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Title: Collection of Cycle Concepts 2012

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Printer: Rounborg Grafiske Hus, Holstebro

Copies issued: 1,300

Publisher: Cycling Embassy of Denmark.
Published with funding from the national cycling promotion fund.
Collection of cycle concepts 2012 revises and updates
Collection of cycle concepts published by
the The Danish Road Directorate, 2000.

FOREWORD

The first edition of Collection of Cycle Concepts was published in 2000 and enjoyed a wide circulation among everyone interested in bicycle traffic. The simultaneous publication of the English version spread the Danish bicycle traffic experience to many parts of the world.

The second edition, Collection of Cycle Concepts 2012, updates the field, featuring new challenges and the latest knowledge.

Collection of Cycle Concepts 2012 is not intended to be a summary of Danish road standards, but to provide inspiration and motivation for creating more and safer bicycle traffic – in Denmark as well as the rest of the world.

Troels Andersen, chairman,
Cycling Embassy of Denmark



Knowledge sharing
Inspiration
Cooperation



Passability
Security
Safety



Cost-benefit
Cycling initiatives
Models



Bicycle parking facilities
Spoiling the cyclist
Bicycle service



Campaigns
Motivation
Benefits



Signage
Cycle maps
Cycle route planners



Cycling infrastructure
Tradition
Road safety



Lifestyle
Activities
Cycling facilities



Maintenance
Quality
Sign posting



Bicycle traffic
Urban planning
Sustainable transport



Cycle tourism
Attractions
Activities



City bikes
Commuter bikes
Company bikes



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INTRODUCTION

COLLECTION OF CYCLE CONCEPTS 2012

Bicycle traffic is healthy, environmentally friendly, and makes cities more livable. Cycling is a fast and efficient urban transport mode and requires less space than motor vehicle traffic.

The Collection of cycle concepts 2012 presents a number of ideas to help generate more bicycle traffic and reduce the accident rate among cyclists.





The growth of vehicular traffic presents a challenge to the environment as well as to traffic flows. The issue is less pronounced in Denmark than in other European countries, but is getting worse. Fortunately, Denmark has a strong bicycle culture, developed over more than a century. Today approximately 1 journey in 5 in Denmark takes place by bike. The denser the urban area, the higher the cycling modal share; in the densest urban areas cycling is the primary transport mode.

In order to create sustainable transport in future, cycling must continue to play a major role. The infrastructure must be designed so as to get maximum use out of the bicycle's features and possibilities. In return bicycle traffic reduces the need for major roads, thereby making it possible to postpone or avoid costly road construction.

A large proportion of short journeys in cities can take place by bicycle. Cars are often indispensable for longer journeys and the bicycle cannot be the sole transport mode. A reasonable interaction between transport modes is necessary. The proper balance of high quality roads and paths that meet the needs of pedestrians, cyclists and drivers can create more livable cities without sacrificing interaction.

In recent years the use of cargo bikes and cycle trailers to carry children or goods has become increasingly widespread. This makes life much easier for families with children even without a car or a second car. A marked increase in the use of e-bikes, which has not been at the expense of traditional bikes, is another factor that helps improve the quality of life over somewhat longer distances.

Increasingly, cycling is being integrated with bus, train and even air travel for long journeys; this is important, since commuting is on the rise and fewer and fewer people can rely on the bicycle as their sole transport mode. There is a need for traffic terminals that provide easy access when changing from one transport mode to another.

Cycling is also of great benefit to the individual. A half hour of daily physical activity, such as cycling, increases the average life span by several years and improves the physical and mental quality of life. Cycling is a healthy, prophylactic form of exercise. Furthermore, in urban areas cycling is often the quickest means of getting from point A to point B. When cycling you experience the weather and the seasons more deeply, becoming an integral part of the life of the city.



Road authorities are not the only ones who are instrumental in changing our transport attitudes, making it more acceptable to bike; businesses, schools, organizations, etc. can also play a major role.

MORE CYCLISTS, PLEASE!

Many people choose to cycle because it's convenient, healthy and cheap. However, it's a major challenge to encourage people to change transport modes so that more people cycle rather than drive.

It is essential to combine public relations, educational campaigns and other soft measures with hard, physical and economic initiatives. The combination of hard and soft measures is crucial to bring about a significant change in citizens' transport habits and road safety behaviour. At the same time the synergistic effect of multiple initiatives yields a higher rate of behavior modification for the money.

There are two general approaches for designing campaigns to promote cycling. The first approach aims at encouraging frequent cyclists to continue cycling and occasional cyclists to cycle more. This is a relatively cheap way to promote bicycle traffic. The young and the middle aged are the primary target audience and can be reached through businesses and educational institutions. A good example of this type of campaign is the "We bike to work" campaign, which mobilizes 100,000 Danish participants. This type of campaign is part of a larger picture in which sustainable mobility is the key concept.

The second type of campaign aims at persuading people who are primarily drivers to cycle. Children as a target group play a vital role in this kind of campaign because bicycle culture is based on a continuous influx of new cyclists and the foundation for cycling habit formation takes place in childhood. Competitions and education have proved effective in encouraging children to cycle, especially in combination with projects designed to improve road safety and sense of security on school routes. Invertebrate drivers are relatively resource demanding, and should therefore be dropped as a primary target group.

It is true of all cycling campaigns that a positive approach based on enjoyable experiences, humour and fun is far more effective than waving an admonishing finger. In addition to running promotional campaigns it is essential to tell the public what steps are actually being taken for cyclists. Over the long haul the continuous marketing of good cycling stories constantly reminds citizens of the advantages of cycling.

Improving physical conditions for cyclists is a must since citizens need to see favourable material changes to make them want to choose cycling as an alternative to driving. The construction of cycle tracks is excellent, but smooth road and cycle track surfaces are also key parameters, as are bicycle parking facilities. Small measures can have a big impact, and cycle friendly installations generate positive PR.

Quality lies in the details. There are many different types of cycle track and the choice of cross profile can be crucial. Intersection design has a tremendous impact on safety as well as passability. Fortunately, Denmark has many years of experience with many different designs to protect cyclists from injury. In recent years work has been done to devise new methods of giving cyclists priority so as to increase travel speeds and reduce the number of stops. Cyclists can be catered to by a number of different services that make daily life a bit easier.

Cycling promotion becomes significantly more difficult when motor traffic is encouraged by favourable physical and economic conditions. Motor traffic conditions are often improved, particularly when automobile related expenses

drop. In Denmark we are accustomed to introducing restrictions on motor traffic, such as fuel taxes, parking fees and speed-limit reductions. Such restrictions will continue to be necessary if the measures intended to boost cycling are to have the desired effect. At least of equal importance is the competition interface with public transport. The goal should be that public transport shouldn't appear too attractive to potential cyclists.

Fruitful collaboration between transport modes is critical to the smooth function of society, socially, economically, and in relation to traffic and the environment. A coordinated effort is an absolute must for improving health and creating more livable cities.

SAFER CYCLISTS

In many cities where the number of cyclists has increased, the total number of traffic accidents has dropped more than in other cities. In other words, it is possible to increase bicycle traffic and improve road safety at the same time. The more cyclists there are, the safer the individual cyclist, the reason being that drivers very rarely overlook a cluster of cyclists. More people cycling means



that cyclists become more experienced in traffic; inexperienced cyclists run a far greater risk than daily cyclists.

Bicycle equipment and design have a major impact on cyclist safety. Cycling in the dark down a country road where there is no cycle track is extremely risky without a tail light, for example. In Denmark bicycle equipment and design have to meet stringent requirements. Many other factors have an impact on safety apart from safety requirements. Cycling with a shopping bag in your hand, for example, is not a good idea from the safety point of view. A three-wheel bike can be a good idea for the elderly. And all cyclists can improve their personal safety by using a helmet (not compulsory in Denmark) and bicycle lights.

Control also plays a major role for traffic safety, including bicycle and speed control. The bike shop can inform customers of any regulation infringements or other bicycle related issues, and the police can help by increasing their efforts to prevent dangerous and unlawful traffic behaviour.

Information and promotional campaigns have proved effective in improving driver safety. Road safety campaigns need to be designed to encourage cyclists to develop safer attitudes and behaviour.

Road modifications are costly but are sometimes the only solution to a specific safety issue. When roads and cycle tracks are being dug up for other reasons, this is an excellent opportunity to change the road's design, making it safer, more comfortable, and more passable.

Road users make mistakes, so it's important to minimize situations where this can happen. When mistakes happen anyway, minimize the consequences of any accidents that may arise.

Cyclist safety can be improved in many different ways. A more systematic approach is necessary, and solutions should be aimed at the areas and groups where they have the greatest impact. One of the major challenges confronting cycling promotion and safety is the need to implement many different initiatives at the same time.

The whole issue of cyclist safety needs to address cyclists' sense of security as well. If cyclists don't feel secure, many will feel compelled to take the long way round or even not bike at all. On the other hand, especially in intersections, cyclists shouldn't feel so secure that they cease being vigilant to possible dangers. The challenge is to create safety and a sense of security by enhancing cyclist vigilance.

GETTING A GOOD START

Encouraging more people to cycle requires an active effort. A number of measures need to be taken simultaneously to improve cyclist safety. The aim of the Collection of cycle concepts 2012 is to provide a general overview of the field as well as inspiration and motivation.

The Collection of cycle concepts 2012 is primarily aimed at traffic planners, but can be usefully read by anyone with an interest in cycling. The publication consists of chapters that can be read independently and is therefore suitable for reference purposes.

Have a pleasant journey!



COLLABORATIONS AND NETWORKS

Informal networks as well as formalized, well-organized associations ensure the necessary knowledge sharing, inspiration and cooperation that cut across local administrative boundaries.

Formal networks also give rise to informal contacts, generating new ideas and projects.

It is typical of the field of bicycle planning that there are very few people whose sole area of responsibility is cycling. In some local administrations the entire field of cycle planning is covered by one staff member. This makes it difficult to test out ideas and exchange views with peers, keep up-dated on the latest solutions and enter into innovative working relationships.

In Denmark there are several opportunities for joining a network and entering into a collaborative alliance.

The municipal cycle network focuses on knowledge sharing among municipal practitioners while the Cycling Embassy of Denmark consolidates cooperation between the private, public and civil sectors. In addition, there are a number of other platforms that consolidate cooperation and knowledge sharing, such as conferences and minor networks.



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The municipal cycle network functions as a professional platform

THE MUNICIPAL CYCLE NETWORK

The municipal cycle network functions as a professional platform for municipal practitioners working with bicycle promotion projects. There is no Danish tradition of close cross-municipal cooperation at this level, and one of the network's aims is to ensure such cooperation. The municipal cycle network provides a platform for:

- Mutual inspiration and exchange of ideas.
- Communicating experiences.
- Building a knowledge base.
- Testing ideas.
- Seminars, workshops and study trips.
- Establishing a reference base of tested measures aimed at decision makers, politicians and police (historical overview of new cycling initiatives).

Establishing the municipal cycle network

Developing Denmark into a cycle friendly country is largely a decentralized, local process. It is therefore crucial that the many valuable initiatives and experiences from all over the country are collected, systematized and passed on. There is always the risk that valuable experience will be lost if the individual authority works in a vacuum. For a number of years Danish municipalities received state funding, financed by the so-called Trafikpuljen, to promote cycling initiatives. A requirement for receiving the grant was to communicate results and experiences to the other local authorities.

In 1999 Trafikpuljen was discontinued and the Danish Road Directorate's secretariat which had administered Trafikpuljen was shut down. The task of ensuring the spread of information was now entirely in the hands of the local authorities, and the professional platform that had been formed between the individual municipalities was in danger of disappearing.

To ensure that the collaboration that had already been established would continue and that the individual municipality's experiences would be passed along, an agreement was reached

between the municipalities and the Danish Road Directorate to establish a professional cycle network.

The Danish Road Directorate withdrew from providing secretariat services for the cycle network in 2001. There then followed a period in which the individual members of the network took turns planning the meetings. At present the Danish Cyclists' Federation has assumed responsibility for the secretariat, including preparing agendas, sending out invitations, and generally being in charge of all practical arrangements.

How the municipal cycle network works

The collaboration is built around two annual meetings and study trips, as well as the on-going testing of ideas.

The members of the network host the meetings on a rota basis. Of course there are also visits back and forth in connection with current projects.

Items on the agenda for the next meeting are agreed on at the last meeting, based on current needs. A main theme is decided on in advance of each meeting. So far the main themes have been: "Collaborating with business stakeholders", "Bicycle parking", and "Cyclist safety". A

constant item on the agenda is "Round the table" in which all the participants report on the current status of their projects.

17 municipalities are members of the network as of 2011, and the Danish Cyclists' Federation functions as coordinator, secretariat and publisher of the electronic newsletter, Cykelviden. The Danish Road Directorate is not a member, but is often present at the meetings so as to keep up-dated on local activities and update the municipalities in return. Non-members such as researchers participate in special events.

Read more about the municipal cycle network at www.cykelviden.dk. (Not available in English.)

THE LOCAL BRANCHES OF THE DANISH CYCLISTS' FEDERATION

The Danish Cyclists' Federation is a member organization, an NGO with around 40 local branches located all over the country. Local authorities can benefit from collaboration with the local branches and the Copenhagen secretariat in a number of areas:

- Impartial assessment of local cycling conditions.
- List of measures with the greatest impact, e.g. best value for money.
- Formulate an overall cycling strategy.



- Establish concrete objectives.
- Mobilize citizen support for new cycling initiatives.
- Cycling related classes for the young and the elderly.
- Cycling initiatives as municipal promotion.
- Collaboration with citizen groups and/or other local institutions.
- Lobby officials and politicians to promote new cycling initiatives.
- Cross-administrative collaboration, e.g. between the health, environmental and traffic administrations.
- Promote new cycling initiatives to citizens and in the media.
- Promote new cycling initiatives to the Ministry of Transport or Members of Parliament.
- Provide cycling inspiration from Denmark and the rest of the world.
- Share knowledge of what other local authorities have done to promote cycling.

Collaboration between the local authorities and the Danish Cyclists' Federation is most successful if project expectations are in sync from the start. The local branches are made up of volunteers fueled by a high level of personal engagement, which can prove invaluable to the community. However, it may not be possible for the local authority to invest what the volunteers consider the optimal amount of resources in a given project; it is crucial to adjust expectations and roles from the outset so the local branch volunteers can fulfill their role as constructive partners.

Meetings held early on in the process can clarify whether the authority and the local branch of the Danish Cyclists' Federation can make common cause. They will often share common interests, and the Danish Cyclists' Federation can be a powerful factor in creating credibility and popular support, both politically and when it comes to selling the idea to the local media.

Making sure that press statements and releases correspond is crucial to the collaboration. Situations can easily arise where the parties have different attitudes and points of view. Indeed, voicing different views is part of the cooperative relationship, but confidence is best served if the parties keep each other informed in advance so new statements do not come as a surprise.

In addition to the local branches located all over the country, the Danish Cyclists' Federation secretariat in Copenhagen is available for advice, guidance and to test ideas.



"We're just doing what you do in Copenhagen", said Michael Bloomberg, Mayor of New York City, when presented with a prize from the Cycling Embassy of Denmark. Inspired by Copenhagen, New York has started establishing bike paths in many parts of the city.

CYCLING EMBASSY OF DENMARK

The Cycling Embassy of Denmark is a network of different players in the field of cycling. No tradition of close collaboration formerly existed between private companies, local authorities and other organizations, but it makes sense to consolidate resources when the playing field is so small compared to the rest of the world.

It is the cycling embassy's vision that Denmark shall be the world's leading cycling country and the primary source when it comes to knowledge, dialogue and innovation in the field of cycling. The organization wishes to encourage cycling all over the world and its members work together to develop and promote Denmark as a cycling country through exchange of ideas, development and communication of bicycle culture in Denmark.

In concrete terms the Cycling Embassy contributes to:

- Joint promotion of Denmark as a cycling country at conferences.
- Making Danish cycling knowledge available to non-Danes.
- Joint knowledge gathering and preparation of publications related to cycling knowledge in several languages.
- Supporting events at Danish embassies and other Danish agencies abroad.
- Knowledge sharing and exchange of ideas.
- Arranging master classes, excursions and courses.
- Professional handling of visiting delegations.
- Ensuring a platform for network formation.



Cycling Embassy of Denmark

The name alone – Cycling Embassy of Denmark – attracts international attention.

Establishing the Cycling Embassy of Denmark

Ever since 2005 the interest in daily cycling has been growing slowly but surely all over the world. This has put a certain amount of pressure on Denmark (and Holland), where the cycling modal share is high. Journalists, city planners, architects, students, and politicians travel to Denmark to discover why this is so. At the same time, Danish embassies and agencies abroad have started to take an interest in promoting Denmark as a bike-friendly nation.

In 2009 a number of Danish players in the field of cycling launched a new network called the Cycling Embassy of Denmark. The network saw the light of day at the European cycling conference Velo-city, in Brussels. At the time it consisted of 13 members and both the Danish Road Directorate and the Foreign Ministry were – and still are – involved in the network. In 2009-2010 seven members jointly initiated a large number of activities and were granted DKK 500,000 by the Ministry for Business and Growth's Marketing Fund.

There are currently 17 members in 2011, including 6 municipalities, 6 private companies (consultant as well as production) and other types of organizations, such as VisitDenmark, DSB, the Danish Cancer Society, the Danish bike shop trade association, and the Danish Cyclists' Federation.

How the Cycling Embassy of Denmark works

Although the Cycling Embassy is a network in practice, it has a formalized structure with a board of directors, articles of association, dues, and a work plan. The network is open to everyone who meets the requirements of the articles of association, which means that you have to be actively engaged; nothing takes place except at the initiative of the membership. Task groups are established as new projects and events are defined, including media activities, annual prize awards, biking tours for cycling enthusiasts, and booths at cycling conferences. Other activities include preparing publications aimed at Danish and non-Danish readers, and arranging bicycle game events and presentations abroad in collaboration with Danish embassies and other agencies.

The Danish Cyclists' Federation has assumed the function of the Cycling Embassy's secretariat; it prepares the meetings, draws up the minutes, and coordinates many of the activities while the Cycling Embassy ensures that the many international enquiries are handled professionally.



3 annual meetings are held for the membership as a whole, and the Board holds 3-4 additional meetings annually. The members host the meetings on a rota basis, and also have a say in the agenda. Members pay dues which primarily finance secretariat work. In addition they invest the time and resources that they find meaningful. You can read more at www.cycling-embassy.org.

CYCLING AT CONFERENCES AND OTHER PLATFORMS

Since 2008 the Danish Road Directorate has held an annual, two-day national conference at which projects, promotional campaigns, and new knowledge are presented and discussed. The event provides an excellent overview of the many activities taking place. Furthermore, cycling is increasingly becoming a subtopic at conferences on other themes, such as health, the environment, mobility, urban planning, children and physical exercise.

EUROPEAN COLLABORATION

It is possible to apply for EU funding for cross-municipal or cross-national cycling projects. Among other things, this has given rise to such projects as Nordic Cycle Cities with the participation of 4 Danish municipalities, and

Cykler uden grænser ("Bikes without Borders"), a collaboration between 4 Danish and 2 German cycle cities. The Danish Cyclists' Federation is part of the European Cyclists' Federation based in Brussels, and is in an on-going dialogue with the European Commission, among others. Lobbying the Commission has important consequences at the regional and local level as the European Commission has an impact on municipal development through the so-called Green Books, which describe challenges, offer recommendations and propose solutions. The Commission also has the power to develop or establish subsidy schemes promoting innovation and development.



The EU can fund cycle projects across national and municipal borders





COST-BENEFIT AND TRAFFIC MODELS

The cycling infrastructure and other cycling facilities are of tremendous benefit to society, and in relation to health impact bicycle transport far out distances other transport modes. New studies quantify the benefits, providing a firm, quantitative basis for prioritization of cycling infrastructure. Further, traffic models can be used with great advantage to model bicycle traffic, particularly in large cities where bicycle traffic constitutes a significant modal share.



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COST-BENEFIT IN GENERAL

Basically, what society wants is maximum value for public money, which is why economic considerations and cost-benefit analysis have become an integral part of the political prioritization process in a number of areas, including the infrastructure. For many years cost-benefit analyses have been mandatory when assessing the profitability of major infrastructure projects, just as medical technology and third world development projects are subject to cost-benefit analysis in order to determine the project's value to society.

In a cost-benefit analysis a project's advantages (benefits) are compared with its disadvantages (costs), and if the benefits outweigh the costs the project is of benefit to society. Every relevant type of advantage and disadvantage is assigned a monetary value if possible.

Costs are primarily incurred in the initial phases (establishment phase), whereas benefits are recurrent as long as the infrastructure is in use (operational phase). Thus, the choice of time horizon in the calculations is of primary importance. Typically, a payback period of 5-8 years on cycling infrastructure is considered satisfactory.

DTU Transport, Technical University of Denmark, published *Transportøkonomiske Enhedsspriser* (the former *Nøgletalskatalog*) for the Ministry of Transport, showing a number of assumptions and parameters for calculating socioeconomic costs and benefits. Unit prices include assumptions regarding economic growth, car ownership and transport costs.

COST-BENEFIT IN RELATION TO CYCLING INFRASTRUCTURE AND OTHER CYCLING FACILITIES

Cost-benefit analysis can be used to assess the value to society of cycle projects. If bicycle traffic is to get equal treatment with other transport modes it is crucial to have a solid planning basis to help decision makers prioritize transport spending.

A preliminary set of unit values methodology for cost-benefit analyses of cycling initiatives was established for a project in the City of Copenhagen. The unit values can be used to perform cycling specific cost-benefit analyses, including new infrastructure construction, renovation of existing infrastructure (e.g. accident reduction measures), and campaign implementation. In addition, unit values can be



Cycling is good business for society

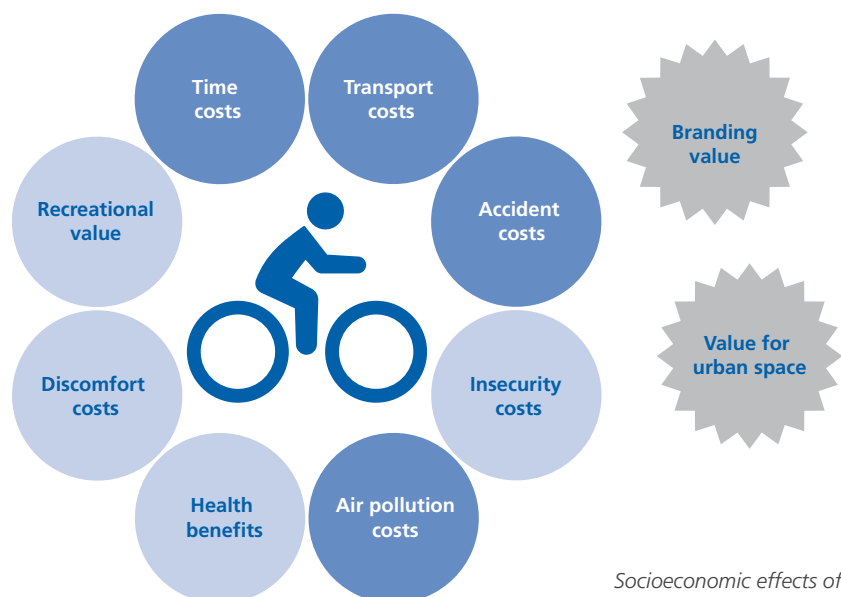
used to compare the different transport modes' costs and benefits.

