and by bicy-

Will bicycle holidays in distant countries be common?





Will bike-and-fly or bike-and-ride-and-fly hit as new upcoming trends?

cle. In larger towns a significant part of the transport will be by bus, tram, subway and local trains. As is the case today bicycles will be used almost exclusively for trips shorter than 7-8 km.

Whether the number of short trips will rise or fall is an open question. One possible scenario is that most people will make many short trips and occasionally make longer trips to, for instance, experience centres, family visits and business relations.

Another possible scenario is that specialisation in the labour market and in leisure activities will require longer and longer trips, thereby reducing the cohesion of local communities.

The urban environment in the 21st century

The urban functions most used by pedestrians and cyclists, such as playgrounds, places of education, retail outlets, sports clubs and places of entertainment, will

become accessible from the majority of nearby homes through safe and attractive urban spaces. Urban spaces with minimal public expenditure on maintenance and low speed limits for cars will be identified as the best. Road maintenance will be paid directly by the real estate owners along the road. And they will be willing to pay in order not to be left with a decaying and depressing road.

In the town centres solutions will be found for the problem of bicycle parking. Initially the large numbers of cyclists in the car-free town centres will result in a lack of parking spaces for bicycles in the streets, not because there isn't enough actual room, but because we will wish to use it for other purposes. Many new solutions will be introduced,



Free automated bicycle parks at pedestrian street – is that possible?



Indoor cycle path with a following wind – future or illusion?

such as automated bicycle parks and multi-storey bicycle parks. Many municipalities will introduce bicycle parking design policies and principles for standards and capacity.

High-class cycle routes may look quite different in the future. This process will start on bridges with indoor cycle paths with a following wind. This brilliant idea will replace the protective wind screens that were necessary to prevent cyclist from being blown away. On these indoor cycle paths it will be easy for cyclists to travel at 40 kph. Perhaps the future will include indoor cycle paths suspended above main roads.

Road safety in the spotlight

In recent decades risk has become an important concept. Greater and greater demands have been made of the interaction between man and

machine. In Denmark the ethical ground rules for road safety were changed in 1997. The vision of Every Accident Is One Too Many is based on the ethical code that

applies in the labour market ¹⁰⁷. It is possible that in the future people will demand the same security and safety on the roads as they have done at work for many years.

The media and the voters will demand more to be done with respect to the important field of road safety. Even today there is a clearly manifested dissatisfaction among voters concerning what is being done to protect cyclists and children on the roads. A cursory glance at the local satisfaction surveys show that road safety should be given a much higher priority ⁶⁰.

Perhaps in the future there will be an accident investigation team for every single fatal accident on the roads. The media will give these accidents intensive coverage because of the great public interest. With a focus of this kind there will be widespread acceptance of solutions that at present appear to be drastic and politically unrealistic, solutions such as the closing of arterials to car traffic, conflict-free signalised junctions and the prohibition of pedestrian and bicycle traffic on more roads.

Will accident investigation teams appear on TV?



Road safety experts will analyse the accidents more systematically. Techniques for mass action analysis and black spot identification will be combined with improved methods for accident diagnosis. The work of road safety specialists will be changed from system analysis to a more creative approach, from Hard Work to Hard Fun. This will at the same time attract qualified staff.

Perhaps it will all end up in a computer-based expert system that knows all the documented ways of preventing accidents. The expert system will just produce 5 possible measures, prioritised in relation to first-year benefit or safety effect – the choice is yours. The system will keep an eye on the effect of the chosen treatment and automatically update its knowledge of the individual measures.

Outside world and market

Firms, institutions, clubs etc, will slowly realise that they themselves can help to create better traffic con-

ditions for their staff, pupils, visitors and members. Some will per-

haps aim more at cycling due to lack of space and funds. Others will maybe stop driving due to their image or health of their employees.

Will the annual bonus be an employee bike?



The strong Danish impulse towards independence will make itself felt. Those who have the possibility of working as an independent “consultant” will do so. Together with more rapid changes in the market and financing a development of this nature will require more and better networks and mean that 5-year plans are impossible to implement. Planning will consist solely of an action plan for the next 6 months and for the vision we hope to realise before the next generation takes over.



Will the bicycles appear during the energy crisis?

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Index

Aalborg	140	Children's travel patterns	137
Accident risk	13	Choice of	
Advanced stop line	90	- target and strategy	22
Advertising, finance	27, 115	- measures	24
Aesthetics	57	- speed limit	52
Age of cyclist	12	- cross section	52
Alternative route	127	- junction design	54
Arrow direction sign	103	- materials	57
Arrow signals	86	- bicycle parking	111
Asphalt ramp	128	City bikes	28, 38
Attitudes	36	Collision diagram	159
Automated bicycle park	110, 152	Com a puter on your bike	37, 160
		Comfortmeter bicycle	120
Barrier devices	127	Comfort of pavement	59
Bicycle accidents	14	Communication strategy	30
Bicycle account	22	Commuter bikes	143
Bicycle day	153	Company and employee bikes	141, 161
Bicycle helmet	14	Company transport plan	149
Bicycle lift	32	Concrete paving	58
Bicycle parking	107, 136	Construction of roads and paths	57
- signing, direction and service	105	Construction projects	114
- placing	108	Contact persons	132
- problem identification	108	Continuous cycle track	83
- capacity	109	Contra-flow cycling	97
- standard	111	Corner radii	54
- design	111	Costs	62, 155, 161
- supervision	112	Cover plates	128
- finance	114	Cross section	52, 65, 69, 71, 73, 79
- design policy	136	Cycle action plan	20, 27, 133, 135
Bicycle parking fund	115	- preparation	20
Bicycle parking norm	114	- interested parties	20
Bicycle parking plan	114	- process	20
Bicycle policy	171	- problem identification	21
Bicycle route symbol	152	- strategy	22
Bicycle theft	108	- measures	24
Black bicycle spot	23, 137	- priorities	26
Blinkers	128	- finance	27
Bridges	94	- realisation	28
Brine	123	Cycle centre	112
Bus gate	99	Cycle co-ordinator	21
Bus stop	76	Cycle crossing	58, 89, 155
Bypassing traffic signals	87	Cycle lane	52, 68
		Cycle lane between right-turn and straight-on traffic	
Campaigning	138	lanes	88
Campaigns, examples	37, 121, 138, 141, 147, 160	Cycle map	105
Campaigns to targeted groups and settings	32	Cycle network	48
Carrot	22	- terminology	48
Capacity	12	- accessible and coherent	48
Channelisation of cyclists	90	- direct and easy	49