Unit costs consist of two parts: a) what the individual making the transport mode decision considers significant and b) the impact that decision has on the rest of society. In economic terms these are referred to as internalized and externalized costs. Internalized costs include value of time, vehicle attrition, petrol (for cars)

and health, while externalized costs include expenses in connection with traffic accidents, hospital costs, negative environmental impact, congestion, etc.

When all these factors are added up, each cycled kilometer costs society DKK 0.60, whereas each kilometer driven by car costs DKK 3.74. The table below shows the costs of driving vs. cycling calculated for different parameters.

SYSTEMIC COSTS AND BENEFITS



Socioeconomic effects of cycling.



Average costs per cycled km, DKK, 2008 prices

	Bicycle (16 km/h)			By comparison: Car (50 km/h) in city			
	Internalized	External	Total	Internalized	External	Fees	Total
Time cost (travel time, private)	5.00	0	5.00	1.60	0	0	1.60
Mileage cost	0.33	0	0.33	2.20	0	-1.18	1.02
Increased life expectancy	-2.66	0.06	-2.59	0	0	0	0
Health	-1.11	-1.80	-2.91	0	0	0	0
Accidents	0.25	0.54	0.78	0	0.22	0	0.22
Insecurity	+(?)	0	+(?)	?	?	0	?
Comfort and discomfort	?	0	?	?	?	0	?
Branding, tourism	0	-0.02	-0.02	?	?	0	?
Air pollution	0	0	0	0	0.03	0	0.03
Climate change	0	0	0	0	0.04	0	0.04
Noise	0	0	0	0	0.36	0	0.36
Road attrition	0	0	0	0	0.01	0	0.01
Congestion	0	0	0	0	0.46	0	0.46
Total	1.81	-1.22	0.60	3.80	1.13	-1.18	3.74

The table shows transport costs. A minus sign indicates a socioeconomic benefit. The assumption is 1.54 persons per car 4.1 for cars: 4.2

Time cost

The highest cycling related cost per kilometer is time, namely DKK 5 per kilometer. The monetary value of time is based on the population's willingness to pay in relation to time, based on a Danish time-value study. People's willingness to pay typically increases with increasing prosperity. 4.3

Accident costs and the health effect

Accidents cost DKK 0.78 per kilometer while the direct maintenance and depreciation costs of cycling are roughly DKK 0.33 per kilometer. However, cycling provides many advantages to society in the form of health and life expectancy benefits. Taken as a whole, the benefits roughly amount to DKK 5.50 per kilometer. Most of these benefits affect the individual cyclist (internalized benefits), calculated to approx. DKK 3.80 per kilometer, while other sectors of society (the health sector and the State) benefit by about DKK 1.81 per kilometer. The benefits include saved costs for medical treatments and increased work value due to less sick leave. The health effect is based on the assumption that 50% of cyclists are already in good shape and derive no added benefit, while the other 50% are in poor shape and achieve the full benefit.

Total socioeconomic impact

Taken as a whole the costs per kilometer from cycling are approx. DKK 0.60, which includes all effects assigned monetary value. This means that



Health and time are the primary parameters in a cost-benefit analysis of cycling. The amenity value and well-being derived from cycling are difficult to value, as shown here on the Frederiksberg greenway

the cost to society of cycling is much lower than the cost of motor transport, assuming there are no more than 1-2 persons per car; society saves

at least DKK 3 per cycled compared to driven kilometer. 4.4 Switching from car journeys to cycle journeys is thus an excellent investment.



Cost-benefit analyses show that Bryggebro Bridge is a fine investment with a return rate of 7.6%.

Moreover, in some instances the result is even better. For example, it is assumed that cars travel at a rate of 50 km an hour. In many large cities, however, cars move much slower during peak hours, not counting the time spent finding a parking space and walking from there to the final destination, making it even more profitable to invest in cycling. One conclusion of the Odense Cycle City project was that the fact that Odense citizens were cycling more had a positive impact on public health and thus a positive socioeconomic effect.

CASES

Bryggebro bridge

In September 2006 the city of Copenhagen opened Bryggebro bridge, a roughly 200 meter long pedestrian and cycle bridge over the Copenhagen harbour. The bridge links central Copenhagen via Fisketorvet with Islands Brygge and Amager.

A cost-benefit analysis was used to evaluate the bridge, and showed that the bridge is very likely an excellent investment. There have been

significant benefits to cyclists, primarily in terms of time saved, estimated to exceed project costs. The bottom line is that the bridge has yielded an expected profit to society of DKK 33 million and a return rate of 7.6%. [4.5](#)

The Gyldenløvesgade intersection

The cost-benefit method was also used when renovating the dangerous Gyldenløvesgade intersection in Copenhagen. The analysis shows that there is a high probability that the renovation is a fine investment. There have been major benefits to cyclists in terms of heightened welfare and to society in terms of saved medical costs and increased tax revenues. Taken as a whole, the benefits of the project are estimated to vastly exceed the costs. The bottom line is that the intersection has yielded an expected socioeconomic profit of DKK 59 million and a return rate of 33%. [4.6](#)

Experience abroad

A Dutch analysis supports the findings of the Copenhagen study quantifying the enormous health benefits associated with cycling. The analysis shows that if 500,000 persons switch to cycling instead of driving for their short,

daily journeys, they will achieve a huge health benefit, vastly exceeding the small reduction in life expectancy due to enhanced exposure to air pollution and a greater risk of accidents, see table below. [4.7](#)

[4.8](#)

IMPACT ON INDIVIDUALS AND SOCIETY

EFFECT	IMPACT ON LIFE EXPECTANCY
Exposure to air pollution	0.8-40 lost days
Accidents	5-9 lost days
Physical activity	90 - 420 extra days



British economists are also devising methods to establish the value of cycling. Researchers at SQW Consulting have discovered that a 20% increase in bicycle traffic means a that society saves £300 million, and a 50% increase means a savings of £1.3 billion due to reduced congestion, air pollution and health expenses. The cost-benefit ratio is estimated to be at least 3 to 1 in favour of cycling. In other words, £3 are saved for every £1 invested, over a 30 year period. 4.9

Cost-benefit considerations will probably become increasingly widespread and come to play a greater role in relation to infrastructure investments as a whole in coming years. Socio economic considerations can be used to great advantage by local planning authorities as well as the State when dealing with cycle projects, providing a more solid foundation for the political prioritization of construction costs.

BIKEABILITY

The Danish Agency for Science, Technology and Innovation has allocated funds for a 3 year project, 2010-2013, to analyze and research cycling behaviour and motivation. The project is intended to provide a model capable of handling these parameters.

The project includes researchers from the Universities of Copenhagen, Aalborg and Southern Denmark as well as the Danish Cancer Society and the Danish Cyclists' Federation. Follow the project at www.bikeability.dk

Cost-benefit considerations can also serve as the foundation for integrating cycling into the bigger picture. For example, health administrations can become more involved in using bicycle traffic as a preventive health measure. See the chapter Health and Cycling.

Cost-benefit analyses compare cycling and driving.



BICYCLE TRAFFIC MODELS

Traffic model software can be used to optimize traffic flows but is traditionally used primarily in relation to motorized traffic. The models are used as tools to calculate the traffic, environmental and economic effects of traffic projects. Traffic models can be used to evaluate the overall consequences of road network modifications, of public transport, population and workplace siting, and of traffic goals. Traffic models and traffic simulation models enable traffic engineers to estimate traffic trends in relation to motorized vehicles, public transport, cyclists and even the consequences for pedestrians.

Simulation models such as VISSIM are often used when planning and designing intersections, for example, providing a picture of present and future traffic flows. The models make it possible to evaluate cost-intensive traffic construction projects prior to the decision to initiate them. Simulation models can accurately simulate motorized, pedestrian and bicycle traffic, which can be crucial when establishing an urban intersection, for example. The simulation models also make it possible to analyse the consequences for cyclists, such as travel time, delays, length of tailback, etc. VISSIM has been used in projects evaluating the cycling effect of road network modifications. The restructuring of Nørrebrogade and the projected bridge system around Christianshavns Canal in Copenhagen are examples of this.

However, traffic models should be approached with circumspection as there is always an element of doubt in relation to future traffic trends and traffic distribution. There is at least as much doubt when it comes to bicycle traffic. There are other options available for estimating a project's impact: considering the separate effects of former projects, or perhaps experimentally rerouting different traffic modes and measuring the effect. Experience shows that a new cycle track increases bicycle traffic by 20%, attracting cyclists away from other routes and transport modes. In the long run there is good potential for further growth in cycling, depending on local conditions.

The city of Odense is working on a vision to create a cohesive town centre where the focus is on urban life, where walking, cycling and public transport are encouraged, and where the planning perspective is sustainability. The local planning authorities chose to create a multimodal traffic model in VISUM as a useful decision making instrument. The software can process motorized traffic, public transport, bicycle traffic and choice of transport mode all in one model.



When the cycle route along Vestvold, Copenhagen's western rampart, was being upgraded the cycling potential for commuter journeys was evaluated based on calculations of commuter traffic streams for the Copenhagen area. The OTM model, an advanced traffic model for the Greater Copenhagen Region, was used. It includes public transport as well as automobile, pedestrian and bicycle traffic.



Traffic simulations can be used to evaluate the consequences of a proposed modification. Bicycle traffic should be factored into the modification process.

For example, the traffic model can provide the planning authorities with the total picture of the consequences of a road closure, calculating, for instance, whether closing the road would mean that drivers of motorized vehicles would choose another route through the city, or instead shift to cycling or public transport as an alternative. The multimodal transport model can simulate situations occurring today as well as for future predictions.

Formerly in Denmark traffic models were not oriented toward bicycle traffic; the focus was on motorized and public transport. Cycling models are thus not very widespread and the existing cycling database is limited.



CAMPAIGNS AND COMMUNICATIONS

Denmark is one of the world's most cycling countries. However, cycling is far from a matter of course today as passenger cars and public transport modes are obvious choices and are affordable for most people. Cycling is a choice, and motivating citizens to bike is crucial if a district wishes to reap the ecological and health benefits of cycling.



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The first part of this chapter describes the local benefits derived from working with communications and promotional campaigns, and how active engagement, active involvement, personal relevance, a sense of immediacy or ownership, role models and competitions can influence transport behavior. This is followed by sections on the choice of communication channel and how what is being communicated must be solidly anchored in daily reality, and finally a section on evaluation. The chapter concludes with an overview of a number of successful cycling campaigns conducted in recent years. The campaigns reach out to different types of target audience using different measures and interventions. The overview is intended to serve as an inspiration for local planning authorities and others who wish to implement cycling campaigns.


Generally speaking, a distinction is made between motivational campaigns and safety campaigns. Motivational campaigns aim at changing transport modes while safety campaigns aim at changing a given behavior. Road safety as opposed to transport choice is regulated by legislation and can be followed up by controls and penalties. The results have been generally favourable when such campaigns were coupled with increased controls, for example in the case of anti-liquour and save-the-seals campaigns.

MUNICIPAL CYCLING CAMPAIGNS

Today cycling expresses the conscious choice of an efficient transport mode that benefits the individual and society as a whole. Cycling is not merely a question of transport – it involves health, safety, a better environment, climate and urban life. Cycling cuts across administrative boundaries and is relevant for children, young people, adults and the elderly. It is thus crucial that all relevant administrations and sections dealing with planning, urban life, health, prevention, the environment and climate work together to promote the use of the bicycle in daily life. Add to this, investing in bicycle traffic is relatively cheap in relation to the socioeconomic benefits: healthier citizens, cleaner air and a more flexible infrastructure.



BEHAVIOUR MODIFICATION

Experience shows that campaigns are effective in moving road users away from other transport modes to cycling so campaigns can be used to great advantage by the local planning authorities, associations and businesses to modify the behavior and attitudes of selected target groups.



Kommunikationsplan for: _____ (aktivitet)

Aktivitet:	Målgrupper (Hvem skal vi kommunikere med?)	Mål (Hvad vil vi opnå?)	Budskab (Hvad skal vi kommunikere for at nå målet?)	Kanaler (Hvor/Plukke budskabet ud i verden for at nå målgruppen?)	Tidsperiode (Hvornår vil vi kommunikere?)	Ansvar (Hvem gør det?)	Budget (Hvor mange kroner koster det?)

5.1 Nordic Cycle Cities communications form. The specified categories are: activity, target group, goal, message, channel, timeline, responsibility, budget.

Not all campaigns, however, are successful in changing the target audience's ingrained habits. In this section we will examine six ways in which campaigns have successfully affected behavior and attitudes. Campaigns are here taken in the broader sense, ranging from national TV spots to the local community handing out muffins and coffee. If communications and campaigns are to be successful the priorities must be made clear: what do you wish to achieve, whom do you wish to affect, and how and when do you intend to do it? Developing a communications strategy is therefore a must. A communications strategy need not be a lengthy document drawn up by communications experts; the main thing is that the sender has given serious consideration to the goal so that resources are used appropriately.

Nordic Cycle Cities, a project in which 11 Danish, Swedish and Norwegian cities work together

to increase the modal split of cycling, came up with a form that all parties would be required to complete when planning a communications initiative.

Knowing where citizens stand is crucial to the behavior modification process otherwise resources are wasted on campaigns that miss the target. The initial goal of communications strategy is to affect citizens enough for them to switch transport modes and to travel more safely for the least amount of money. Afterwards it is essential to maintain the behavior change.

Credibility plays a major role in the success of cycling campaigns. For example there is no point in directing cyclists to unsafe roads or combating irritating but safe traffic habits. It is a great advantage to coordinate the different campaigns for better physical cycling conditions, motor vehicle restrictions, road safety, and police control of road users; a coordinated strategy has the greatest chance of success.

6 WAYS OF MODIFYING BEHAVIOUR

- **Active engagement** – knowledge isn't enough, participants have to get out there and bike!
- **Active involvement** – the campaign has to offer the participants something they want.
- **Relevance** – the campaign has to match the target audience's needs.
- **Immediacy and ownership** – the target audience have to feel their immediate concerns are addressed and it's their campaign.
- **Role models** – we need to see ourselves reflected in others.
- **Competitions** – everyone loves to win!

Active engagement

Research and experience show that information in itself is not enough to change people's habits. Most people, for example, know that cycling is healthy and eco-friendly, but more is needed before they change their habits. Consequently a key objective in most Danish cycling campaigns is to get the participants actively engaged; they have to get out there and bike. You can present convincing arguments for cycling until you're blue in the face, but in the last analysis the goal is to get the participants onto their bikes. Experience shows that it can take up to three years to get people to accept a new message and recognize





The behaviour modification process. 5.2

the need for change. The purpose of active engagement is to break down people's ingrained habits, allowing them to find out for themselves, but first they need to be coaxed out of their comfort zones, throw prejudices or anxiety to the winds, and immerse themselves into something new - and they have to do it more than once. So it is possible to get people to change their behavior and form new habits (see the behavior modification section.)

Active involvement

People need to feel that they themselves have a say in changing their transport habits or attitudes if they are to get actively involved in a campaign. The choice to change transport mode or behaviour is up to the individual, no one else. Cycling campaigns should therefore never lecture, apply pressure or preach to potential participants; campaigns need to offer something the participants want, and campaigns have to show that here is a choice worth considering.

The annual, nationwide "We cycle to work" campaign draws attention to cycling as a potential transport mode to and from work by means of communications and marketing, but what actually involves people actively is an enjoyable common activity that participants wish to be part of. You and your co-workers are on the same team, and the participants motivate each other. At the same time you see yourself reflected in colleagues that already cycle, reinforcing the idea that you can bike to work instead of drive. As part of a team you try the new transport mode for a month. This has proved highly effective: Every year 10,000 new cyclists are inspired to cycle by the "We cycle to work" campaign, and they continue cycling after the campaign is over.

Relevance

In addition to getting participants actively engaged and involved, campaigns need to be personally relevant. The "We bike to work" campaigns, for example, are irrelevant if it is impossible to bike to work. This may seem obvious, but is important nevertheless. If the target audience feel that the campaign is above

their heads or that it has nothing to do with them, the campaign will have no impact, but merely be experienced as random noise. The target audience's needs, situation and wishes need to be clearly identified in advance if the campaign is to be experienced as relevant. Generally speaking, the more homogenous the target group, the more effective the communication. If you aim at everyone you hit no one.

Immediacy and ownership

Immediacy is an important parameter in a campaign. No matter whether the campaign is local or national, whether the target group is broad or narrow, people have to feel the campaign addresses their immediate concerns in their daily lives. Many communities successfully incorporate local activities into national campaigns since it is easier for citizens to identify with a local campaign than a national one. For example, there is a national right-turn campaign (see diagram on p. 29) featuring TV spots, outdoor advertising, and other marketing, but it includes a local element in which school children get to watch the road from the seat of a lorry. Another example is the nation-wide "Mind the side streets!" campaign (see diagram on p. 30), which is a national platform but contains local elements: the local authorities are the actual campaign senders since they designate the intersections where the warning markings are painted.

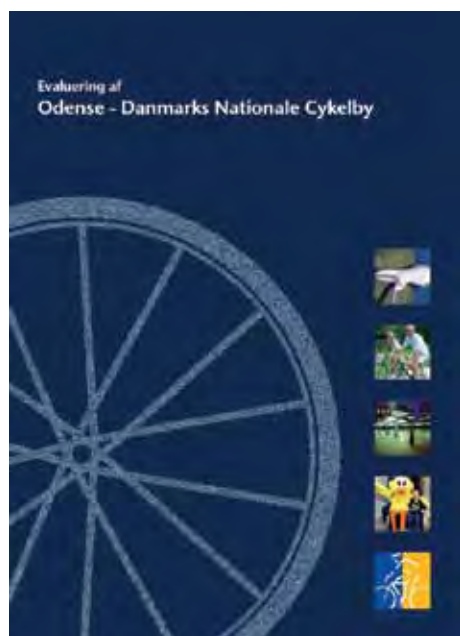
It is crucial when carrying out local activities to involve local stakeholders, thereby bringing extra resources as well as familiar spokesmen into the community. Those selected need to be sufficiently informed and motivated about the campaign so that afterwards they can continue to run the campaign on their own or, even better, implement new initiatives. It is vital that the selected stakeholders are able to anchor the campaign and consolidate behaviour changes.

The immediacy of personal relationships is an important factor at the workplace and in schools. When a school class or a group of co-workers collectively agree to cycle, this creates more



ODENSE, DENMARK'S NATIONAL CYCLE CITY 1999-2001

From 1999-2001 Odense was Denmark's designated national bicycle lab where for the first time Denmark worked systematically combining plans for a better cycling infrastructure with targeted communications and campaign initiatives. The overall campaign strategy was inspired by the National Board of Health's anti-smoking campaigns of the time. The idea was to create targeted communications, campaigns and events using the major national media. More than 20 different campaigns targeting the city's small children, school children, commuters and existing cyclists were carried out as well as more general community campaigns on cycling and lifestyle using outdoor media and the cinema. The strategy proved highly successful. See the evaluation which can be downloaded at www.odense.dk/cyklisternesby or ordered from the city of Odense.



The evaluation report, "Odense, Denmark's national cycle city", was published by the city of Odense in 2002. 5.3

binding social expectations than merely signing up for a national campaign. When colleagues, school children or friends make an agreement, for instance to bike, most people feel committed to live up to it.

Local, social activities generate teamwork and give the target group a sense of ownership of their small corner of the campaign. Furthermore, local activities increase the value of a national campaign. The "We bike to work" campaign provides many examples of how the number of participants in a competition was more than doubled by local activities.

Role models

The role model effect can be used to advantage, i.e. actively involving people who can serve as an example to others due to their personality, their work or their social status.

Role models can be well known personalities such as professional cyclists or politicians. Cycling has a broad, popular appeal which is why well-known role models gladly participate as front figures for cycling campaigns.



15 cyclists from the capital region's blood bank won first prize in the national "We bike to work" campaign in 2010.

Ritt Bjerrgaard, former Lord Mayor of Copenhagen, for example, was the front figure for the "We bike to work" campaign in 2006 when she appeared on the front page of the campaign magazine in the company of Peter Aalbæk Jensen, director of Zentropa. Another pertinent example of using celebrities to serve the cycling cause is Team Rynkeby which sends cycling fundraising teams from Denmark to Paris in continuation of the Tour de France. The teams fund-raise for the children's cancer society and consist primarily of business leaders, politicians, actors, etc., which attracts media coverage in itself. Several local authorities have appointed an ambassadors' corps to promote cycling in their daily activities and at special functions.

Role modeling can also take place locally or in the workplace. Familiar local figures, such as police officers, school teachers, employers, leaders, or mayors can show the way toward behavior change, as can co-workers and other kindred spirits in whom you can see yourself reflected. The role of team captain in "We bike to work" is an example. 5.4



Connie Hedegaard, then Minister for Climate and the Environment, in the saddle. Photo. Søren Hytting

Competitions

Finally, competitions are often the bait needed to get people to join a campaign or activity. Prizes are generally an extremely motivating factor. The prize need not necessarily be large and expensive; the lure is in the competition itself. The prizes of course have to be attractive to the target audience and have a clear bearing on the campaign's motivating message. For example, "All kids bike" is an exercise competition for



Henrik Jensen is a busy, active businessman with his own carpentry business in Randers Midtby. He cycles round to his customers on his carrier bike, and saves lots of money on petrol and parking fees. He is proud of being a cycle ambassador and wishes to show Randers citizens that cycling is a fantastic transport mode both for work and leisure activities.

school classes and the prize is a class excursion such as an MTB tour or a bike decoration course.

NEW CHANNELS

When planning a campaign it is vital to choose the appropriate channel for reaching the audience. Formerly, organizing a campaign meant printing piles of posters and folders and distributing them to the target group.



Today new technology and new media offer new possibilities and platforms: interactive homepages, smartphones, YouTube, Facebook, GPS technology and much more. A growing number of campaigns are using the new platforms with great success as the new technologies and social media make it possible to design campaigns that directly attract and communicate the message to the selected target group.

The social media, for example, are an excellent channel for communicating with younger target audiences since this is how they themselves communicate. Social media have a broad outreach potential since users pass on the message – if it's interesting enough! There

is also the huge advantage, which is also a challenge, that the social media are a platform for interactive communications; they enable the sender to enter into interactive dialogue with the target audience and the target audience to contribute ideas and attitudes, thereby strengthening the participants' involvement in the campaign. This also means that the sender needs to be prepared to enter into a dialogue with the target audience if they respond to the campaign.

Today many communities have supplemented the municipal website with local cycle city websites and Facebook pages where they inform citizens of the cycling situation in the area and where citizens can directly offer suggestions and comments on municipal initiatives.



www.randerscykelby.dk

Newspaper article about a committee chairman in Elsinore presenting a gift voucher for a cycling holiday on Bornholm to a local family who had participated in the cycling campaign called "Vi cykler nu". The campaign was a parallel, local campaign to the national "We bike to work" campaign in 2011. The aim of "Vi cykler nu" was to activate the whole family. Parents were urged to bike to work and children to bike to school. www.vicykler.nu.



Aarhus Cykelby Facebook page



New technology is also becoming an important element of campaign design. For instance, it is an excellent idea to use cell phones since practically everyone over the age of 10 has one today. One example of a campaign using new technology

to mobilise the target audience is "Around the world in 80 days" in which school children take turns cycling with a GPS device which registers the number of cycled kilometers. Their results are then uploaded onto the campaign website.

For every kilometer they cycle, the virtual circumnavigator, Dr. Glob, moves a corresponding kilometer on his trip around the world. See more at <http://www.cycling-embassy.dk/2011/06/29/gps-tech-makes-cycling-fun/>.

Another good example is the campaign called "Use a helmet because we love you". The campaign included a video showing a couple of local police officers distributing hugs and helmets to random passing cyclists. The film was viewed 500,000 times on youtube.com over the course of three days, and commented on by 2,200 bloggers. The campaign was an unparalleled viral success drawing enormous attention to the campaign, both abroad and in Denmark. The campaign was followed up by the distribution of helmets: Children, for example, gave their parents helmets under the slogan "Because I love you!"



Children give their mother a helmet because they love her as part of the campaign "Use a helmet because we love you".



The police distributed hugs and helmets to cyclists, viewed all over the world on YouTube, as part of the "Use a helmet because we love you" campaign.

ANCHORAGE AND DAILY REALITY

Very few people will change their traffic behavior merely on the basis of a campaign; promotional campaigns need to be coupled with better physical cycling facilities, restrictions on motorized traffic, road safety measures, etc. A coordinated strategy, preferably cross-administrational, has the greatest chance of success. If you want to encourage more people to cycle you need to take a careful look at local cycling conditions: Are the cycle tracks geared to an increase in cyclists? Is it safe? Are there satisfactory bicycle parking facilities? etc. Motivation and structural innovation are closely linked, and if the campaign has no connection to everyday reality, the campaign will fail to have the desired effect.

When people have once taken the first step and changed their behavior, it is crucial to maintain their motivation. This can be done, for example, by regularly repeating a campaign such as the right-turn campaign or “We bike to work”, which runs annually. Generally speaking it’s a good idea to keep people at it so they don’t take a break but maintain a regular daily rhythm.

Furthermore, it is essential to get people to want to maintain the new behavior themselves, internalizing the campaign message. Although a campaign may be nationwide, it must articulate the individual participant’s personal values. One way of maintaining a high level of individual motivation is use of the so-called SMART objectives.

SMART OBJECTIVES

- S** Specific
- M** Measureable
- A** Attainable
- R** Results Oriented (realistic)
- T** Timeline

5.5

What is particularly effective is catching people at a time when they are confronting a new phase of life, for instance if they recently moved, or are starting a new job or at a new school. People are easier to reach in such situations since they are about to form new habits anyway. This is the basis of the city of Copenhagen’s campaign aimed at new Copenhagen residents. New residents receive a kit welcoming them to the bike friendly city of Copenhagen. The kit includes a cycle route map, road manner tips and a set of bike lights.









Branding





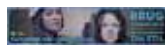

In recent years a growing number of cities and municipalities have started supplementing other promotional campaigns with actual branding campaigns in which the city or municipality wishes to establish itself as bicycle friendly in the eyes of its citizens and possible newcomers, linking its image to the positive values associated with cycling, such as health, sustainability and modern life style.



In 2009 Aarhus Cycle City launched its brand campaign “8000 good reasons to cycle”. The brand serves as a logo and a slogan and is used in all cycling related activities initiated by the city involving infrastructure as well as communications. The brand communicates directly to Aarhus residents (the Aarhus postal code is 8000), the message being that there are many, many good reasons to bike and that every cyclist has his or her own personal motive. All the pictured localities are well known locations that the audience can relate to.

The following overview shows examples of different types of campaigns that have run over the past 5 years, national as well as local. Contact the campaign sender for further information and inspiration

CAMPAIGN	SENDER	AIM	TARGET	CONCEPT	IMPACT
<p>We bike to work</p> 	Danish Cyclists' Federation and Firmaidrætten, (the national sports organization for the promotion of sports at workplaces)	Encourage more people to bike to and from work; Focus on the environment, health and congestion	Adults	You sign up as a team. The idea is to bike to and from work as often as possible in a given time period. The strength of the campaign is derived from the sense of community in the workplace	Between 80,000-110,000 participate annually. 8% of the participants are new cyclists. This is the equivalent of around 10,000 new cyclists joining the campaign every year.
<p>Tail wind on the cycle tracks</p> 	City of Odense	Persuade passenger car commuters to choose to cycle rather than drive	Adults	100 drivers are supplied with free e-bikes over a 6-month period	The evaluation showed that around half the participants used the e-bike instead of the car 4-5 times a week. Roughly two thirds of the participants continued to bike or e-bike rather than drive at the final evaluation three months after the conclusion of the campaign. The campaign was thus highly successful in getting drivers to bike
<p>Welcoming campaign (tilflytterkampagne)</p> 	City of Copenhagen	Encourage newcomers to cycle	Adults	Every year Copenhagen experiences a population turnover of 10%. New residents receive a kit welcoming them to cycling Copenhagen. The kit includes a cycle route map, cycle track tips, and a set of bike lights.	Not evaluated at time of printing
<p>Snabelræs</p> 	City of Aarhus	Let small children have fun learning to bike	Adults	Get more kids biking; day care centres and child minders can order a free visit from a Snabelræs bus. The bus contains: a small group of trained instructors who play cycle games with the children; 10 striders (small bikes without pedals); helmets; and the Snabelræs mascot, Snabel Elephant. The aim of the visit is to provide children, parents and educators with ideas and inspiration to continue integrating bike games and cycling into the children's daily lives	Snabelræs visited over 30 Aarhus institutions in 2010. In addition Snabelræs was awarded GF insurance company's road safety prize in 2011.
<p>Spacey from Cyclos</p> 	City of Frederiksberg	Get school children to bike to and from school	Years 0-5	The campaign is introduced by a task force who distribute flyers to parents containing: campaign information and good advice on children cycling; a board game poster; and a schedule in which the children are to note down their bicycle journeys and helmet use. The children are also given a small present which includes a competition booklet. The children are urged to jump on their bikes to hand in the booklet, if possible with Mum and Dad.	Not evaluated at time of printing
<p>Cycling proficiency tests</p> 	The Danish Road Safety Council and Trygfonden in collaboration with local police and schools	Teach school children traffic rules and road safety behaviour	Years 3 - 6	Schools are urged to give annual cycling proficiency tests in Years 3 and 6. The test is both theoretical and practical and tests the children's basic traffic skills.	
<p>Distribution of "monster" reflectors</p> 	Trygfonden	Encourage more children to remember to wear reflectors	Day care centre and school children	Every year Trygfonden donates 1 million reflectors to the country's schools and day care centers. The children can help design the year's reflectors via the internet.	The risk of getting hit by a car in the dark is reduced by 70% if you are wearing a reflector.
<p>Mind the side streets</p> 	Danish Road Safety Council and the regional road safety committees	Encourage cyclists to be more vigilant in non-signalized intersections	Adults and children	Nation-wide TV spots and outdoor work followed up locally by marking selected intersections with the "Mind the side streets" symbol.	

CAMPAIGN	SENDER	AIM	TARGET	CONCEPT	IMPACT
Right turn campaign 	Danish Road Safety Council, Danish Transport Authority, Danish Cyclists' Federation, and the Danish Transport and Logistics Association (DTL)	Inform cyclists of the danger of being in the lorry blind spot. Inform lorry drivers how to adjust their cycle safety mirrors	Adults and children	Nation- wide TV spots and outdoor work and educational materials for cyclists and lorry drivers. In addition, local initiatives in which school children , for example, sit in a lorry and view the road from there.	The number of dead and seriously injured cyclists involved in right- turn accidents has generally dropped over the past 5 years, which coincides with intensive right-turn campaigns. However, the figures indicate that this varies from year to year so it is imperative to keep reminding cyclists and lorry drivers to keep an eye out for each other.
Bike light campaign 	Danish Cyclists' Federation	Encourage more school children to remember their lights and reflectors after dark	Year 4 school children	The campaign exploits children's innate curiosity to find out how the world works. All participating classes receive: a kit containing bike lights, reflectors, etc; a teacher's manual for integrating the materials into different school subjects; and post cards that can be sent to parents informing them of the campaign	In 2010 more than 33,000 school children from around half the country's 4th year classes and their teachers evaluated the campaign. They said that the number of school children using mandatory bike lights and reflectors had increased by 10%.
Around the world in 80 days 	City of Aarhus	Make cycling fun for kids and make them want to bike more	School children in Years 6 -7	School children take part in a friendly competition as to who can bike furthest. Every class is given two GPS's that chalk up kilometers into the class account as the children take turns cycling. The children upload their kilometers onto a homepage and for every cycled kilometer, virtual Dr. Glob advances a corresponding kilometer on his journey around the world.	370 children from 17 classes signed up. 62% of the participating students cycled more than usual and 40% took their bikes along on journeys which would otherwise have taken place solely by car
My helmet 	Danish Road Safety Council and Trygfonden	Encourage more people to use a helmet	Adults and children	A number of designer helmets sold at bargain prices were launched all over the country in collaboration with a designer and Netto, the supermarket chain. In addition, on the homepage you could design your own cool bike helmet idea, the 5 best of which were put into production.	In 2010 25% of cyclists used a helmet; in 2008 the figure was 15%. A helmet reduces the risk of head injury by 50%.
Use a helmet because we love you 	City of Aalborg	Get more people to use a helmet	Adults	The campaign consisted of a video in which a couple of local police officers stopped random cyclists and gave them a hug and a helmet. The punch line was: "Use a helmet because we love you". In addition to the film the campaign consisted of a number of events in which children presented their parents with helmets.	The campaign attracted major international attention and in the following years has been supplemented with new angles, the most recent being "Use a helmet, it's cool" in 2011.
All kids bike 	Danish Cyclists' Federation and Tryg fonden	Encourage school children to bike to school and remember their helmets	School children Years 0 -10	The campaign was based on the sense of community that already exists among school children. The participating classes competed as to which class could cycle the most days in the course of the given campaign period. The students were awarded 1 point for cycling and 1 point for using a helmet.	In 2010 over 140,000 school children from all over the country took part. In the two weeks the campaign ran the participating children biked a total of more than 637,000 days and used helmets on more than 559,000 days. (90% used a helmet.) 30% of the children enjoy cycling more after the campaign.



6

HEALTH AND CYCLING

Cycling is healthy and always has been. Today, however, there is an added focus on creating favourable conditions for a healthy lifestyle that includes physical activity. Statistics show that the proportion of overweight citizens is rising and a large proportion of the population is decidedly inactive. High-grade cycling facilities are an initiative that promotes an active lifestyle.

This chapter provides insight into why it makes good financial sense to use cycling as a health promotion initiative as well as examples of how to go about it.



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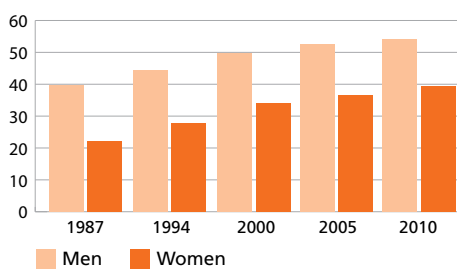
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THE PROBLEM

For a long time modern lifestyle has become increasingly inactive, in Denmark as well as a number of other Western countries. This is partially due to increasing automation, increasingly sedentary jobs and increased dependence on motorized transport. Add to this easy access to high-fat and high-sugar foods and the result is a rising number of citizens that are overweight and seriously overweight. Increasingly, being seriously overweight is becoming a public health issue just as inactivity in itself constitutes a health risk for the individual; being overweight or seriously overweight results in a heightened risk of developing a number of chronic diseases, social isolation and depression.

A survey conducted in connection with the National Health Profile 2010 shows that 47% of the Danish adult population is overweight (BMI >25.0). The occurrence is significantly higher

Proportion of overweight adults BMI>25



The proportion of overweight adults defined as having a BMI>25 has been steadily increasing since 1987 6.1

Cycling is healthy for all age groups – seen here in Frederiksberg.

among men; 54% of men are overweight while the figure is only 39% for women. The figure has been rising since the late eighties. The same applies to the proportion of the seriously overweight (BMI >30), which increased from 5.5% for both genders in 1987 to 11% for women and 12% for men in 2010.

There is a connection between being overweight and such factors as education and location of residence; there are fewer overweight citizens among the highly educated and in the nation's capital than the national average, while in the North Denmark region the figure is above the national average. By the same token, citizens of Northern Jutland are the population group with the lowest share of people engaging in moderate to strenuous physical activity, according to the National Health Profile, whereas the citizens of the capital have the highest share. 6.2

The Danish Board of Health estimates that roughly 30-40% of the adult Danish population are physically inactive, i.e. physically active less than 2 ½ times a week. This segment of the population has a heightened risk of developing various lifestyle diseases, which constitutes a problem for the individual and for society as a whole. Reduced life expectancy, increase in lifestyle diseases, etc., have an impact on the number of sick days, hospitalization, and personal well-being.

PHYSICAL ACTIVITY

Moderate physical activity has a well-documented health effect. The health authorities have concluded that physical activity corresponding

to 2,000-2,500 kcal/week is sufficient to significantly reduce the risk of disease and mortality. This is the equivalent of a little more than 4 hours a week of brisk walking, for example. The recommendation is 3-4 hours of light to moderate exercise per week or ½ hour per day in addition to daily activities at home and work.

The Board of Health recommends a half hour of physical activity a day in order to reduce the risk of lifestyle diseases. Children should be significantly more physically active and the Board of Health recommends 1 hour a day for them. The concept of physical activity covers any type of muscular activity regardless of whether it is structured, as in running, cycling, etc., or unstructured in the form of daily activities such as climbing stairs. However the activity should be of at least 10 minutes duration to achieve a health impact.

Current research into the effect of physical activity shows that normally inactive people can improve their health and physical well-being by exercising regularly and that people of all ages, children, adults, the elderly, women as well as men, achieve positive physical changes as a result of physical activity.

THE BOARD OF HEALTH RECOMMENDATIONS FOR PHYSICAL ACTIVITY

Children and young people	1 hour a day
Adults	½ hour a day
The elderly	½ hour a day
The overweight	½ hour a day

Physical activity affects the heart, the circulation and the muscles as well as the metabolism and the endocrine and immune systems. Add to this love of life, energy, good relationships, self-confidence and the ability to act. It has also been proven that there is a positive connection between physical activity and the cognitive processes which are a prerequisite for children's learning. 6.4

A Danish study shows that active transport to and from work, such as cycling, reduces the risk of premature mortality by 40%, after adjustments are made for physical leisure-time activities. 6.5

The health benefits of cycling are thus a key parameter when considering the socioeconomic consequences of increased cycling. The economic





Bikes can be used for strenuous exercise.

benefits of cycling are discussed in the chapter "Cost-benefit and Traffic Models".

An international study has further shown that children who cycle to school are more active throughout the rest of the day than those who are driven to school by car. 6.6

Cycling is an excellent form of exercise for most people. Being overweight or injured, for example, make running or contact sports difficult, while cycling along with swimming are much gentler activities. When there are balance problems, in the elderly for instance, 3 wheel bikes make it possible to continue cycling, and e-bikes help maintain an active lifestyle even in old age. Cycling is an inclusive form of exercise, and can be practiced regardless of age and physical prowess.

Daily exercise such as walking or cycling to and from school/work, choosing the stairs instead of the elevator/escalator and doing housework and gardening also have a demonstrable health effect. 6.7



Biking to school or work is a form of daily exercise (Randers).

Concrete examples of the connection between cycling and health

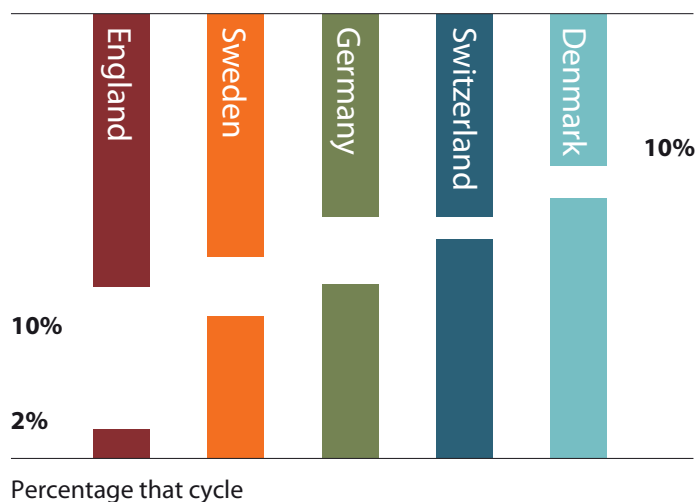
The Odense cycle city project proved that an integrated and coordinated approach to cycling initiatives produces positive health effects. Odense citizens between the ages of 16-74 were more physically active on average approximately three minutes a day compared to a control group. The conclusion was that the project had a significant positive public health impact; for

example, a lower mortality rate among Odense citizens was registered during the project period, 1999-2002, leading to an average increase in life expectancy of roughly 2 ½ months.

It was also noted that anticipated sick leave increments received by Odense residents were reduced by one half-day. This meant a 6% reduction in disbursed sickness benefit, or the equivalent of DKK 42 million for the period 1999-2002. Although National Health Service expenses increased by approximately DKK 8 million during the same period, this coincided with a drop in the number of hospital admissions and bed-days. The DKK 33 million cost reductions were larger than the campaign cost, DKK 20 million. It would appear that there are cash benefits in the form of reduced health care spending when people are encouraged to cycle.

In a project in the city of Randers 25 cyclists were given an e-bike for daily use. Car journeys were replaced by the e-bike, in which an electric motor assists the cyclist. The cyclists biked up to 15 km each way, but were able to get to work without having to change their clothes, thanks to the electric motor. 8 of the e-bikers accepted an offer to measure their fitness level during the project. Prior to the project 2 participants had a

Frequency of overweight 10 year olds



Percentage of overweight 10 year olds compared to percentage of children that cycle in the same countries 6.8

INSPIRATION TO EXERCISE

www.legepatruljen.dk
www.cykelleg.dk
www.getmoving.dk
www.sundhedsspor.dk
www.trafiklegedag.dk

very low fitness level, 4 participants a low fitness level, and 2 participants an average fitness level. At the project's conclusion they all had a very high fitness level. This voluntary test indicates that daily exercise has a powerful effect on people who formerly used a car as their primary transport mode.

The exercise argument for biking

For many people exercise is already one of the main reasons for cycling on a daily basis. A number of councils have carried out bicycle account surveys or other opinion polls about people's reasons for cycling, from which it is evident that the exercise aspect plays an important role. In Frederikshavn 92% cite exercise as a reason for cycling while the fact that it is fast and convenient comes in second with 71%. In Copenhagen and Frederiksberg exercise and fresh air are cited as the second most important factor while the fact that biking is fast and convenient is number one. In Frederiksberg 83% cite exercise as one of their reasons for cycling. The same pattern emerges when citizens are asked



what could get them to bike more. Faced with daily time pressure, the opportunity to combine exercise with transport may be a determining factor when choosing to cycle.

In other words, adding a health benefit focus to behavior campaigns aimed at adults and children is an excellent idea, and at the same time cross-disciplinary collaboration within local administrations should be strengthened,

combining the traditional traffic and environmental arguments for cycling (i.e. cycling is faster, results in less congestion and has no negative environmental impact) with the health benefits.

HEALTH POLICIES

In many areas cycling promotion is an integral part of the community's health policy and preventive health strategy. Effective cross-administrative collaboration creates a synergistic effect between cycling itself and the use of cycling as an active preventive element for all age groups. Politicians as well as the general population are increasingly focusing on health and prevention, and specially earmarked funds are often allocated for the purpose. Collaboration can mean increased value for money. It activates the inactive, encourages more children and commuters to bike, and creates better conditions for those who bike already.

A good example of this is the city of Aalborg. In 2007 Aalborg formulated a health policy for the entire municipality. Health policy work was broadly based involving all municipal administrations, and focused on diet, smoking, alcohol and exercise. Cycling was one of the focus areas and the following was made explicit: "... it is important that there are green recreational areas available to all citizens and that there are safe roads and cycle tracks to cycle on." The policy serves as a guideline for cross-disciplinary initiatives; the different professional administrations cooperate, thereby generating increased value across administrative boundaries.



A survey carried out by the city of Odense shows that people who cycle feel they are in better shape than people who don't. 6.10



CAMPAIGNS AND OTHER CYCLING AND HEALTH INITIATIVES

On the national level as well as in the local communities, campaigns and projects are being developed that include a focus on the health aspect of cycling. For example, The Danish Road Safety Council and Trygfonden, (the Danish non-profit organization for the promotion of safety, health and well-being) have designed a special cycle training track that schools and after-school centres can borrow from the local authority and use in road safety education and physical education classes. Students in Years 4-6 are given the opportunity to train their cycling skills and learn about cycling and health.

There are many examples in recent years of how communities have increasingly focused on the health angle of cycling promotion, generating increased value by coupling cycling with health. In contrast to many other types of exercise cycling often has a dual purpose, namely to get from point A to point B, so that many people experience cycling as an efficient form of exercise. Children derive great health benefits from walking and cycling to school.

Randers – Learning, playing and moving

Over the past several years Randers has focused on cycling as a way of ensuring exercise for all age groups. The idea was further developed in the municipal cycle plan Cykel-og stiplan of 2011 emphasizing the fact that cycling is fun. In 2010-2011 campaigns targeted schools, day care institutions and ordinary citizens, especially in the Hornbæk neighbourhood. Special bike game tracks, velocipedes and unicycles were provided for schools, there were bikeability days with scooters for preschoolers, local cycle paths were established for geocaching and guided cycle tours, all of which focused on promoting cycling as a fun game and a great leisure activity.

The focus on cycling as a means of learning, playing and moving goes hand in hand in Randers with the focus on road safety, high commuter passability, etc., encouraging citizens to bike to work and education.