- mesh width	49	Illness	142
- safe and secure	50	Image	16
- self-explanatory design	51	Individualised campaign	34
- comfortable and attractive	51	Inspection	120
- process	59	Internet	152
Cycle path	77	Interrupted cycle track	84
Cycle route direction signing	102		
Cycle route map	143	Karlebo	138
Cycle route Svendborg-Thurø	159	Kerb height	74
Cyclist signals	86	Killed cyclists	14
Cycle to the baker's	139		
Cycle track	52, 72, 140	Lane width obstruction	100
- capacity	12	Local features in campaigns	35
Cycle track/lane to the stop line	88	Location of workplaces	44
		Location of shops	45
Danger lamps	128	Logo	146
Delivery scheme	145	Longitudinal guiding barrier	127
Design of traffic areas	63	Luggage equipment	144
Design speed	50		
Desired speed	50	Main cycle routes	48, 135
Detection of cyclists	87	Manhole covers	120
Dialogue meetings	144	Map-type direction sign	103
Dialogue with the public	121	Materials	57
Direction signing	102	Media	31
Draft design	48	Mini cycle lane	89
Drainage	123	Mini-roundabout	92
Dynamic roundabouts	91	Mixed traffic	64
		Mobile without a car	161
Employee bike	147	Mobility	10
Enjoyment	16	Mobility centre	153
Evenness	119	Multi-storey bicycle park	134
Exclusive turning stage	86		
Experiments at priority junctions	153	National cycle routes	170
Extruded kerbs	74	Network planning	48
		Næstved	133
Fiery soul	32	Næstved path bridge	133
From construction to maintenance	123		
		Odense	150
Gradients	79	One-way street	97
Granite	57		
Gravel	58	Parking restrictions	99
Gravelling	123	Patches	119
Gully gratings	120	Path junction	80
		Paved shoulders	71
Harlequin pattern	155	Pavement quality	120
Health	13	Pedestrian street	93
Health festival	38	Perceived risk	16, 158
Herning	146	Perceptions	36
Hills	96	Personal approach	34
Hot-mixed asphalt	57	Pesticides	119
Humps of rubber, guiding	128	Physical activity	13
Hypermarket	46	Plan formulation	59
		Planning of traffic areas	47

Police enforcement	147	Squares	93
Population	42	Stack-type direction signing	103
Population density	42	Staggered stop lines	89
Principles for junction design	54	Stairs	95
Prioritisation of road maintenance resources	118	Stick	22
Priority junctions	82	Svendborg	158
Promotion of bicycle traffic	36	Sweeper	123
Public awareness campaign	31	Sweeping	123
Push-button	87		
		Temporary speed reduction	128
Questionnaire survey 10, 16, 22, 59, 137, 148, 157, 158		Test pilots	144
		Traffic calming	66, 85, 168
Radii, horizontal and vertical	79	Traffic closure	128
Raised junction	85	Traffic moral	147
Randers	154	Traffic pool	132
Readers' guide	8	Travel speed	12
Recessed cycle track	85	Treasure hunt	139
Recommended widths	52	Tree, growth conditions	118
Repair methods	118	Trip purpose	10
Repaving	120	Truck gate	100
Reporting corps	121, 145	Truncated cycle track continued in a narrow cycle lane	88, 154
Resurfacing	119	Truncated cycle track/lane	88
Rewards	33	Tunnels	95
Right-turn stage	90	Types of projects	61
Road capital	119		
Road closure	98	Unsafe, feeling	16, 158
Road maintenance	117	Urban development	42
Roadworks	125	Urban planning	41
- announcement	126	Urban shape	42
- information	126	Urban sprawl	42
- speed reduction	128	User payment	115
- placing of cyclists	129		
- accidents	130	We cycle to work	38
Roundabouts	90	Wearing course	119
Route sign	102	Wheeling ramp	95
		Winter maintenance	121
Safety	7, 137		
Safety campaign	39	Zebra crossing at bus stop	156
Salting	123		
Scenarios for the future	171		
Schoolchildren	34, 137, 139		
Seasonal variation	13		
Separated cycle-footway	74, 147		
Separation principles	52		
Service and repair (bicycle)	112		
Service direction signing	104		
Service goal	59		
Shared-use roads	94		
Shopping centre	46		
Signalised junctions	86		
Single accident	124		
Snow-clearing	122		
Speed reducing measures	66		



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