Vejle – adult cycling classes

A community project in Vejle offers adult cycling classes. The course is funded by the Danish Board of Health and is part of a special offer to the overweight in a neighbourhood with a high proportion of residents of a different ethnic background than Danish. The cycle training course is one option among others, such as a food workshop, individual counseling, etc.



Children on balance bikes in Randers, one way of using bicycles for exercise and fun.



In Vejle immigrant women learn how to bike so as to become more physically active and teach their children good exercise habits too.

20 women have participated in the class which takes place in a town parking lot. Project funds were spent on acquiring two junior bikes and hiring a cycling instructor, who in this case is a community integration officer. In other communities the local branch of the Danish Cyclists' Federation helps out.

The project's health effect has not yet been evaluated but the local Vejle authorities report that the women learning to bike are extremely proud and energized, balance laughing when

successful. The project gives them a lot of freedom, self-confidence and some exercise. An Arab woman of 38 hadn't cycled since the age of 10 because her mother thought she was too old to play. When she learned how to bike she raised both her arms high, lowered them again and exclaimed, "Yes! Now I can bike with my sons!"

Odense – integration and cycling

In 2010 the city of Odense received a grant from the national cycling promotion fund for a project targeting 12 – 15 year old girls from the Vollsmose neighbourhood, an area with a high concentration of residents with an immigrant background. The project's stated objective was to educate the girls about nutrition and health. A cycle team was formed that trained twice a week all spring in order to be able to participate in the annual cycling race around Funen in the summer of 2011. The girls received a bicycle and cycling clothes for the project. The aim was that in the long run the girls should use a bicycle as their daily transport mode.

Aarhus – Health on 2 wheels

In 2011 Aarhus implemented a health project focusing on cycling's many health benefits. The aim was to encourage even more Aarhus citizens to cycle to and from work. 6 former drivers had to cycle to work over a 6 month period, either by bicycle or e-bike.

Another project objective was to study the impact of daily cycling on the participants' health. The half-way evaluation shows that their physical condition has improved, they have more energy and it's easier for them to find the motivation to cycle to work and to other activities. The final results, including measurable health effects, were not available at the time of printing.



Team Odense Integration



"Healthy on 2 wheels", Aarhus.

URBAN PLANNING AND BICYCLE PLANNING

Good city planning helps create a viable transport framework. However, urban planning has a negligible effect on bicycle traffic volumes unless a conscious effort is made to improve cycling conditions and incorporate cycling into the infrastructure and the site selection of urban functions. Changes in land use and residential patterns take place gradually; nevertheless urban planning can have a major impact on the siting of individual traffic generating functions, and be instrumental in ensuring their accessibility to bicycle traffic.

Urban planning and transport engineering go hand in hand. When a concerted effort is made to work together toward the common goal of more sustainable transport, including bicycle transport, this generates a synergistic effect in relation to cycling conditions.



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ORGANIZATION AND PLANNING PROCEDURES

Bicycle transport planning in Denmark typically takes place in the technical administration in charge of traffic engineering and safety. However, bicycle planning and urban and municipal planning are inseparably linked, and a cross-disciplinary collaboration between the fields of health and prevention, public transport, climate and the environment, construction management, etc. markedly improves bicycle transport conditions while at the same time providing the other fields with a new angle for meeting the challenges they confront.

The many options for interfacing with other fields can create a synergistic effect and even economic gains for the local authority, promoting awareness of the authority's many new cycling initiatives, or incorporating cycling into integration and health prevention efforts, for example. Awareness of bicycle transport on the part of urban planners and construction project managers can create a bicycle friendly framework for city planning, which includes writing bicycle parking spaces into the local plans or creating new squares and urban spaces. This makes it possible from the outset to create a bike friendly urban environment and to ensure that there are the required number of bicycle parking facilities at new construction or renovation sites, thereby saving the extra time and expense of establishing them afterwards.

Bicycle planning should be an integral part of all planning, including the strategic plan, main structure and municipal plan, and all other work in the various municipal administrations. The bicycle must be included as a matter of course in any mobility or transport plan. However, it is crucial to the plan's implementation that the local planners and politicians take ownership of decisions to prioritize cycling initiatives, including arranging workshops, dialogue meetings or other measures where professional staff, politicians and potential community stakeholders get together to discuss and propose ideas for future cycle planning. This is an instrument for creating broad ownership of the bicycle planning process.

Since the various administrations and organizations have a high diversity of interests and expertise, large local councils would benefit from a coordinator or cycle secretariat. Citizens should be actively involved from the outset. Citizens' concerns, visions, general views and concrete daily experiences working in conjunction with professional expertise and overall view are an excellent means of achieving the desired goal. Public involvement also provides an opportunity



Bicycle Action Plan workshop in Frederiksberg – citizen involvement not only provides an excellent insight into what citizens want, but also helps create co-ownership of the plan.



The car is the preferred transport mode at shopping centres on the outskirts of town, as shown here at Aalborg Shopping Centre.

for airing ideas for new and better projects. Strong roots in the local community are essential from the start, as this greatly improves the chances for cooperation and success. The project has a far greater chance of success when citizens as well as politicians are involved. It is crucial that ambitions, goals and means are linked from day one - economically and throughout the entire process.

GOVERNMENT REGULATIONS AND PLANNING

Urban sprawl increases the distance between home and destination thereby increasing the need for a car.

The Danish government has established a number of overall goals for the country's physical planning aimed at reducing the energy consumption and negative environmental impact of motor traffic while maintaining the flow of retail goods. One of the guiding rules is that new residential construction may only take place within existing urban zones and in areas specifically designated for urban development, and that commercial construction and new public institutions must

be sited in regional and municipal centres. Since the year 2000 the population of Danish cities has increased by 10% and in 2010 86% of the Danish population were residents of cities covering an area of 2,700 km² or the equivalent of 6% of the total area of Denmark. **7.1** Since the Danish population is relatively concentrated in urban areas, this means that many local journeys are easily carried out by bicycle. However, the layout of many cities is characterized by the fact that in recent years Danish residential planning

Dwellings, workplaces, institutions and other destinations should be located in such a way that the need for transport is reduced, local conditions permitting. Whenever possible, functions and activities should be concentrated in centres so as to reduce total traffic volume, including motor vehicle traffic. Municipalities can usefully establish safe, passable access roads for cyclists and pedestrians.

Landsplanredegørelse 2010, (National Plan expectations to municipal physical planning)..



has aimed at creating low-rise single-family houses in open spaces so that distances within the city itself can be so great that some people choose to drive.

In the capital area, municipal plans must not be in contravention of the Finger Plan of 2007, which includes guidelines aimed at ensuring desired urban development and space for expansion over the next 12 years. Residential and commercial development must be concentrated in areas with easy access to public transport.

Outside the capital area it is up to the individual authority to determine the degree of urban renewal and development within existing urban areas. However, the State requires that the local authorities demarcate new areas as urban development zones in their municipal plans and that the demarcation should be based on an overall evaluation. Expansion must take place within the urban boundary so as to ensure urban density and minimize the use of open land. Using abandoned industrial sites is one way forward. This principle has been in force in recent years and received the approbation of the national environmental centres during negotiations with the local authorities when drawing up the municipal plans of 2009.

Formerly, only major cities with a population exceeding 40,000 could plan to build large, durable goods sales outlets, but since the amendment to the Planning Act in Denmark in the spring of 2011, cities with more than 27,000 inhabitants are now allowed to establish three new large durable goods outlets every four years. In future, all municipalities will be allowed to plan for one new durable goods outlet of over 2,000 m² in one of its cities of over 3,000 inhabitants.



Bicycles can be used for shopping, too. Frederiksberg.

The amendment additionally enables municipalities that do not have cities larger than 20,000 to request the Minister to draw up a national plan directive for durable goods sales if special conditions apply, such as major tourist attractions, large business concerns, international ports or cross-border shopping. 7.2. The amendment, which took effect on 1 September 2011, could have an impact on bicycle transport in medium-sized and small cities since they can now permit major durable goods outlets that typically attract driving customers. On the other hand, the amendment might encourage people to shop locally rather than drive to the large cities which have hitherto monopolized the durable goods market.

POPULATION DENSITY AND URBAN SPACIAL STRUCTURE

Terrain has a major impact on cycling volume: If the city is flat, people cycle often, but if the terrain is hilly they cycle less often. This means that a cycle route that circumvents a large hill could be usefully incorporated into the planning process. (See also the section Bridges, tunnels, hills, and stairs in the chapter Designing the Cycling Infrastructure).

Data retrieved from transport habit surveys in a number of Danish cities of over 10,000 shows that bicycle journeys make up a little more than 20% of total journeys. In these large Danish cities there is no connection between the size of the population and the cycling modal share since the proportion of bicycle trips is approximately the same regardless of the extent to which the city population exceeds 10,000. However, this does not apply in Copenhagen, where the cycling

modal share is higher. The modal share of public transport, on the other hand, increases as the size of the city increases whereas the modal share for passenger cars drops; this depends largely on the availability of public transport. Generally speaking, public transport is given the highest priority in densely populated areas where the passenger potential is greatest. This means that in large cities a number of new cyclists will be drawn from public traffic whereas in smaller cities (under 10,000) they are likely to have been former drivers. A more integrated approach to public and bicycle transport would increase the number of combination journeys, for example cycling to the station or the bus stop and continuing the journey by public transport. Collaboration between cycle planners and planners of public transport would encourage cooperation rather than competition.

For cities of under 10,000 the cycle modal share increases with the size of the city since many destinations increasingly lie within the city boundary and are thus accessible within a reasonable distance. The cycling modal share in large cities varies according to residential location within the city. The closer the dwelling is to the centre, the more the residents cycle. A more intense utilization of urban areas means shorter

Research shows that more people choose cycling if the city has more than 10,000 inhabitants; is densely populated within a circular form; has no hills; and has workplaces located in the city centre. 7.17



An integrated approach to cycling and public transport can create a synergistic effect and encourage cooperation rather than competing for the same customers.

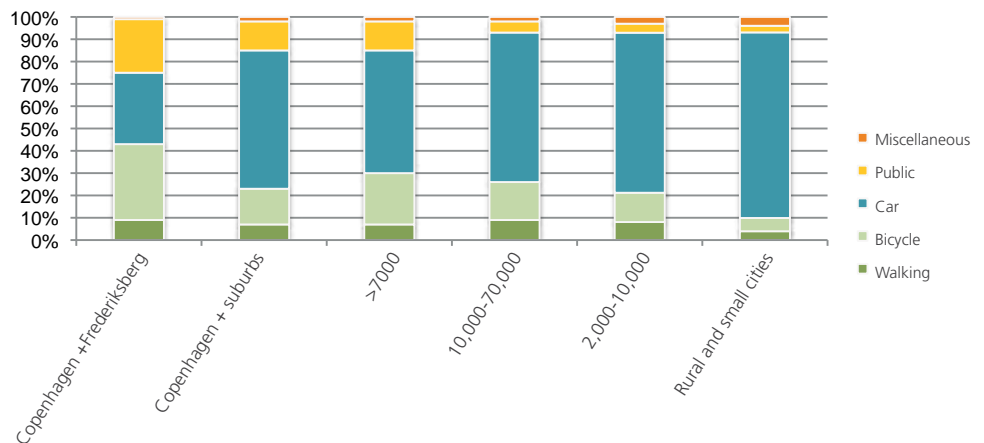


People bike less when the weather is frosty, but the decisive factors for cycling are travel time and terrain.

distances between homes, workplaces, shops, etc. A greater population density also means an increase in the customer base for local services, thereby reducing the need for longer journeys. All things being equal, urban density increases bicycle traffic.

The prime factor influencing choice of transport mode over short distances is the difference in terrain, according to a study based on transport habit surveys. In the flattest areas of Denmark 21% of total transport activities take place by bicycle; in the hilliest areas such as Vejle only 10% of transport activities are cycled, in other words the cycling modal share is more than halved. This also means that passenger car transport increases from 66% in the flattest part of Denmark to 74% in hilly areas such as Vejle. On the other hand people walk a bit more in hilly areas. The same study shows that differences in temperature and in the number of daylight hours also influence transport choices; people cycle less in frosty weather and women particularly avoid cycling in the dark.

Travel speeds are essential when it comes to choosing a transport mode. A Dutch study shows that cyclists' own travel speed as well as the difference in their mutual speeds are significant factors when choosing to bike. According to the



Distribution of transport modes in relation to urban structure for trips of less than 22 km. 7.4

study, the degree of hilliness and the number of stops as well as the cyclist's travel time are the main motivating factors in the decision to cycle. Cyclist travel time is based on the direct route to the destination and a 10% speed increase increases the cycle modal share by 3.4 %. 0.3 fewer stops per km means a 4.9% greater cycle modal share (Both are measured as a city average.) 7.3, 7.4

An urban spatial structure in which a large part of the built-up area is concentrated along narrow bands of public traffic routes means short walking distances to public transport and, normally, high quality public transport services. Greater Copenhagen, formed as a "finger" city, also encourages people to combine cycling and public transport, for example by cycling to the S- train stations.

The demand for dwellings located close to the coast or a lake has resulted in band shaped cities in Denmark. Travel distances, however,

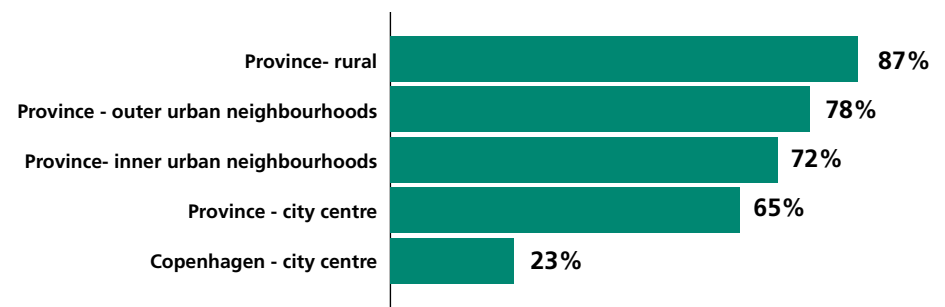
are greater in band cities thereby increasing automobile dependency. This means there will be fewer cyclists in a band city than in a more compact, circular city.

SITING WORKPLACES AND EDUCATIONAL INSTITUTIONS

A balance between the size of the active work force and the number of workplaces in a given area seems to reduce commuting, all things being equal. The location of homes has a greater impact on transport activities than the location of workplaces.

A Danish study shows that the location of workplaces is of some significance in all Danish cities, but plays a major role in the capital. It is true of all cities that fewer people drive to businesses located in the city centre than to businesses outside the city centre. The city centre effect, however, seems most pronounced in Aarhus and Aalborg.

Driving to work is significantly more widespread in the provinces 7.5

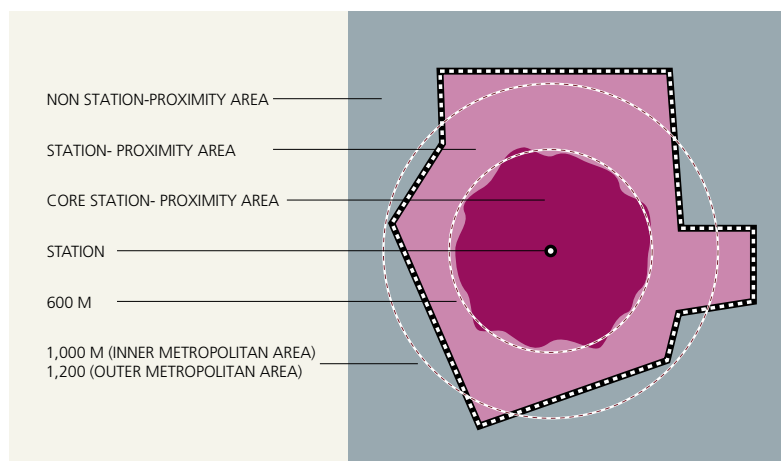


In the capital area planners are working systematically on siting activities and enterprises in close proximity to a station, based on the principles set forth in the Finger Plan of 2007. Station proximity is typically defined in terms of pedestrian distances. The use of a bicycle can significantly expand the proximity zone, although this depends on the quality of the station bicycle parking facilities, including the option of being able to lock your bike indoors.

The conversion of many cities' disused, centrally located commercial and port areas can also significantly increase the modal share of cycling, especially if the number of car parking spaces can be kept down, thereby enhancing the area's potential to attract a large number of cyclists. Collaboration between urban planners and traffic engineers is essential in this connection, and investors will typically need to be convinced of the value of developing a sustainable area.



Bicycle parking facilities at the stairs leading to the platforms at Copenhagen Central Station make it easy to combine cycling and train travel.



Criteria for demarcated areas

Characteristic examples of siting options

Core station-proximity area

Defined by municipal plan as lying within walking distance of max. 600 m to a station, as well as other urban planning considerations



Urban – high density

- Large business and service entities employing many office workers (> 1,500 m floor space)
- Major, highly frequented institutions
- Dense housing
- Shops in accordance with retail regulations

Station-proximity area:

Defined by municipal plan as normally based on an area within a 1000 m radius to the station in inner metropolitan areas and an area within a 1,200 m radius in outer metropolitan areas, as well as other urban planning considerations



Urban – middle density

- Dense housing
- Dense- low-rise housing
- Small business and service entities (<1,500 m floor space)
- In exceptional cases large business and service entities employing many office workers (> 1,500 m floor space)
- Local institutions
- Shops in accordance with retail regulations

Non station-proximity area:

The other urban areas



Urban areas with varying degrees of density

- Dense and dense- low rise housing + single family housing
- Local institutions
- Extensive building, storage and production enterprises
- Small business and service entities (< 1,500 m floor space)
- Dense housing (in accordance with supplementary measures)
- Shops in accordance with retail regulations

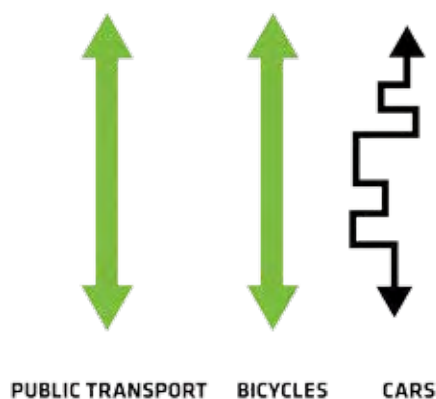
THE FREIGHT YARD, AALBORG

The freight yard in Aalborg (Godsbanearialet) is an example of an urban conversion in which station proximity and proximity to the city centre were planning priorities. The campus concept incorporating housing and educational facilities was predominant, and cycle tracks and bicycle parking facilities were central elements when developing the housing plan. Work began in the spring of 2011.

NORDHAVNEN, COPENHAGEN

The city of Copenhagen is developing a new neighbourhood in the former port area of Nordhavn, in which 45,000 Copenhagen residents are expected to settle. In addition, workplaces, educational institutions and entertainment venues will be established. The overall vision is that Nordhavnen should become Copenhagen's sustainable city of the future, with a special focus on sustainable traffic solutions. The obvious transport choice here will be to cycle, walk or use public transport instead of driving. A special, linked cycle-metro infrastructure called "the loop" is being designed for the area. Since the cycle route will run underneath the metro a covered cycle track can be established over a relatively long distance. Bicycle traffic is closely linked to the existing neighbourhood of Østerbro through the loop system.

Principles of traffic access to Nordhavnen, Copenhagen's new sustainable neighbourhood.
7.7



SITING SHOPPING FACILITIES

Fewer people bike when they go shopping than for other purposes since shopping typically involves a large number of short journeys, and Danes often prefer to walk. However, some people choose not to cycle even though the shopping trip is of the same length as a trip with another purpose. This is partly due to the difficulty of transporting goods on a bicycle, which is an issue that can be actively addressed.

A study was made of the transfer potential from



Freight Yard, Aalborg 7.8



Centrally placed bicycle parking facilities encourage bicycle traffic when shopping, as shown here in Viborg where bicycle parking facilities are placed at the entrance to the pedestrianized zone.

driving to cycling and walking for short journeys less than 22 km; a journey in this context is defined as a round-trip, for example home-work-home. Not surprisingly, the study shows that the journeys most susceptible to change are home-work journeys, and that it is fairly difficult to change recreational travel choices (only by 6-7%) whereas, surprisingly, shopping by car can be reduced by 13%. 7.4

The vast majority of shopping trips start at home. The use of a car to reach a shopping centre varies greatly depending on what goods are available in the surrounding area. If people have a car and are displeased with the assortment of goods and the price level in the shop nearest them, they choose a shop that is not within walking distance. Owning a car thus increases the number of driven kilometers.

Cyclist shopping patterns differ from drivers' in that the former spread out their shopping over the entire week. Cyclists shop locally to a greater extent, for example on their way home from work. A Dutch study showed that cyclists spend

less per visit, but shop more often so they spend at least as much as drivers during the course of a week. 7.9

The number of discount shops in Denmark rose by 65% between 2000 and 2010, or the equivalent of 500 new outlets. The turnover in this type of shop has also significantly increased. 7.10 There are now discount shops in small and medium-sized cities as well as in local neighbourhoods in larger cities. Other things being equal, this development means that it is now easier for cyclists to shop locally at a discount shop instead of having to bike out to a major discount outlet on the outskirts of town.

Traffic to shopping centres and discount stores on the outskirts of town differs significantly from traffic to shops within the city centre by being much more automobile dependent. One reason is that shopping centres and discount stores have a larger surrounding area than other shops, which means that on average customers have to travel further.





People cycle to centrally located shopping centres with good cycling facilities, as shown here in Frederiksberg, which has a very high cycle modal share.



Parking norms and dual-use principles are strategic instruments for reducing automobile traffic.

An explicit goal is to shorten transport distances to shopping facilities in order to cut down on automobile dependency when shopping. Furthermore, shopping areas should be easily accessible to all types of traffic, including pedestrians, cyclists and public transport. [7.1](#) One of the guiding rules is that newly designated shopping areas should be located in the central part of a city, in the very city centre or in the local neighbourhood centre in the case of large cities.

PARKING AS A TRAFFIC MANAGEMENT INSTRUMENT

Parking norms for automobile traffic in connection with new construction projects is an effective instrument for keeping auto traffic down. Traditionally, parking norms have been used to ensure a sufficient number of parking spaces. However, it has become increasingly common to operate with upper limits for passenger car parking within central urban areas in order to reduce the number of car parking spaces in new construction projects. The local authority itself determines whether it should specify a lower limit.

When planning a dense urban area the principle of dual-use parking is useful in order to create the desired parking capacity in relation to the area's functions. Differentiated parking rates according to zone based on urban density is another measure that encourages bicycle traffic.

A further option is the strategic use of parking funds; a municipal parking fund is granted revenues to create parking capacity if it is not otherwise possible to establish the required number of parking spaces. The local authority can use the fund to establish parking garages in accordance with the overall plan, for example

on the outskirts of the city centre. However, the requirement that the money must be spent within 5 years makes it difficult for some cities to amass sufficient funds to finance a parking garage.

It is possible to limit parking capacity in existing commercial areas by voluntary cooperation between private firms and the public authorities.

Studies show that an increase in cycling is best achieved by creating better cycling conditions while at the same time making life more difficult for car owners, for instance by reducing car parking capacity.

A study of the transfer potential from driving to

walking and biking shows that passenger car traffic drops by 3 percentage points when the percentage of people who perceive a change in parking conditions as being too expensive or as making it too difficult to find parking spaces increases by 50%. [7.4](#)

Communities can also write bicycle parking norms into the plans for new construction projects, just as with car parking. This ensures that the developer includes bicycle parking facilities from the outset so that cycling can become a viable alternative to the automobile. Read more about bicycle parking options in the separate chapter, Bicycle Parking.

Function	Bicycle parking norm
Residential and blocks of flats	2-2.5 per 100 m ² living area
Student residence	1 per resident
Child care centres	0.4 per staff + reserved area for trailers and special bikes
Schools	1 per student 4th year and up and 0.4 per staff
Educational institutions	0.4-0.8 per student and 0.4 per staff
Retail/ shops	2 per 100 m ² in the capital and 1 per 100 m ² in the provinces
Other urban professions (doctor, dentist, etc.)	0.3-0.4 per 100 m ² and 0.4 per staff
Stations	10-30% of the number of passengers (departures per day)
Bus stops and terminals	1 per 10 peak hour passengers (6 a.m. -9 a.m.)
Cinemas and theatres	0.25 per seat and 0.4 per staff
Hotels and restaurants	1 per 15 guests and 0.4 per staff
Sports centres and stadiums	0.6 per participant and 0.4 per spectator
Office and industry	0.4 per staff
Recreational areas	1-4 per 10 visitors

Bicycle parking norms are an excellent instrument for incorporating bicycle parking into the local planning and handling of construction projects [7.12](#)

BICYCLE TRANSPORT STRATEGY AND PLAN

As discussed above, cycling should be incorporated into overall urban planning at all levels on equal terms with automobile transport, public transport and walking. The optimal situation is for local authorities to draw up mobility strategies and action plans in which walking, cycling, public transport and passenger car transport are considered as a whole, and visions and goals are formulated for overall traffic development.

If an overall solution proves unfeasible, the local authority should promote bicycle transport by drawing up a cycle strategy and cycle action

plan focusing on visions, goals and actions to encourage cycling. A cycling strategy or cycling action plan can also be devised as a supplement to or preparatory work in advance of a general mobility or traffic plan.

A bicycle strategy should contain an overall vision for the long term development of bicycle transport. In addition, it should formulate a number of measurable objectives to be met within a shorter time span, such as the desired bicycle transport percentage increase, desired modal split for cycling, desired modal split for commuting to and from work, etc.

At the same time the stated objectives should be

followed up by concrete action plans and political priorities. It is crucial that the action plan, goals and economic resources correspond since the action plan loses its credibility otherwise. Some communities that have made cycling a high priority have typically aimed at increasing bicycle traffic by roughly 20-25% over a 4 year period.

In the EU project, Nordic Cycle Cities, 11 Danish, Swedish and Norwegian communities formulated procedures for bicycle strategy and action that include the involvement of politicians, citizens and other stakeholders. You can learn more at www.nordiskecykelbyer.dk or in English at http://shoploppen.dk/Velo-city_presentations/Marianne_Weinreich.pdf.



MUNICIPALITY	GOAL	PERIOD
Elsinore	25% increase in bicycle traffic	by 2012
Aarhus	Significant increase	-
Aalborg	10% increase in bicycle traffic 15-20% of journeys less than 5 km are cycled	by 2020 by 2012
Odense	25% increase in bicycle traffic 35% increase in bicycle traffic	by 2012 by 2020
Copenhagen	50% of commuters to work and education within the municipal boundary are cyclists	by 2015
Fredericia	25% increase in bicycle traffic	by 2015
Randers	20% of trips less than 5 km are cycled	

Bicycle traffic objectives in different cities 7.13

An increasing number of communities are drawing up bicycle accounts as the basis for monitoring the effect of bicycle strategies and bicycle action plans. A bicycle account should incorporate citizen/cyclist ratings of a number of conditions, monitor developments within the cycling infrastructure, etc., and follow up on the extent to which goals and objectives are met. The city of Copenhagen has year-long experience with the bicycle account and actively uses it as a prioritization tool for making decisions. A number of other communities have already or will shortly draw up similar bicycle accounts. Bicycle account measurements and calculations can be carried out at a cost of approx. DKK 25,000 and upwards, depending on the scope.

Bicycle accounts or other types of cycling surveys should be key elements in an active and forward-looking municipal planning effort to promote bicycle traffic. Such surveys can also be used as a marketing tool, telling the story of what cyclists want.



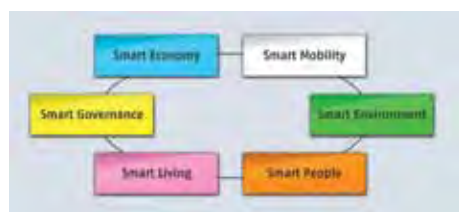
In the EU funded project, Nordic Cycle Cities, 11 Danish, Swedish and Norwegian local authorities developed procedures for compiling a bicycle account, including what type of facts it can and should contain and how to collect the relevant data.

(See the bicycle accounts in Danish at www.nordiskcykelbyer.dk).

Benchmarking is another tool for getting cycling onto the local agenda, as is BYPAD (Bicycle Policy Audit). The purpose of BYPAD is not simply to benchmark; it is primarily a tool to get the ball rolling, cutting across local interests and ensuring that public officials, politicians and cyclists take part in the process. The benefit of the round table discussions depends largely on the composition of the constituted groups. The systematic approach often gives rise to fruitful discussions and the matching of expectations, both internally within the local authority and, as the group is cross-functional, between politicians and interest groups participating in the process. The Danish cities of Viborg, Nakskov, Odense and Hillerød received the official BYPAD certificate in 2003 and Aalborg and Sønderborg were certified in 2010. Learn more about BYPAD at www.bypad.org.

A number of local authorities have participated at various times in EU funded projects in which cycling was a focus area to a greater or lesser degree. The authorities exchanged experiences with other European cities, which can be useful although collecting comparable data is no easy task. The authorities were inspired by other participants' projects to implement projects that would otherwise have been difficult to fund. EU funded projects typically contain benchmarking requirements in one form or another, and cycling projects typically do not involve physical construction.

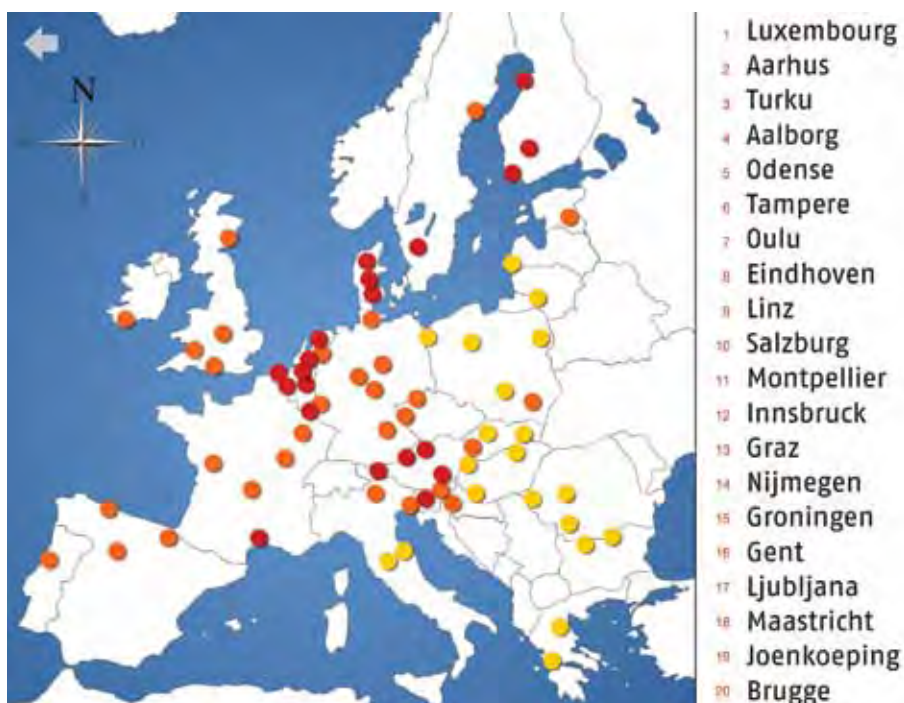
A European project called Smart Cities compared 70 medium- sized European cities, including Aalborg, Aarhus and Odense. The cities are



Project Smart Cities compares medium- size cities on the basis of 6 different indicators 7.15



The BYPAD process 7.14



Out of 70 European cities 3 Danish cities rank among the top 5. 7.15

compared on the basis of 6 indicators: economy, mobility, environment, people, living and governance, and are required to perform well in terms of predefined factors within each area in order to qualify as a "smart city".

In 2009 the Danish State reintroduced a national cycling promotion fund. The grants it provides have been instrumental in quick-starting local initiatives. Even though funding is not always granted due to limited resources, the mere act of concretising a cycle project sets the stage for developing creative new cycle projects. Projects that receive a grant from the cycling promotion fund are required to evaluate their project's strengths and weaknesses and communicate their

experiences to other cities. At the time of writing, evaluation procedures were not sufficiently advanced for such information to be included in this publication. Projects that have received a grant from the national cycling promotion fund range from isolated cycle track projects, near a school for example, to educational campaigns targeting schoolchildren and the preparation of cycling game materials, to comprehensive major cycling city projects including infrastructure, bicycle parking, marketing, new ITS initiatives (Intelligent Transport Systems), and campaigns.

MUNICIPAL CYCLING CITY PROJECTS (APPROX. DKK 12.6 MILLION)

- Herning Municipality: Herning – cycling as a daily transport mode (DKK 4.1m)
- Horsens Municipality: Horsens – two wheels ahead (DKK 5.0 m)
- Hørsholm Municipality: Hørsholm cycling city (DKK 3.5 m)

BICYCLE COMMUTING PROJECTS (APPROX. DKK 20.8 MILLION)

- Billund Municipality: Grindstedvej, Billund – Cycle path linking Billund and local commercial and recreational areas (DKK 0.5 m)
- Gladsaxe municipality: The Farum cycle super highway, (Gladsaxe construction costs: DKK 0.8m)
- Hillerød municipality: Nr. Herlev path (DKK 2.5 m)
- Hjørring municipality: Bicycle traffic development in Hjørring – The Højene cycle route (DKK 1.9 m)
- City of Copenhagen: The Farum cycle super highway Copenhagen part, (Copenhagen's construction costs: DKK 7.0 m)
- Middelfart municipality: The green shortcut (DKK 1.4 million)
- Odense municipality: New bicycle parking garage at Odense Station Centre (DKK 1.4 m)
- Rødovre municipality: Jyllingevej Bridge along the Vestvold cycle route.

CYCLING TO SCHOOL AND LEISURE ACTIVITIES (APPROX. DKK 26.1 MILLION)

- Assens municipality: Two-way cycle track in Haarby (DKK 0.3 m)
- Ballerup municipality: Two-way shared-use track along Klakkebjerg (DKK 0.5 m)
- Residents' Association for Ørum and its Environs (Hedensted municipality): Shared-use cycle and walking paths criss- crossing the area between Ørum and Daugård (DKK 0.7 m)
- Furesø municipality: Increased cycling to school by means of cycle "buses" (DKK 0.1 m)
- Faaborg-Midtfyn municipality: Project cycle track Nyborgvej (DKK 1.0 m)
- Hedensted municipality: Tørring (DKK 1.1 m)
- Kerteminde municipality: Extension of an existing cycle track along a section of the railway path at Hindsholm between Dalby and Martofte (DKK 1.0 m)
- Lemvig municipality: Cycle track along Ballegårdvej (Kontorvej-Høgevej) (DKK 0.2 m)
- Mariagerfjord municipality: Extension of cycle/walking path along Løgstørvej in Hobro (DKK 3.7.m).

Examples of National Cycling Promotion Fund project grants, 2011. 7.16

€ = DKK 7.4, £1 = DKK 8.9 and \$1 = DKK 5.6 at the time of writing.



8

PLANNING THE CYCLING INFRASTRUCTURE

This chapter is about planning the cycling infrastructure, and offers ideas for a cycling infrastructure that will encourage more people to cycle.

The cycling infrastructure is defined here as cycle tracks/lanes, paths, greenways, intersection solutions, etc., in other words anything that might be termed the cyclist circulation area. Bicycle parking is discussed in a separate chapter.

The chapter first examines Danish cycle tracks, cycle routes, etc., and the Danish cycling tradition underlying all planning. A basic distinction is made between daily cycling and recreational cycling. Road safety, a sense of security and travel speed and comfort are taken up.

In Denmark cycling has always been recognized as an independent transport mode with the "right" to its own designated circulation area on equal footing with vehicular, public and pedestrian transport. This tradition underlies any discussion of cyclist circulation areas and the integration of cycling and other transport modes.

The section offers suggestions for drawing up a cycling infrastructure plan; different principles are discussed and an overview is provided of the road section and intersection solutions currently available in Denmark. The chapter also offers ideas for new solutions and initiatives.

Finally there is an overview of methods for planning and pricing construction projects.



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THE CYCLING INFRASTRUCTURE

Existing cycling infrastructure and the Danish cycling tradition

In a number of Danish cities the cycling infrastructure is almost entirely cohesive, whereas in other cities and rural areas it is less so. Usually, though, there is already something to build on. Furthermore, there is a strong Danish cycling tradition. Improving existing cycling facilities, making high quality additions to the cycling infrastructure, and introducing untraditional measures encourage more people to cycle.

The cycling infrastructure can be improved by linking existing circulation areas, upgrading facilities to a contemporary standard, and actual expansion. All such initiatives should be based on a bicycle infrastructure plan, sometimes referred to as a "cycle track plan", or should be an integral part of a "cycling action plan", which includes many different aspects of cycling promotion.

Traffic calmed roads or slow-speed zones and secondary roads with little motor traffic may be included in the cyclist circulation area.

Future cycling infrastructure

The municipal plan should contain a road network plan and a cycle network plan. If this has not been done yet, it might be useful to start out by drawing up a cycling infrastructure sector plan which can then be integrated into the next municipal plan. Better cycling facilities can also be written into a traffic or mobility plan.

Ideally, establishing principles for road network solutions should be addressed in the municipal planning process, for example in connection with road and cycle track classification, as well as in the local plans in relation to principles for street function and design. The concept of "strøggade", i.e. a shared space shopping street with mixed traffic and functions and priority to pedestrians and cyclists, can be usefully introduced as a special category. Another interesting category to consider is the "bicycle street", inspired by the German "Fahrradsstrassen".

The cycling infrastructure includes cycle tracks/lanes, paths, greenways, intersection solutions, mixed traffic areas with special priority to cyclists (slow speed limits for cars, extra space, etc.), signed cycle routes, bicycle parking facilities, and other physical measures to encourage cycling. Bicycle parking is discussed in a separate chapter.

A cycling infrastructure plan is partly based on a survey of cyclist issues and proposals, knowledge of existing cycling patterns, siting of primary corridors/links and major cyclist destinations (workplaces, service institutions, shops, link-up with public transport, recreational amenities, etc.)

In addition, road safety objectives will often be included. For many years planners have worked systematically improving road safety, and most recently there has been a special focus on cyclists and pedestrians. This is backed up by national goals and policies which are often converted into goals and policies on the local level. The aim of road safety work is to combat and prevent accidents, however, not encourage more people to cycle.

Indeed, it is rather the cyclist's sense of security, i.e. the cyclist's subjective perception of being safe, that actually encourages cycling. For many people insecurity is a reason for not cycling. A better sense of security is often an explicit objective of infrastructure plans, strategies, etc., but this is generally less clearly formulated than road safety objectives. This is due to the fact that it is more difficult to "measure" a subjective sense of security. It can be done, however, as proven by the telephone interviews carried out for the bicycle accounts, for example. [8.1-8.3](#)

It is also possible to draw up measurable objectives for improved passability or faster travel speeds. Copenhagen aims at increasing cyclist travel speed by 10% over a few years. This has made it necessary to develop a methodology for measuring and monitoring the objective. [8.4.](#)

Increased bicycle traffic will often be a more or less explicit ambition in a cycling plan. Such an objective may be qualitative or quantitative, and more or less binding.

When a cycling action plan (or the more limited cycling infrastructure/cycle track plan) is politically approved and initiated it will often be insufficiently funded. Public debate, however, frequently serves to focus political attention, often resulting in a higher funding priority. Sometimes co-financing with the State is possible (e.g. National Cycling Promotion Fund grants for construction projects) or EU funding (normally not available for construction projects). Danish communities are in great demand for EU projects and experience shows that local politicians are very interested in getting their share. External co-financing can be the kick-off for improving the cycling infrastructure. In the long run it may turn out that some cycling infrastructure construction can be implemented in connection with utility construction and road renovation. Building construction and site development projects that include cycling infrastructure as an integral part



One way of improving cycling facilities is during utility construction.

of the project in a given area may also come to play a role. Furthermore, school route projects and road safety projects often take the cycling infrastructure into account.

A well thought out plan is often needed so as to be able to grasp any opportunity for improving the cycling infrastructure that may arise.



A section of the green cycle route through Copenhagen, which was financed by a private developer in accordance with an urban development project (Ny Tøjhusgrunden). The cycle route appears in the municipal and the local plans as part of the "Amager route".

High political ambitions for cycling should be reflected in higher standards for new infrastructure design. The existing infrastructure can be improved, too. Focusing on security and passability is an excellent starting point for an upgrade, but of course safety concerns are paramount too.

DAILY CYCLING AND LEISURE CYCLING

The functional requirement for a successful cycling infrastructure is that traveling from point A to point B should be convenient and quick, and the journey should be a safe and pleasant experience. This applies especially to daily cyclists (particularly commuters), but all types of cyclists appreciate not having to make major detours.

Daily cyclists' destinations are schools, institutions, workplaces, shops, parks, leisure facilities, train stations, and bus stops. Many journeys are relatively short, but particularly commuters are willing to cycle further, perhaps 6-8 km between home and work. Since many people are now focusing on exercise and health, perhaps more people will be willing to commute even further, some with the assistance of an

Daily cyclists bike to school, child care, employment, shopping, public transport, and many other daily destinations.

e-bike. 8.5 Long cycle journeys are comparatively few, but are already becoming a factor in the kilometer account.

A special group of cyclists are cycling toddlers, learning through playing how to become the cyclists of the future. Children need to be able to cycle safely near their homes, and traffic calmed streets are a fine offer.

For Sunday cyclists a convenient link between the city's infrastructure and the activity destination plays an important role. Sunday cycling takes place within the course of a day, often in a group. Typically, 10-30 km are cycled often in combination with a public transport mode. Holiday routes need not necessarily be direct but on the other hand should never take cyclists in the opposite direction of their destination. The starting point for cyclists on holiday is a home, train station, bus terminal, bike rental shop at the holiday destination, etc. Lodging and shopping facilities as well as active fun play an important role for this group.

Cycling toddlers develop motor skills through play.



Holiday and Sunday cyclists focus on an active, fun experience.

TRAFFIC SAFETY VS. A SENSE OF SECURITY

There are good grounds for taking safety and security (and in the next section passability and comfort as well) as a starting point in bicycle traffic planning.

First of all, safety and a sense of security are NOT the same thing.

A sense of security is the cyclist's subjective perception of what cycling in traffic feels like, whereas safety is the objective registration of accidents. A sense of security (or insecurity) can be recorded by different types of interviews: focus groups, telephone interviews, street surveys. Safety (or accidents rather) is registered by the police, categorized according to whether or not the situation involves personal injury. Accident rates can be calculated on the basis of number, density, frequency, risk, etc.

A classic example illustrating the difference between safety and a sense of security is when the cycle track is shortened before cyclists enter the intersection. This was introduced at one point to make it easier for motor vehicles to turn right at intersections. The solution means that cyclists and cars merge which proved quite safe purely from the safety point of view. However, cyclists feel vulnerable and insecure, preferring to have their own area that takes them all the way up to the intersection. It is usually possible to establish solutions that are both safe and secure. Unfortunately, however, in some cases set back stop lines for cars are not quite as safe as the shortened cycle track.

If more people are to be encouraged to cycle, cyclists need to feel that what they are offered makes them feel secure. It is crucial that women feel secure since that means increased cycling among children, women and the elderly – as well as men. Children cycle if they have learned how and if they're allowed to. It is the local administration's responsibility to ensure that they may do so safely.

The trick is to develop solutions that are at once safe and make cyclists feel secure. Good solutions are either a narrowed cycle lane leading from the shortened cycle track to the intersection or a continued cycle track in its full width up to the intersection. Set back stop lines for cars and cycle crossings are provided in the intersection.

It is occasionally argued that some cyclist insecurity is good for road safety since it keeps cyclists on their toes. It may be that "planning by fear" is effective, but it also discourages many



Shortened cycle track. Cars and cycles merge, which makes vulnerable cyclists in particular feel insecure. Tietgensgade, Copenhagen.



Narrowed bike lane leads into the intersection. Cyclists are visible and have their own area. Reventlowsgade, Copenhagen



Cyclists and buses, but not cars, share the area around this bus terminal. It works since the speed limit is low. Aalborg.



Cycle track capacity issues can be addressed by widened cycle tracks on the sections of the network where there isn't enough room. The blue cycle crossing shows the former cycle track width. Dr. Louises Bridge, Copenhagen.

TRAVEL SPEED AND COMFORT

Travel speed from point A to point B plays an important role for the individual cyclist and also for cycling's competitiveness in relation to other transport modes. Travel speeds can be improved by removing detours, e.g. by allowing contra-flow cycling (reduced "detour factor") and providing better passability, e.g. pre-green for cyclists at intersections.

Although cycle tracks may mean that cyclists ride somewhat slower (perhaps because they feel more secure than in mixed traffic) cycle tracks on road sections generally provide good passability since there are no parked cars in the way. Cycle tracks can be so narrow, however, that overtaking is difficult. In some cases cycle tracks cannot accommodate the growing number of cyclists, causing definite capacity issues. Generally speaking, cycle tracks that make overtaking difficult should be discouraged as they give rise to dangerous situations and a high level of insecurity since some cyclists prefer riding fast while others ride slowly.

Cyclists should not experience unnecessary delays in intersections; as a minimum they should be given priority on equal footing with car and bus

potential cyclists. The problem should rather be looked at in reverse: planning should serve the interests of the most vulnerable cyclist groups so that all types of cyclists will be able to use the infrastructure. 8.7

The "self-evident road" is crucial in modern traffic planning, meaning that the road design should steer the road user's attention and vigilance to possible conflict areas. Road users should not be made to feel afraid or insecure in order to be vigilant; this should be a natural consequence of speed, traffic regulations, social responsibility, etc. A "forgiving" traffic environment is another principle to ensure that the consequences of making traffic mistakes are minimized.

There are other ways to draw cyclists' attention to potentially dangerous situations than making them feel insecure: road narrowing, for example, which brings cyclists and motorists a little closer to each other, or a speed hump that reduces speed and heightens vigilance at the same time.

On some road sections it is easy to choose the right solution since traditional cycle tracks offer cyclists both safety and security. To a lesser extent this also applies to cycle lanes, which all in all are better than cycling in mixed traffic.

When the task is to encourage cycling in an area with few cyclists, it is sometimes worth considering which is better: many kilometers of cycle lane or a few kilometers of cycle track. If cycle lanes are installed initially they must have full cycle track width so they can later be upgraded to a cycle track. The cycle lane can function as well as a cycle track if cars are parked along the edge. Cycle lanes and parking spaces must not be too narrow if the solution is to function properly.

When cyclists have to share an area with many cars and where speeds are high it is crucial that cyclists have enough space. For example, the inner lane on a heavily trafficked street without a cycle track should be wider than normal to prevent cyclists from being squeezed.

In Denmark "30 km scooters" may be used on cycle tracks. Although the scooter modal split has dropped significantly in cities, mopeds should preferably (in contrast to the present legal situation) use the carriageway in order for cyclists to feel more secure. This would also improve cyclist safety, although it is not clear what it would mean for scooter safety. A new category on the cycle tracks is the e-bike (up to 25 km/h), which is legally considered a bicycle in Denmark.



Narrow cycle track – "the art of the possible", Aalborg.

traffic and should even be given preferential treatment in some areas. This can be done by coordinating the existing traffic signals on the basis of average cycle travel speeds (20 km/h in Copenhagen). Even without a green wave it is essential to give serious consideration to cyclists when planning the individual intersection's design since this plays a major role for cyclist passability.

Heavy headwinds reduce cycling speeds. On some sections passability and comfort can be increased by wind breaks such as trees or shrubs. Canopies, trees, etc. can be used to create shelter from rain squalls.

Stops, half-stops, road incline and elevation, and uneven road surfaces mean that cyclists expend more energy, which reduces speed. This has a negative impact on cycling's competitiveness 8.8. and may mean that fewer people cycle. Add to this, delays, which at a signalized intersection may last 40 seconds depending on the timing interval. Measures that increase passability on the other hand, (e.g. pre-green for cyclists), few stops (e.g. allowing cyclists to "go straight on red" through the top of the T in a T-intersection) make cyclists feel they are advancing faster than other traffic.

Comfort is essential. A smooth, even road and track surface means that a cyclist can maintain speed without constantly having to keep an eye out for unevennesses. This increases comfort and passability as well as enabling the cyclist to

observe other road users and attractions along the route.

Basically there must never be potholes on the cycle track, and when they do arise they must be addressed immediately for reasons of cyclist safety and to avert compensation claims against the local authority. Furthermore, uneven surfaces signal to cyclists that nobody cares about them. Traffic engineers are used to considering road surface service life (often 15-20 years), but to maintain a satisfactory comfort level it may be necessary to apply a powdered asphalt treatment at an interval of perhaps 10 years. The appropriate time interval should be determined by road surface measurements in relation to bicycle traffic volumes, or some other systematic approach.

30 km/h speed zone in Odense where school children can cycle safely.



Road surface measuring vehicle equipped with laser devices. A sign on the back of the van explains why the van is on the cycle track.



Cycle tracks and routes should be kept open in winter to at least the same extent as traffic lanes in the interests of cyclist safety, security and comfort. Prioritization of the primary sections to be gritted, salted and cleared can be based on the number of cyclists benefited. Another option is to define a primary cycle path network hierarchy with a higher priority than the rest.

SEGREGATION VS. INTEGRATION

The general speed limit in Denmark is 50 km/h within city limits and 80 km/h outside urban areas, not counting motorways, etc. This means that at both levels cyclists should have their own circulation areas on major city streets and on primary roads for reasons of road safety alone.

Many cyclists on heavily trafficked roads feel insecure. This is often due to heavy motor traffic, high speeds and not enough space, all of which are excellent reasons for establishing cycle tracks. Cycle track design and maintenance should always be of such a standard that cyclists never choose to ride on the carriageway instead.

Mixed traffic is acceptable on secondary country roads where there are few cars. Furthermore, it's often unnecessary to segregate cyclists and cars on minor roads in urban areas.

In cities, motor vehicle traffic can be concentrated along fewer roads within a general road network, along which cycle tracks should be established. Roads not used by through-motor traffic can be closed off to motor traffic or calmed, thereby allowing them to serve as direct, secure cycle routes with few cars.

Cyclist visibility in traffic is a prerequisite for road safety. Parked cars, verge vegetation, bends in the road, planting, noise barriers, etc. can make it difficult for cyclists to view the road and make cyclists less visible. Accidents between cars and bicycles primarily occur in intersections so extra efforts should be made at intersections to ensure that cyclists are visible.

Areas between major traffic arteries, where bicycles and cars are not segregated, are often designated as slow-speed zones with a lower speed limit than the general 50 km/h. An appropriate speed for motor traffic is 30 km/h as in the slow-speed zones in Odense. Unfortunately, the police in other areas will only accept 40 km/h in such zones. The signed speed limit indicates the desired speed, but what really counts when pedestrians and probably cyclists as well are injured in accidents is the actual speed. At 40 km/h an accident will have far greater consequences than at 30 km/h. [8.9](#)

The figure at right shows cycling solutions in relation to motor traffic volume and speed. Road safety is a priority and segregation between motor traffic and cars is enhanced to make cyclists feel more secure. Cheaper principles are of course an option but would mean a lower level of cycle service. Some of the studies upon which the example is based are described in this publication. However, some of the assumptions needed to draw the figure are not fully documented.

A defect of this figure is that the number of cyclists is not included. Cross traffic volumes (for all types of traffic) and the distance between intersections are also important. On-road



This closed road in Malmö is open to cyclists. Cars are removed, not bikes.



segregation becomes less attractive the greater the volume of cross traffic and the shorter the distance between crossing points.

CYCLISTS VS. PEDESTRIANS

The Danish planning tradition considers cycling to be an independent transport mode with the same right to its own area as pedestrians. Generally speaking segregating bicycle from pedestrian traffic is an excellent principle. However, this can result in an undesirable fear of contact in areas where it is acceptable (or even desirable) to allow the two transport modes to share the same area. The need to place responsibility in the case of accidents means that the police often require that cyclists and pedestrians should be segregated; under present regulations the police must approve all municipal traffic projects and thereby in practice have the power of veto.

Only in areas where there are very few cyclists and walkers, such as recreational paths, is it generally accepted that the two road user groups can manage to share an area. However, pedestrians and cyclists may share space in busier areas such as urban pedestrianized zones, at certain times of the day if necessary; pedestrians should always have priority.

Traffic restricted streets inspired by the Dutch "woonerf" in Denmark became "opholds-og legeområder" (living streets/home zones) i.e. a residential area where pedestrians and cyclists have priority, which was an early example of an integrated solution. This entailed a specific set of rules ensuring that speeds did not exceed 15 km/h.; it was later supplemented by "stilleveje" (traffic calmed streets), where the speed limit is 30 km/h. Most recently Denmark introduced the concept of slow-speed zones (30-40 km/h) making it possible to introduce lower speed limits than usual in large urban areas; this requires fewer physical modifications than traffic calming, for example.

LEGAL OR ILLEGAL?

Public squares are an example of how cyclists' need to pass across an area is completely neglected so they cut across illegally. Cyclists should be able to bike legally, however. A planning authority cannot accept a traffic solution that doesn't meet cyclists' needs because "they bike illegally anyway". Cyclists' reactions to a planned traffic solution need to be carefully analyzed (will they react legally or illegally?) in order to adjust the solution so that more people are encouraged to cycle legally.



Vestergade in Odense has small speed humps and over 5,000 cyclists over a 24 hour period. Odense allows cycling from 9 pm - 9 am throughout the entire pedestrianized zone.

The concept of "shared space", which like traffic restricted streets was inspired by Holland, applies the principle of integration to the deregulation of even primary roads and intersections based on esthetic principles, the desire to create beautiful solutions. For example, areas are built up with uniform surfaces and traffic lights are removed forcing road users to "negotiate" their way through traffic. This requires nerves of steel for all the road users involved and does not encourage children and the elderly to cycle, although experienced cyclists may perhaps be able to handle the consciously chaotic traffic situation. Shared space is discussed in a report by the Danish Road Directorate. [8.10](#)

It is likely that the vision impaired will fight shared space solutions. This may lead to complications in basing a cycling project on such principles.

GOOD PLANNING ATTRACTS CYCLISTS

Cities where bicycle traffic has increased have this in common: they have established a cohesive cycling infrastructure with a high level of cyclist service (security, passability and comfort).

New cyclists can be drawn from public transport or automobile traffic. The journeys that are the easiest to influence are commuter trips. A DTU (Danish Technical University) report [8.11](#)

Cyclists in Kristiansand, Norway, are handed a cash compensation for cycling (NOK 10).



concludes that automobile traffic on short journeys can theoretically be reduced by 39%. Leisure traffic will be affected very little, 6-7%, while, surprisingly, shopping traffic by car can be reduced by 13%. There is thus a great potential for moving car journeys over to cycling (and walking). The willingness to change transport mode can be further supported by promotional campaigns such as "inga löliga bilresor" (no absurd car journeys), a campaign carried out by the Swedish city of Malmö.

The traditional philosophy underlying a cohesive cycling infrastructure is that cycling should be boosted by giving cyclists a better offer (the carrot), whereas there has been general reluctance to create restrictions on motor traffic (the whip). In addition cycling can be marketed in various ways (the tambourines). The Odense national cycle city campaign put a great deal of effort into marketing, changing attitudes to cycling, etc. 8.13

The Danish cycling tradition means that there are often so many cyclists on the road that motorists are always prepared for a potential conflict between cars and bikes over a large area, such as an entire city or even country. The concept of "critical mass" is relevant here. The mechanism is that drivers watch out for cyclists and possible conflicts. When the critical mass of bicycle traffic has been reached the accident trend is positive;

THE WHIP, THE CARROT AND THE TAMBOURINES

THE WHIP can consist of motor vehicle parking restrictions and fees, regulation of the number of cars that may enter the central urban areas and toll rings, road pricing, congestion charges, etc.

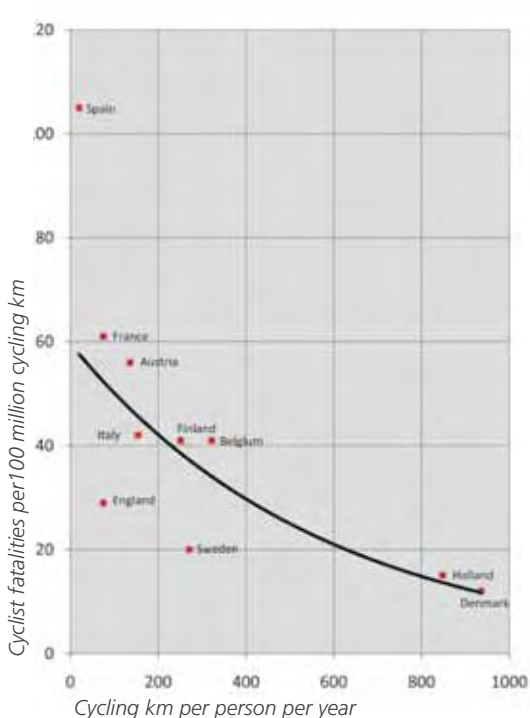
Traffic signals make it possible to control the number of vehicles entering the city to a certain extent. In Copenhagen the signals are regulated so that traffic queues occur on the motorway towards the city rather than within the city itself.

Paid parking and other regulations such as few spaces and high parking rates are used in many large cities as a means to manage traffic, particularly when it comes to reducing traffic in the city centre. New parking spaces requiring fees or higher rates are, however, subject to Danish government restrictions based on the idea that the local authorities should not use paid parking as a source of revenue. This means that such income is deducted from government subsidies. As of 2011 it is not clear whether such funds may be used wholly or in part to establish parking facilities in construction projects.

At the time of writing local authorities don't have the power to introduce road pricing, congestion charges, or toll rings, according to Danish legislation. However several Danish cities are interested in introducing congestion charges if it becomes possible. The city of Copenhagen and a number of surrounding suburbs have agreed on a concrete GPS based road pricing proposal. It is difficult to say what effect this will have on bicycle traffic since this would partly depend on public transport rates and options. Lessons can be learned about road pricing and toll rings from Kristianssand, Stockholm and London. In addition to the question of whether such measures are actually effective in reducing motor traffic and promoting alternative transport forms, the question of the right to dispose of the revenues and their use is also at issue. In Kristianssand some of the revenue is used to improve the cycling infrastructure in 6 municipalities in the region.

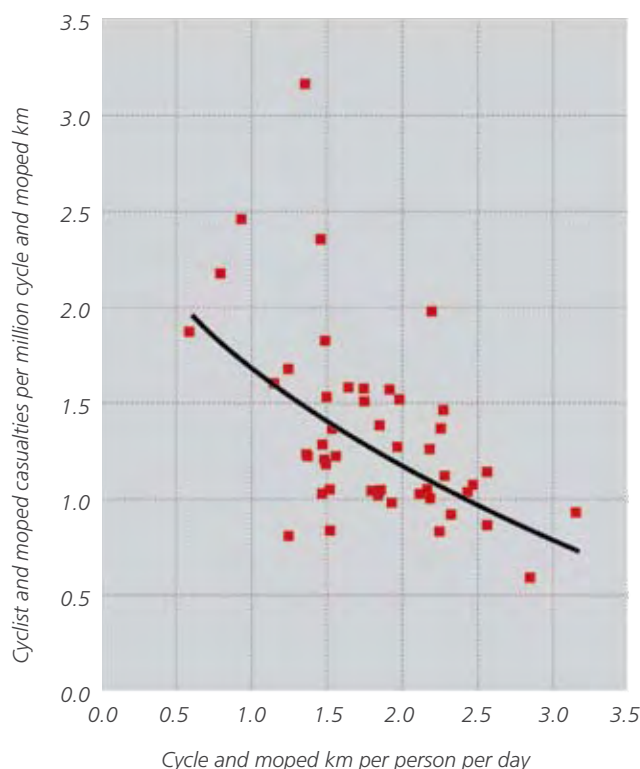
THE CARROT when it's a question of encouraging more people to cycle is a cohesive, high-standard cycling infrastructure. It is also important to be able to integrate cycling with public transport since this can improve the competitive edge of both in relation to the car.

THE TAMBOURINES consist of promotional campaigns, for example, which are discussed in a separate chapter.



"Safety in numbers" shows that the more people that cycle in a European country, the safer it is. 8.14

Comparison of 47 Danish cities
– the more people cycle, the safer the cyclist. 8.19



i.e. more cyclists mean fewer accidents [8.15](#). This is in sharp contrast to the situation in many areas abroad, which start out with very few cyclists. In this case more cyclists will typically result in more accidents – and more negative headlines.

It is probable that high bicycle traffic volume activates another mechanism, as is now the case in parts of central Copenhagen and a few other cycle cities: Here cycling seems to be the dominating factor in the traffic scene, defining the traffic flow.

It has gradually become a recognized principle in Danish traffic planning that cars in residential and central urban areas should make a detour whereas cyclists get the direct route. This has been challenged in several instances, however, and the local authorities must stand firm when dealing with project developers and others.

In recent years in major Danish cities there has been the will to give preferential treatment to cycling solutions at the expense of motor traffic. In small cities the traditionally high priority given to motor traffic is more pronounced due to the greater modal split of motorized traffic and the more positive attitude to cars; bicycle planners in these areas need to use the carrot principle more extensively.

On shopping streets there is often an interest in avoiding through-vehicular traffic, but also in retaining at least some car parking facilities. Since experience clearly shows that cyclists cannot be moved from shopping streets/main traffic arteries to back streets, planners should focus on providing good cycling facilities on shopping streets even when this is at the expense of motor traffic.

There is a temptation to establish cycle tracks where it would be easy and cheap to do so. However cycle tracks should only be built where they are necessary, which is often where it is difficult and controversial.

The cycling infrastructure should be direct, logical and convenient, otherwise a number of cyclists will choose roads that are not planned for bicycle traffic. At worst they won't bike at all.

The bicycle is a transport mode in competition with other transport modes. The daily cycle commute should be able to compete with the car and public transport. The reasons potential cyclists choose cycling rather than another transport mode varies greatly from city to city. The quality of public transport and the size of the city (and thereby the length of the journey) are



"Fahrradsstrassen" in Germany inspired Aarhus to apply to the Danish Road Directorate to initiate a bicycle street pilot project.



Nørrebrogade in Copenhagen is an example of a radical reorganization of a street area to the benefit of cyclists, pedestrians and buses (2011). The street is designated in the City Plan of Copenhagen as a "strøggade", a shopping street with priority to pedestrians, cyclists and buses

significant factors in determining whether the bicycle is competing primarily with the car or with public transport.

Good coordination between cycling and public transport improves the competitive edge of both. This means that it should be easy to bring a bicycle onto public transport and there should be good parking facilities at stations and bus stops.

Traditionally bicycles have been allowed on trains

and to a limited extent on coaches. However, it appears that bus companies are becoming increasingly interested in allowing bicycles on board. In 2011 MOVIA (operating in the Greater Copenhagen Area) experimented with bicycles on two bus lines in the capital area and BAT on Bornholm, where there are many bicycle tourists, is introducing new buses with space for 5-6 bikes. A cycle space on BAT buses can be booked online and at bus shelters. [8.16](#) [8.17](#)

Danes cycle primarily because it's convenient and fast, but increasingly also because daily cycling is an excellent form of exercise. This should be reinforced when planning the cycling infrastructure. The topic has been discussed in various bicycle accounts. 8.1-8.3. It appears that particularly residents of cities in western Denmark focus on the health aspect; in cities in eastern Denmark (e.g. Copenhagen) there is more focus on cycling as the fastest transport mode whereas health plays a secondary role.

By contrast, the fact that cycling is good for the environment, e.g. reduced CO₂ emissions and particle pollution, does not seem to play a significant role for the individual when asked why he or she cycles. For the local authorities of course reduced air pollution levels and better public health are significant factors.

In order to stay on course and maintain focus it's a good idea to formulate explicit objectives for bicycle traffic development. Qualitative objectives, such as "more cyclists", are not particularly binding. Quantitative objectives, such as Copenhagen's goal that "50% shall bike to work and education situated in the city of Copenhagen by 2015" 8.18, 8.19, 8.20 are more ambitious.

A distinction should be made between bicycle and pedestrian traffic so that the goals and objectives for each traffic mode can be monitored independently.

PLANNING PRINCIPLES

The cycling infrastructure can be based on different principles. The existing infrastructure may well be excellent, but initially it can be a good idea to leave it out of account for a minute and examine the available options from a general point of view based on one or a couple of general principles.

A city's current traffic volumes (registered by a traffic count) is an excellent starting point for improving cycling facilities for the maximum number of cyclists within the allocated budget.

The potential for increasing bicycle traffic is another prioritization parameter, e.g. employment nodes. There is great potential in establishing a cycle path near a school, creating a secure school route and thereby encouraging children to bike to school rather than be driven or take the bus. On roads without cycle tracks, prioritization can be based on estimates of the number of potential cyclists. However, this is a more complex process than basing it on a traffic count.



It is now allowed to take a bicycle free of charge on the S- trains at all times of the day in the greater Copenhagen area. This is one way of enabling a car free lifestyle.

Heavily trafficked, high speed roads with few cyclists should have cycle tracks on safety grounds alone.

In areas currently without bicycle traffic the sole basis for prioritization is cycling potential as in the case of new construction where a large modal share of cyclists can be anticipated if cycling facilities are favourable. Bridges can also create brand new links and attract and/or generate many new cyclists. In this connection a qualified guess is highly appropriate.

There is also the question of one- way streets in city centres or residential areas. A traffic count of illegal contra-flow cyclists cannot be used to predict future legal use, for assessment purposes, however. In some streets legalization of contra-flow cycling can provide cyclists with a short-cut, thereby increasing cycling volume substantially.

In addition to calculating current and potential bicycle traffic volume, it is helpful to know the location of primary destinations and how they can be linked. Mapping can be difficult, but when the focus is destination rather than bicycle traffic volume it is possible to locate the "missing links" in the cycling infrastructure and point to other solutions than traditional cycle tracks along major roads.

Motor traffic volume, speed and in some cases cyclist age breakdown can and should influence the choice between a cycle track, cycle lane or mixed traffic solution. Principles for a high standard of intersection design are crucial and should have top priority.

Since Danish municipalities vary greatly in terms of size and structure they approach cycle planning in different ways. Central Copenhagen,

EXAMPLES OF PLANNING PRINCIPLES

ODENSE has used traffic counts for many years as the basis for prioritization – from the inside and out. Where would a new cycle track benefit the maximum number of cyclists?

AALBORG formerly used a model developed by the county authorities to establish: potential school route cyclists; a factor indicating which cyclist groups (commuters, recreational) are benefitted; funding (to create a balance between city and country)

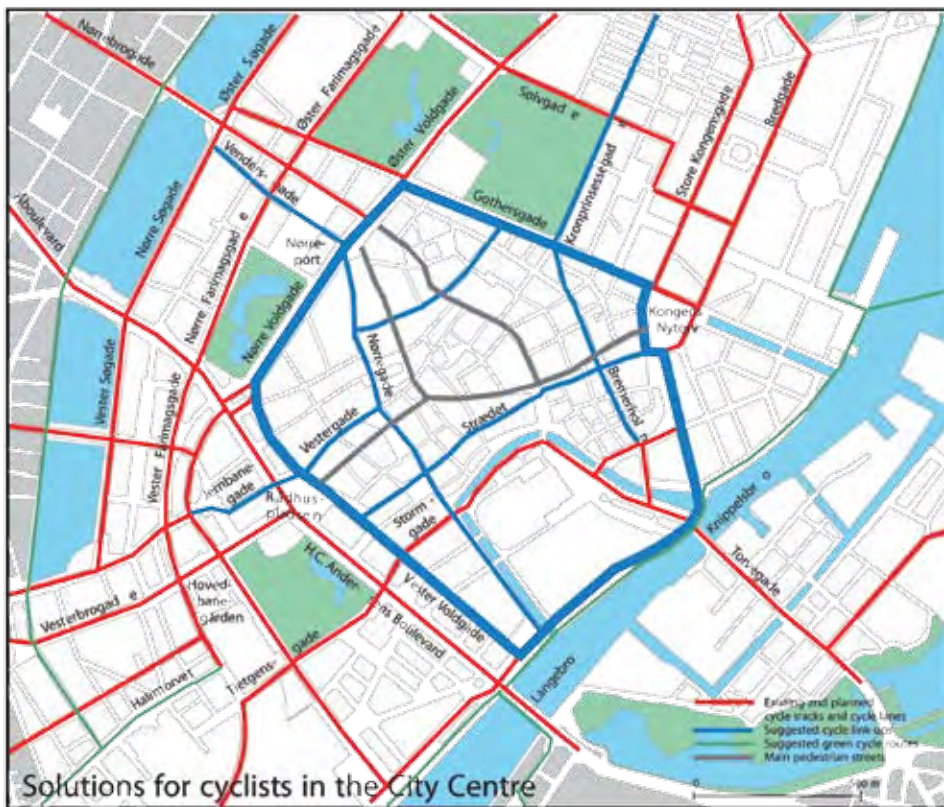
COPENHAGEN uses 5 "cycling criteria" in its cycle track prioritization plan: many cyclists; accidents; insecurity; network cohesion; contra-flow cycling. Other considerations are coordination with other urban projects and whether the cycling infrastructure can be established "simply and cheaply".

Frederikshavn and Albertslund have been selected as examples. In urban areas an appropriate cycling infrastructure mesh size is 4-500m. Superimposing the infrastructure network onto the plan makes it possible to assess whether the network is sufficiently fine-meshed.

In rural areas planning must take into account daily traffic, including commuting, cycling to

CYCLE PLANNING IN FREDERIKSHAVN

The municipality of Frederikshavn has drawn up a cycle policy 8.21 containing 7 focus areas, one of which includes plans for expanding the cycle track network in the three main cities (Skagen, Sæby and Frederikshavn). Cycle tracks are being planned for daily urban cycling, school routes in the countryside, and recreational purposes. To accommodate Skagen's many tourists, for example, a cycle track has been established all the way from Frederikshavn to Skagen. The municipality is currently (2011) investigating opportunities for developing luggage transport for leisure cyclists and a "very bicycle friendly" label for accommodation. The cycle policy was drawn up in connection with the project Nordic Cycle Cities 8.22, funded by the EU Regional Development Fund.



Cycling solutions in Central Copenhagen Planned "cycle link ups" in central Copenhagen, an element of municipal cycle planning. A ring around the historic city centre, and cross links through a number of one way streets will be made two-way for bicycle traffic. The idea is that such a simple structure will gradually be stored as a map in the cyclist's memory.

Frederikshavn Municipality's plan for expanding the cycle track network in the three main cities (Skagen, Sæby and Frederikshavn) and in open country. The first map shows existing paths in rural areas, the second shows plans for expanding the cycle network in the city of Frederikshavn.



CYCLE LINKS IN ALBERTSLUND ARE PLANNED ON THE BASIS OF THE FOLLOWING PRINCIPLES:

1. Retention of the differentiated traffic system should be a priority of municipal plans and projects.
2. A network of commuter paths should be installed ensuring high passability within and across the municipal boundary.
3. Plans for establishing the missing cycle links in order to create cycle path cohesion should be drawn up with a special focus on:
 - a. Commuter paths
 - b. The area around Albertslund Centre
 - c. Municipal commercial areas
4. When traffic terminals are established (light rail station, greater capacity bus stops, etc.) cycle tracks should be established that link up with the municipal cycle network.
5. Municipal local plans, site development, etc. should ensure access to the municipal cycle network whenever possible.
6. Wherever motor vehicle traffic is allowed on the primary cycle network it should be restricted to the greatest possible extent.
7. The municipal authorities should enter into and support strategic efforts to improve national and regional cycle routes.

school, etc., as well as Sunday and holiday cycling. Since traffic volumes in the countryside are much lower than in cities, traffic counts are

less appropriate as a planning tool since the figures are too small and the chance of random variation too great. Destination mapping in the

countryside needs to take account of the entire surrounding area, the public transport structure and the registered accident rate.

When it comes to Sunday and holiday cycling it is vital to link planned urban infrastructure with cycle tracks along the highways and existing and planned cycle routes, including paths with their own segregated layout. Although natural areas, beaches, etc. are the primary attraction, holiday cyclists in particular need to pass through cities to shop but also for the sake of variety. Accommodation facilities such as camping areas, hostels and inns should be accessible without having to cycle the last 5 km in the dark down a country road with fast moving traffic.

In rural areas it's a good idea to initially plan daily cycling and recreational cycling separately. The first phase of recreational cycle planning is to identify desirable corridors or routes. The next step is to take a look at existing routes, such as the national cycle routes, a path along a stream or a disused railway. The final phase is to identify options for convergence or coordination. These are most likely to occur near cities and in the transition between city and countryside. 8.6

Albertslund municipal cycle path plan



CYCLE PLANNING IN ALBERTSLUND

Albertslund was designed according to the principle of traffic differentiation. Albertslund Syd is a large differentiated residential area, which was traffic calmed around 1980, opening some of the roads to bicycle traffic. 8.24. Albertslund commercial zones are not differentiated, unlike the residential areas. The local authority is working on improving bicycle commuting facilities that will link cycle tracks along the primary roads with the existing network of separate paths and a new network of bicycle superhighways.

Albertslund municipal cycle strategy of 2009 8.25 aims at improving cycling facilities in Albertslund in order to encourage citizens and employees to cycle rather than drive. The stated objective is to increase bicycle traffic in the community by 10% from 2009-2012. This would reduce CO2 emissions and benefit the environment while improving public health. The strategy also aims at improving passability, access and security. Better road safety is a municipal priority, concentrating on paths and roads outside the segregated path system.

The aim of the cycle network plans is to ensure that the network covers the entire municipal area, creating cycle access from residential areas to all urban functions, including employment centres, institutions and shopping. The plans should further ensure access to municipal recreational areas as well as attractive links to the surrounding communities.

Friluftsrådet, the Danish Outdoor Council, has issued a publication providing inspiration for the planning and administration of cycle paths in the great outdoors. 8.23

Cycle tracks along heavily trafficked roads in cities and in the countryside are often perceived as more logical and easier to navigate than segregated, off-road tracks and routes along local roads. This applies particularly to new cyclists who are either former motorists or newcomers to the area. Confusing changes of direction on the cycle route can disorient the cyclist; distinctive geographic features in the area can serve as landmarks and help cyclists find their way.

A uniform design over a long stretch is an essential component of cycle route planning. Clear signage, however, can make otherwise disconnected cycle infrastructure elements more coherent. Some cities have chosen to mark special routes with road studs, or mark road plates with cycle symbols, etc. as a supplement to normal cycle path signage.

Cycle routes that are clearly visible from the road, in fact any form of human activity, create a greater sense of security. When cycle routes are hidden from other road users, fear of being attacked is increased while segregated, off-road tracks are occasionally plagued by fast moving



This Malmö cycle tunnel provides excellent visibility thereby enhancing cyclist's sense of security.

scooters. Segregated off-road tracks are thus sometimes inappropriate as they create a sense of insecurity. Good lighting and a feeling of openness in the construction and planting can counteract this effect to a certain extent.

DRAWING UP THE PLAN

Before the overall visions and general guidelines for the municipal cycling infrastructure can actually be put on paper, the principles discussed above as well as other planning principles must be taken into account. Add to this the local authority's former policies and the municipal traffic plans that are currently in effect. Finally, decisions must be made on integrating the

existing cycling infrastructure into the plan.

In the 1960s a number of communities were built around the principle of traffic differentiation, i.e. one infrastructure for motor vehicles and another for cyclists and pedestrians. Crossings between roads and paths were grade separated (usually tunnels). Such systems offer a high sense of security in traffic, which means that significantly more people choose to cycle and children start cycling at an earlier age than in more traditional traffic systems. However it appears that there may be benefits to some softening of the rigid segregation between road users in traffic differentiated systems.

Cycle tracks along roads are one of the most useful types of circulation areas for cyclists. In addition there are a wide variety of other options, including safe and secure intersection design.

The existing and planned road hierarchy, i.e. specifically designated road and cycle path categories (including the appropriate speed limits for cars), is absolutely crucial. If there is no basis for identifying a suitable primary cycle network, then there is good reason to take another look at the overall road structure.

A presentation of ideas for a cycling infrastructure plan includes choice of corridor; the routes are worked out in greater detail in an actual plan. Since all cycle journeys ultimately start and finish with a parked bicycle, bicycle parking is discussed in a separate chapter.

There are a number of considerations when it comes to an overall plan and choice of suitable cyclist circulation areas.

- Road closure and supplementary traffic calming can make cycle tracks unnecessary.
- A parking garage may create more space on the cycle tracks by reducing the need for kerb side parking.
- Alternate-side parking creates a couple of meters extra for cycling. This may be enough for a cycle track/lane on one side of the road. If a few more meters can be found, cycling facilities can be established on both sides.
- Contra-flow cycling on one way streets can greatly benefit cyclist passability.
- "Back street solutions" in which cyclists are directed to cycle in parallel with primary roads are NOT a good idea, according to all Danish experience. Good cycling facilities should primarily be created on major shopping streets; cyclist issues must be addressed where cyclists circulate.
- Existing traffic differentiated residential areas with grade separated crossings (usually

tunnels) can be made more cycle friendly by allowing cycling on roads and some road level crossing.

- Mixed-traffic residential areas between primary roads with mandatory cycle tracks may be designated as slow-speed zones (30-40 km/h), in some areas supplemented with 30 km/h or even 15 km/h streets.
- Through-roads running through villages can be traffic calmed according to the Danish principles of "environmentally friendly thoroughfares".

When restructuring and developing urban areas the priority given to cycling must be decided in advance. Objectives for the cycling modal split should be explicitly defined in major projects. The planned cycling infrastructure should render it probable that the objective is achievable. It is absolutely crucial that the infrastructure provides a link between the existing urban area and new urban development, and funding for the necessary infrastructure in the adjacent areas must be ensured and written into the urban development project.

In addition to cycling infrastructure requirements, such factors as road lighting, operations, maintenance, etc. are vital when it comes to offering cyclists favourable cycling facilities.

ANCHORING

A "cycle track plan" involves politicians, the general public, planners, operations personnel, etc. In the final analysis the plan must be politically approved and becomes binding for the local authority in the form of an action plan or by being written into the municipal plan.

The public must be involved along the way, organizations as well as the general public, partly because citizens know a great deal about cyclist issues and partly to anchor the plan solidly in the community. Focus groups or workshops can help identify issues and possible solutions. A bicycle account in which citizens' views are clearly voiced can help create a constructive public debate.

8.1-8.3

Citizens should be involved in the process before the local authority fully commits to a plan. Openness is vital when presenting the underlying principles and prioritization methods to the public.

Citizen input can be used as an argument for larger budget allocation and can motivate stakeholders such as underground cable owners, operations personnel, etc. to support the plan. The plan can usefully include infrastructure and



IS THE PLAN COHESIVE?

When an administration draws up a cycling infrastructure plan, often with the assistance of a consultant, it should be discussed and assessed whether the plan will be cohesive in practice.

Does the cycling infrastructure link residential areas with primary cycling destinations such as schools, educational institutions and employment centres? Are the routes direct? Is it easy to get to shops, sports facilities, entertainment venues and traffic terminals? Are the residential locations linked, providing cyclists with shortcuts that make it faster to bike than drive on local journeys?

Has an overall hierarchy been established (formalized or informal) that gives priority to primary routes rather than side streets and local routes, so that the majority of cyclists are attracted to primary routes? Is the flow broken by poor lighting, annoying barriers, too many signal intersections or poor maintenance? Small breaches should be addressed as quickly as possible since they drive cyclists away. Major “missing links” should be addressed in the long term.

Does the existing cycling infrastructure live up to the newest construction standards? If not, a “cycle track inspection” should be carried out with a special focus on intersections. The individual intersection’s design is often characteristic of the period of its construction and the aim of the inspection is to upgrade the existing design to a uniform standard.

Does the plan accommodate experienced as well as vulnerable cyclists? A direct but heavily trafficked road may be acceptable for adult cyclists but not for school children. School children (and their parents!) need to feel secure and should perhaps have an alternative route to school rather than a major road. Are school route plans coordinated with the cycling infrastructure plan?

Are there recreational options for Sunday cyclists and cycle tourists? They need an active experience and service.

If the infrastructure is initially established to a relatively low standard, have provisions been made for improvements over time, so that, for example, signed routes can be upgraded to cycle lanes, which in turn can be upgraded to actual cycle tracks?

Is the mesh-size of the urban cycling infrastructure appropriate? In many areas 400–500 m is sufficient but in areas with many destinations, for example a city centre, the mesh size should be smaller while in the periphery it should be larger. In the countryside it is necessary to check whether the proposed infrastructure leads to primary destinations such as schools, workplaces and services, and that routes leading to attractive recreational destinations and lodging are secure and clearly signed. Are enough provisions for supplementary segregated off-road tracks included in the plan?

Are cycle tracks planned for roads with fast moving traffic? It may be necessary to construct cycle tracks along such roads for reasons of cyclist safety and health. Perhaps the speed limit can be reduced until cycle path construction is completed?

other facilities such as bicycle parking as well as operation and maintenance priorities.

The overall structure must be clearly established as a great many people are actively involved in the process of changing road and path systems. The cycle track network plan is an integral part of a common understanding and collaboration within the local administration. However, planners are not allocated sufficient funding to build up the cycle network alone. The local authority (the road administration) should require that all tasks and projects that might be useful in implementing elements of the cycle network

should be investigated at the earliest possible moment. One obvious example is that the funds received by the road authority from independent user financed utility companies for reinstating municipal roads after underground cable construction should be coordinated with the cycle track plan. There can be a 50% price reduction for establishing a segregated cycle track in connection with new construction, such as laying natural gas pipelines, reducing the track price by half in reality. Of course the rest of the money has to be raised somehow!

It is useful to estimate construction costs within

the plan’s timeline. Anticipated co-financing from other sources can be included. Copenhagen, for example, operates with a price of DKK 8 million per 1 km of cycle track (for one side of the road) whereas elsewhere in the country it might cost half that. When estimating the price of concrete construction projects it is necessary to perform actual price calculations.

When prioritizing different projects, especially in small municipalities consisting of several equal communities, an objective prioritization may be based on an assessment of bicycle traffic potential, including traffic to school routes, educational institutions, businesses, and cycle track network links. Of course there will always be a certain amount of local politics involved in the final political prioritization no matter what method is used.

A politically approved priority plan for the realization of the cycling infrastructure is an enormous help. It saves many working hours answering citizens’ inquiries.

THE WAYS OF THE STATE

In 2007 the Ministry of Transport published the national cycle strategy, “Flere cykler på sikker vej i staten” (More bicycles, safer roads) 8.26 outlining a number of desirable focus areas for cycling on state roads. These included: establishing a new cycling infrastructure, focused maintenance efforts, improved road safety for cyclists, and better planning. The Danish Road Directorate is drawing up a cycle track plan for state roads based on 7 priorities.

The cycle strategy did not contain provisions for new funding, however, apart from the existing cycling promotion funds. In the transport

It is crucial for planner to be well acquainted with the project area. This is done best by initial inspection by bike. In the picture below agreement has been reached that the shed needs to be torn down to establish a cycle link in Østerbro in Copenhagen.



agreement of 2009, "En grøn transport politik" (A Green Transport Policy), 8.27 a DKK 1 billion cycling promotion fund was established distributed over a few years 8.28. One third of financing was earmarked for the cycling infrastructure on state roads and approximately two thirds for grants and subsidies to cycling projects initiated by the local authorities, organizations and businesses.

Implementation of the cycling promotion fund takes place by means of annual follow-up traffic agreements based on Road Directorate recommendations concerning cycle projects on state roads, and grants to local cycling projects by application.

INFRASTRUCTURE, ROAD SECTIONS AND INTERSECTIONS

Although road sections and intersections are discussed separately below it is essential that they be seen as a whole. A suitable general standard should be established, and the types of solutions chosen should be used consistently whenever possible on long routes or within a smaller area.

There are a number of available options for road section and intersection design when planning the cycling infrastructure.

On major roads the traditional one-way cycle track on both sides of the road will normally be the preferred solution. Over almost a century they have proved their worth and solidity in Danish traffic planning.

In cities caution is advisable when using two-way cycle tracks on one side of the road as the main element of the urban cycling infrastructure since Danish drivers do not expect cyclists to come from the "wrong side". Two-way tracks can be used in moderation, however, to link the network if there are no other options available. In the countryside two-way cycle tracks are often the most obvious consistent solution.

Cyclists can perfectly well cycle in mixed traffic with low motor traffic volume and when car speeds have been reduced by traffic calming. In other areas segregated, road adjacent or off-road paths are a good solution; sometimes cycle routes can be composed of different types of solutions.

The solution chosen for road sections also determines the intersection treatment to a certain extent. Danish intersection design is largely characterized by the fact that "small, soft, flat" left turns were discontinued several years ago to keep cyclists from floundering about in the middle of the intersection. Intersection design



Shunt in Aalborg improves passability since cyclists needn't wait for the green signal before turning right.



Bus nub (kerb extension) where the waiting area between the cycle track and the bus takes space from the cross profile. Car traffic – but not cycle traffic – has to wait while the bus stops at the bus stop.

should reinforce the Danish Traffic code principle that cyclists must keep right and that they have to proceed to the opposite corner before turning left.

A number of considerations enter into the choice of solution: the professional and political level of ambition, space, funding, etc.

The Danish road standards are an invaluable support when designing cyclist circulation areas. The rules regulating the cycling infrastructure are integrated into the general set of road standards and regulations. Forming an overview may be difficult, but all road standards are available on the Danish Road Directorate's "Vejregel Portal" 8.29

There are a number of road standards and

regulations that are of special interest to Danish cycle planners pertaining to: urban traffic areas

In many new cycle cities abroad solutions are often established merely by painting. Here a bike box in New York. Occasionally it might be worthwhile to consider "Quick and dirty" in Denmark as well.



CYCLE TRACK CAPACITY

A two-lane cycle track should be at least 2 m wide theoretically; the 2.2 m recommended in the road standards for one-way tracks works as a two-lane track. A two-lane cycle track has a capacity of 2,000 cyclists/hour according to the road standards from 1943 as well as more recent versions. Each new lane means an extra 1,500 cyclists. A 3.0 m wide one-way cycle track will be able to accommodate 3,500 cyclists/h.

These calculations do not take into account the rising number of wide or long bicycles. Cycle path capacity studies would be useful to determine whether large bicycles can be converted into “standard bicycle equivalents” in the same way as lorries and cyclists are converted into passenger car equivalents when calculating motorized traffic; a cyclist counts as 0.3 passenger cars.

A purely numerical approach to bicycle traffic capacity calculation is not necessarily the only relevant input for determining cycle track width. “Conversation cycling”, i.e. cycling two abreast with enough space for a third party to pass, might be an argument for a width of 3.0 m on important routes, as promoted by Copenhagen in 2011. Copenhagen’s cycling strategy of 2011 also introduces “fast lanes” on very wide cycle tracks. 8.20

8.30, planning roads and paths in open country
8.31, signage on cycle routes, equestrian paths
and hiking trails 8.32, and fauna and human
passageways. 8.33.

The road standards that regulate cycling primarily belong in the category “guidelines” or “explanatory notes”. This means that actual infrastructure design is largely determined by the local authorities. Two-way cycle tracks, however, have their own “norm”, i.e. the prescribed rules must be followed.

In recent years several Danish cities have profiled themselves as cycle cities. When Odense was the national cycle city the local authorities developed new infrastructure solutions. For example Odense allows right turn on red (shunts) in many areas. Copenhagen aims at becoming the world’s best cycle city. Aarhus, Aalborg, etc. have also demonstrated that focused cycling promotion generates more cyclists.

Cycle cities provide an opportunity for innovation and higher standards. There will also be a need for new solutions for which no standards have yet been formulated. Although road standards are regularly updated a number of revisions are necessary before many manifestly sensible cycling solutions can be implemented.

Options to consider when revising road standards and regulations:

- Contra-flow cycling in mixed traffic should be legalized without having to establish contra-flow cycle track/lanes that often make it necessary to remove all car parking facilities.
- Bicycle streets should be introduced where cars have to give way to bicycles.
- Cyclists should be allowed to turn right on red when this can be done without seriously inconveniencing other road users.
- Cargo bikes, cycle trailers, etc. should be integrated into all calculations from cross profiles to curve radii. This will require a number of special studies.



A short section of a two-way cycle track and a signalized cyclist crossing makes the Nørrebro cycle route continuous and cohesive.



Car bays act as buffers protecting cyclists in the cycle lane. Farimagsgade, Copenhagen.



New cycle tracks along Koktvedvej in Frederikshavn. The cycle track and pavement are clearly segregated by a beveled kerb. This facilitates cleaning and winter maintenance of cycle tracks and pavements.



Two-way cycle track along Kragholmen in Frederikshavn. The solution works well as there are no side roads.



Skagavej, one of the approach roads to Skagen, has a cycle lane on each side. The financially challenged municipality of Frederikshavn chose cycle lanes, which is far better than the alternative: nothing.

It is possible to try out new solutions on an experimental basis to a certain extent. This requires a dispensation from the Danish Road Directorate, but they are generally willing.

In Denmark transport planning lies with the State and the municipal authorities. The police and the local authority need to agree on new road projects, and if this proves impossible appeal can be made to the Ministry of Justice. The police thus have a good deal of influence on traffic planning in practice, including cycling infrastructure design.

ROAD SECTION SOLUTIONS

The traditional Danish cycle track with a kerb separating cyclists and pedestrians is almost always placed between the pavement and any parked cars. This solution can be used in the great majority of urban situations and is a familiar element to everyone, so familiar that it is no longer necessary to mark it with the cycle track sign. Cycle tracks offer cyclists safety, security and passability on sections between intersections. Cyclist satisfaction is doubled on cycle tracks as compared to cycle lanes. Cycle tracks can increase bicycle traffic. For example, in Copenhagen, a bicycle traffic increase of 20% and a motor traffic drop of 10% are observed when a new cycle track section is opened. [8.34](#), [8.35](#), [8.36](#)

Communities without much bicycle traffic such as Frederikshavn can choose relatively narrow, cheaper solutions such as cycle tracks with maintenance-friendly segregation of cycle track and pavement, two-way cycle tracks, and cycle lanes in urban areas. [8.24](#)

When cycle tracks are installed between the pavement and the carriageway there is a built-in conflict between cyclists and bus passengers. Efforts must be made to ensure that bus passengers do not descend directly onto the cycle track. When this is not possible, cyclists must give way to bus passengers.

Road safety issues involving parked cars are almost always completely resolved by establishing cycle tracks provided they are wide enough. However, some of the cycle track's comfort and safety benefits are lost on roads with large, closely spaced intersections regulated by give-way rules. Cycle tracks work fine on roads with signalized intersections and minor side roads when the right intersection solutions have been chosen.

Cyclist insecurity even on cycle tracks increases when car speeds are high. Verge segregation along the section improves the sense of security.

Less costly solutions such as painted barrier lines or other tactile or colour surface treatments which are common abroad, might be used to a greater extent in Denmark. Less space demanding and cheaper solutions such as nailed or glued-on kerb ramps, etc. could also be used.

Two-way cycle tracks along the road should only be used to a limited extent in urban areas and only after careful consideration. The problem is that Danish drivers do not expect cyclists to come from both sides. However, two-way cycle tracks can be used in urban areas where there are few intersecting roads. Special attention should be paid to managing possible conflicts when the tracks terminate. Two-way cycle tracks can and should be used when there is no other way to create a continuous cycling infrastructure.

Two-way cycle tracks are often the only realistic solution in the countryside where there are often few intersecting roads. It will usually be possible to design intersections where cyclists are clearly visible. Two-way cycle tracks are considerably cheaper than cycle tracks on both sides of the road. Be advised that there are binding road rules in Denmark for minimum two-way cycle track width, 2.5 m, and perhaps verge to carriageway

HOW MUCH SPACE IS REQUIRED?

Cycle track width is increasingly becoming a practical issue in cycle cities with growing bicycle traffic volumes and more and more 3 wheeled cargo bicycles which may be as wide as 1.25 m according to official regulations [8.37](#).

On a 2.5 m two-way cycle track (2.5 m is the minimum required width for a two-way cycle track according to the road standards), two legal cargo bikes will not be physically able to pass each other. A width of 3.0-3.5 m can prove necessary with high cyclist volumes. The road standards [8.33](#) need to be adjusted on this point.

On a one-way cycle track the road standards guide-line width is 2.2 m, minimum 1.7 m. The minimum width barely allows two ordinary bicycles to pass each other and it becomes even more difficult if one of them is a wide cargo bike. 2.5 m will often be a suitable standard in cities with many cyclists, but to ensure that cargo bikes can pass each other this should be increased to 3.0 m. The alternative is that the fastest cyclist can't pass. In cities with less concentrated cycling the guideline width of 2.2 m is usually appropriate.



width as well. It should be carefully considered on which side of the road the two-way cycle track should be placed. Ownership can be a factor, but the choice of solution should primarily be based on the number of intersections and on which side of the road the primary destinations (e.g. schools) are located. If crossing the road cannot be avoided, a traffic island makes it much easier and more secure for cyclists to cross.

Cycle lanes marked with a 30 cm wide solid white line and of suitable width can be an acceptable solution when speeds are 50km/h and under and traffic volumes are medium. If the road is wide enough, establishing a cycle lane is cheap, but when the road has to be widened cycle lane costs end up being the same as the costs for a proper cycle track. Cycle lanes improve cyclists' sense of security although not to the same extent as cycle tracks. Cycle lanes are a good solution on urban roads without shops and with few intersections. Cycle lanes do not address the safety issues connected with parked cars on the cycle lane, but if car bays are clearly marked outside the cycle lane virtually all cars will park correctly and serve as an effective buffer against moving motor traffic.

Cycle lanes can serve as precursors to actual cycle tracks. If this option is to be kept open, the cycle lane must be of the same width as the future cycle track and the same parking restrictions should apply. It will then be easy to install cycle tracks when funding is available.

Shoulder lanes ("kantbaner") are primarily used in the countryside. They resemble cycle lanes but are usually narrower and cars are allowed to park on them. Parking can be prevented by signage, however. In cities with a great deal of through traffic, traffic calming is often necessary to meet the needs of the inhabitants and vulnerable road users. In such areas and on highways with little motor traffic wide shoulder lanes are often better than nothing. If the road needs to be widened in order to establish the shoulder lane, cycle tracks should be established instead.

In Denmark comparatively few major urban roads are one-way but on minor roads one-way traffic is more common. It may prove necessary to establish contra-flow cycle lanes or cycle tracks on major one-way roads, which is usually approved by the Police with no trouble.

When one-way traffic is only signed at a single point or section, it will often be possible to allow cycling by merely replacing the "No entry" sign with the "No motor vehicles" sign. Contra-flow cycling without a designated cycle lane or track



"The necktie solution" allowing contra-flow cycling on a small street in the historic centre of Copenhagen. This has the advantage that only the start and the finish need to be marked at intersections, and car parking need not be removed from the section.



Cycle tracks of varying widths on Gammel Kongevej, Frederiksberg.

will often be quite safe on a small street, but of course the concrete situation always needs to be assessed. In some areas of Denmark the police allow contra-flow cycling without requiring a designated contra-flow cycle path-signage is enough, and perhaps pavement markings at intersections ("neckties"). Elsewhere the police require a special cycle track/lane even though the local authority does not consider it necessary. This means that some projects are simply not implemented since kerb-side parking may not be removed without due cause. A revision of the

road standards 8.38 might make it possible to allow contra-flow cycling in mixed traffic.

In Brussels it was decided to "shift the burden of proof" and allow contra-flow cycling on all streets apart from those actively designated and documented by the road authority as being unsafe for the purpose. A similar procedure could be considered in Denmark.

When speeds are slow and motor traffic volumes low, cyclists can perfectly well circulate in mixed



When cycle tracks are very narrow, rain water gullies built into the kerb remove rough spots making the cycle track more bikeable.



traffic. Physical traffic calming is often necessary to achieve a sufficiently slow speed. There are specific regulations that apply to "home zones" or "living streets" (opholds-og legeområder), (15 km/h), "traffic calmed streets" (stilleveje), (30 km/h) and "slow speed zones" (hastighedszoner), (30-40 km/h.). The lower the speed, the more small children can circulate safely and securely, including cycling toddlers who are "learning by playing".

Even when no cycle tracks have been established there should be room for cyclists. For this reason the inner lane on Danish streets will often contain an extra meter to accommodate cyclists. 8.30. Options for installing a cycle track or lane should

always be investigated first as this is preferable to a widened mixed lane.

When drawing up cycling infrastructure plans, planners should always be sure to include enough space for the desired cycling solutions. Sketches should be made on the section cross profile on the basis of the widths required in the road standards (including minimum widths). In addition to cyclists there must be room for pedestrians, buses, moving motor vehicles and perhaps parked cars. It will often turn out that there is not enough space for all of this within the ideal width. If this is the case the individual elements can be "filled down" and the minimum width can even be used for some elements. Another option is to give priority to some elements and remove others completely, for example introduce car parking on only one side of the road or reduce the number of traffic lanes from 4 to 2. It is crucial not to end up in a situation in which cycle tracks are too narrow to function properly.

Setting the bar high is important, but sometimes compromises may prove necessary in order to actualize fundamental cycling improvements.

In the final analysis, the "fight for street space" is political.

INTERSECTION SOLUTIONS

In recent years a great deal of effort has been put into improving cyclist safety, security and passability in intersections. It could be argued that when cycle tracks are established on road sections the conflicts are moved to intersections where they have to be finally confronted. It is crucial that cyclists are highly visible and that the intersection design makes them vigilant to other road users.

There are various options for intersection

solutions depending on whose duty it is to give way, etc. Duty to give way is often marked by give way lines, traffic signs, zebra stripes or traffic signals. Otherwise the usual rule applies, give way to the right.

In Denmark the so-called 10 meter rule was introduced a number of years ago, making it generally illegal for cars to park in the immediate area of a crossing. This rule provides cyclists with a better line of sight than in many other countries where legally parked cars at street corners is not unusual.

In signalized intersections where there are cycle tracks or lanes there should be no parking or waiting closer than 20-30 m from the intersection in the interests of cyclist visibility. Giving cyclists space (for example when they are waiting to turn left towards the opposite corner) is another recurring principle of intersection solutions. Due to growing bicycle traffic volume in large cities it may be necessary to give more space to cyclists waiting at corners. This is becoming increasingly necessary as separate turn phases become more common in Danish cities.

In signalized intersections the stop line for cars (all traffic lanes) should be set 5 meters back in relation to the cyclist stop line. Set-back stop lines make cyclists more visible and reduce the number of potential conflicts at the start of the green phase.

A narrow cycle lane leading up to the intersection, in contrast to a shortened cycle track, means that cyclists need not merge with motor traffic, and cyclists are able to enter the intersection before cars at the start of the green phase.

The cycle track or cycle lane should lead up to the stop line and continue as a blue cycle crossing (blue thermoplastic) or, less visibly, as one of the various types of so-called international cycle crossing. International cycle crossing designs used in Denmark are indicated by one or two 30 cm wide dashed white line and cycle symbols.

Blue cycle crossings are a safe, secure solution that especially benefits children and other vulnerable cyclists who cycle slowly and easily feel insecure. Research shows that the number of blue cycle crossings through an intersection should be limited to one as more than one blue cycle crossing can have a negative impact on road safety, according to a major road safety study. 8.38 In other words 4 blue cycle crossings through an intersection is not a good idea. Copenhagen, however, is beginning to establish



Blue cycle crossing, and international cycle crossing of the "one quarter type" indicated by a white dashed line on the cyclists' left. Enghavevej/Vesterbrogade, Copenhagen.



Internal road safety considerations in the City of Copenhagen tend toward using up to 2 blue cycle crossings per intersection, based on a concrete assessment of the individual situation. Tagensvej.



When the cycle track incline means that cyclists ride faster than normal the cycle track is shortened in the interests of cyclist safety. Knippelsbro bridge, Copenhagen.

up to two blue cycle crossings in intersections. This is done only after giving close consideration to road safety issues and careful prioritization of which directions are most in need of blue cycle crossings.

If the road goes downhill cyclists ride faster than usual. This is one of the few cases where the cycle track should be shortened so that cyclists and motorists merge. If the cycle track is shortened the right-turn lane must be at least 4 m wide to make merging possible.

Cyclists experience shortened cycle tracks as insecure. Shortened cycle tracks were formerly in common use since it's a safe design and leaves space for turning cars. The idea that the solution is acceptable in certain situations cannot be dismissed, but it is not a solution that makes cyclists feel more secure or that will attract more cyclists. One might consider continuing some of the shortened cycle tracks that are to be found in Danish cities as a narrow cycle lane leading into the intersection combined with set-back stop lines for cars.

Bike boxes are established in many cities abroad but do not fit in well with the mandatory wide Danish left turn. Lorry drivers cannot necessarily see a cyclist waiting in a bike box. One might consider a pilot project testing bike boxes as a continuation of the bicycle lane since possibly a cluster of cyclists can be moved through the intersection faster than a long queue of cyclists, thereby enabling drivers to turn right before the next red.

It should also be considered whether provisions can be made for cyclists to turn right on red, possibly by means of a "shunt". Experience from Odense shows that this results in a high level of cyclist satisfaction and no change in road safety levels. 8.16 It must be determined in advance whether there is enough space for the shunt, and appropriate pedestrian facilities must be provided.

The local authorities in Copenhagen are at the time of writing discussing with the police whether signage can be established in selected intersections allowing cyclists to turn right on red. At T-intersections it is already allowed to "go straight on red" through the top of the T since pedestrians can cross the track at the non-regulated pedestrian crossings where cyclists have the give-way duty.

On small side roads in urban areas a continuous cycle track allowing cyclists to cross the pavement without dismounting is a safe, secure and



Traffic calmed roundabout with tarmacked cycle lane all the way around. Halmtorvet, Copenhagen.



Åbuen. A bridge was the only feasible solution here as the alternative was a traffic signal which would significantly reduce motor vehicle capacity on this approach road. An underpass was not an option either since a stream runs under the road. The bridge links the municipalities of Copenhagen and Frederiksberg.

comfortable solution for cyclists.

On large urban side roads and on highways the cycle track should be dropped. Cycle tracks and lanes may be continued as a cycle crossing marked through the intersection. Blue marking can be used if the marking needs to be especially clear.

Small roundabouts and mini-roundabouts can occasionally serve as traffic calming measures. Cars leaving the roundabout have to give way to cyclists continuing through the roundabout. Drivers may perceive this as going straight, which is dangerous and insecure for cyclists continuing left in the roundabout. When there are many cyclists the motor traffic capacity of a

small roundabout is lower than in a signalized intersection.

Bicycle traffic management in large roundabouts, *Barriers are replaced by speed humps in Aarhus.*



which are common in rural areas, requires special consideration. Solutions at road level or two-way tracks combined with tunnels are both options. A set-back, give-way cycle track may enhance safety. On one-way cycle tracks in rural areas it has been found that set-back, give-way crossings have produced favourable results.

Cycle bridges and tunnels are used when there is a large volume of motor traffic and/or fast moving motor traffic. Ramps have to live up to the incline regulations prescribed by the road standards and are thus quite long. This applies especially to overpass elevation which has to be fairly high to allow for sufficient headroom for the motor traffic below. Access to tunnels should be wide and it's important that the tunnel is perceived as "open". Good lighting and perhaps openings to the sky are important elements. Malmö and Odense have put a great deal of effort into designing secure tunnels.

When roads are fairly large, traffic islands in middle of the crossing between the road and a segregated cycle track are useful in making it easier for cyclists to cross the road. If there is a great deal of motor traffic it may be necessary to signalize the crossing.

It is often useful to regulate crossings between cycle paths by the duty to give way to the right. Give-way regulations are particularly indicated when the line of sight is poor, combined with other measures if possible. All road users must understand well in advance who has to give way.

Placing barriers at the cycle path entrance and exit should be used only as a last resort, in fact it is barely acceptable, partly because cargo bikes can rarely pass through barriers. If barriers are used, the distance between them must be wide enough to make it possible to cycle through slowly. Rumble strips or speed humps can be necessary, especially if there is a considerable amount of scooter traffic. The road standard line of sight requirements are mandatory.

In intersections as on road sections pilot projects

ROAD SAFETY AUDIT CHECKLIST EDITED WITH A FOCUS ON CYCLING FACILITIES 8.39

- Has the placement of left-turning cyclists in intersections been taken into account?
- Does the signal timing sufficiently take cyclists into account (intersection clearance times in head winds and up-hill, and whether the cyclist can cross the intersection in one stage)?
- Is there a need for special cycle phases (max. waiting times; pre-green for right turning cars should generally be avoided; can cyclists wholly or in part be exempt from signalization, for example on right turns)?
- Is the placement of detectors when the cyclist approaches the intersection suitable and sufficient?
- Is coordination with other nearby signals suitable?
- Is the selected type of intersection suitable and have (blue) cycle crossings been considered for road level intersections?
- Is the road user's route through the crossing clear in all directions and for all manoeuvres?
- Are traffic islands wide enough for waiting cyclists?
- Are there gully grates or other surface obstacles on the cycle route?
- Will drivers of motor vehicles realize that they are crossing a two-way cycle track?
- Is there a need for barriers or speed humps on the track to make give-way rules clear? (barriers, etc. may pose a collision danger for cyclists).
- Are there safe waiting and boarding and deboarding areas for bus passengers? Are the waiting areas wide enough? They should be min. 1.5 m wide and clearly marked as not belonging to the cycle track.
- Is there a need for special measures to point out give-way rules between passengers and cyclists, such as raised areas, special surface colours, rumble strips?
- Is the road surface in satisfactory condition at crossings and on the adjacent cycle paths?
- Are there special requirements when mopeds are allowed on paths, such as traffic calming for mopeds?
- Is there a need for extra segregation between the cycle track and parked cars when opening car doors?
- Two-way cycle tracks along roads should be avoided if there are more than very few side roads/private driveways.

can be carried out reducing the width of the individual elements or giving priority to one of the elements. Allowing the cycle track, or at least a narrow cycle lane, to lead all the way up to the intersection, is desirable. Parked cars do not take up space in the intersection, but right-turn and left-turn lanes for motor traffic are highly space demanding. One might consider dropping a left-turn lane for motor traffic in order to make room for something else, but of course the safety impact must first be assessed.

When a concrete design proposal, of an intersection for example, is on the table the next step is to cycle through it mentally, preferably in dialogue with a colleague, to assess whether it will actually work for cyclists and other road users.

ROAD SAFETY AUDITS VS. SERVICE LEVELS

Cycle projects will often be assessed in a road safety audit 8.39 to ensure an impartial assessment of the project's anticipated safety impact and to point out and study possible safety issues. The work is done by specially educated road safety auditors.

Road safety audits can be carried out at different times throughout the planning process, from the

sketch project to the completed construction.

Some administrations choose to perform an audit when the complete project plan has been drawn up, whereas others may benefit more from an assessment of a sketch project.

Ideally a project should promote cycling and be safe, secure and passable at the same time. Road safety audits focus solely on safety and do not include any other factors that may influence the design of cyclist circulation areas. It is not easy to oppose a road safety audit recommendation, but

Cycle lane, "enhanced" by cycle track installation on some sections. Pile Allé, Frederiksberg



sometimes it can be the right thing to do, based on overall considerations.

Hitherto, a suitable instrument for evaluating security and passability has not been available. As a supplement to road safety audits the road standards' new instruments for measuring perceived service levels can calculate the level of cyclist satisfaction for the individual road section and intersection as well as for a larger network. 8.40. The instruments are based on a relatively small amount of data concerning road design, surroundings, and traffic. The primary cyclist parameter, "satisfaction", is closely linked to security and passability. Service level instruments can be used to identify the least satisfactory intersections and road sections or to calculate the impact of a given renovation on cyclist satisfaction. The instruments can also be used to optimize a renovation's service level so as to maximize road user satisfaction for the money.

MATERIALS, CONSTRUCTION AND AESTHETICS

If city streets are not merely to serve as traffic arteries, but should also be beautiful and attractive places for citizens to enjoy, the traffic situation must be considered as a whole; architects, engineers and landscape gardeners must collaborate and gain insight into each other's fields. 8.41

Road surfaces are often up for discussion when squares and other urban spaces are being renovated. Design considerations may require a uniform road surface whereas traffic engineers tend to prefer varying surfaces indicating the different traffic functions.

As a general rule asphalt is the most suitable material for cycle track surfaces and is therefore standard on Danish cycle tracks. Asphalt offers

“ENHANCED” CYCLE LANES AND THE LIKE

It is not always possible to establish the best solution, which in a Danish context is the classical Danish cycle track. The local authorities address this in different ways:

- **FREDERIKSBERG** has installed a number of cycle lanes boosted by individual measures such as traffic islands and the like.
- **COPENHAGEN** uses the “enhanced cycle lane” model when cycle infrastructure funding is limited. Cycle lanes are installed as this is a less costly procedure provided the kerb need not be moved. The cycle lanes are enhanced in certain areas by establishing a traditional cycle track (for example at bus stops, where they are compulsory).
- **AALBORG** has established a long cycle lane section on Hadsundvej. When side roads are closely spaced proper cycle track crossings replace the cycle lanes.

a smooth, even surface and can be repaired as a matter of routine. Powdered asphalt is produced by mixing hot soft bitumen and crushed stones. Powdered asphalt is well suited as the wearing course for cycle tracks and normally has a technical service life of 15-20 years, although it may only remain acceptably even for 10 years. Powdered asphalt's excellent surface makes it easy and pleasant for cycling, provides good friction, and is available in many colours. Asphalt should always be applied mechanically.

Gravel should not be used on cycle paths although it may be used when the path doesn't need to be bikeable when there's snow. Recreational paths can be laid out with stone dust which is well suited for cycling. A newer type of gravel is “castle gravel” (and similar terms) which provides a good surface for cycling. Another advantage to this material is that it can be laid at one go and also serves as the bearing layer. Gravel surfaces cannot be swept or snow cleared.

A road surface treatment is the cheapest fixed surface. It bears a certain similarity to gravel and may be a compromise option in natural areas where there is a reluctance to use asphalt.

Surface quality is perceived differently by each road user group. Cyclists' field of vision is naturally directed downwards and cyclists' experience of street space is largely dependent on surface quality.

Granite paving slabs and paving stones in general can be used to indicate a pedestrian area. Paving slabs over a large area tend to become uneven with time. Paving stones and sett paving make for a more uneven surface than asphalt but are becoming somewhat more acceptable if they are sawn (for evenness) and jet burnt (for better friction). Slabs, paving stones, and the like should not be used on cycle tracks and only to a very

limited extent at squares, etc., primarily in the shape of bands to focus attention, for example. Cycling areas in pedestrianized zones can be segregated from the pedestrian areas by a 3 cm high border. Cyclists must be able to cross squares, and other spaces legally, otherwise they will often be forced to make a long detour.

In more regulated traffic areas the choice of surface and colour can clearly indicate the area designated for each road user. Surface and colour should guide road users to the appropriate area and clearly indicate the give-way regulations. In areas where road users are left to themselves to negotiate their way through an area, it is important to try to predict cyclist behavior in advance.

A coloured surface application that clearly stands out from the surroundings can highlight a circulation area and help render give-way

regulations visible. Examples of this are coloured asphalt or blue thermoplastic cycle crossings. When special colour materials are used, e.g. the red asphalt used for cycle tracks in Nakskov, it is important that sufficient material is available for repairs.

Cycle track surfaces should be even and provide sufficient friction in the interests of comfort and safety. The track's construction should be able to withstand pressure from motor vehicles using the track such as maintenance vehicles or illegally parked lorries. The road bed can usefully continue under the cycle track along roads with no verge.

On segregated cycle tracks the base, etc. should be constructed so that maintenance materials do not cause cracking along the sides of the track.

CONSTRUCTION PROJECTS

It is crucial that plans for the cycle network are included in investment decisions regarding traffic and other physical planning, for operations as well as construction. Prompt action is sometimes required, which means that it is a good idea to have prepared a priced overview of ideas or a sketch project for key cycle network elements. Visionary, long-term thinking makes it possible to promote safe, secure bicycle traffic within reasonable budgets if this is coordinated with other on-going projects.

When other considerations than cycling are the starting point for new construction or renovation, a cycle audit or revision defined by cycling parameters ensures that elements of the cycling infrastructure are implemented as an integral part

	Metropolis (many intersections)	Towns	Countryside
Two-way cycle track (2.5 – 3.0 m wide)		DKK 2.5 – 6.0 mill. per km	1.0 – 2.5 mill. per km
One-way cycle track (2x2.22 m) incl. drainage	DKK 5.0 -15.0 mill. per km	DKK 3.5-8.0 mill. per km	DKK 2.5-5.0 mill. per km
Cycle lanes (2x1.5 m wide) The low price only covers surface marking	DKK 0.5-10.0 mill. per km	0.25-5.0 mill. per km	DKK 1.5-3.0 mill. per km
Recreational stone dust paths (3.0) m wide		DKK 0.5-2.5 mill. per km	DKK 0.4-1.0 mill. per km
Extensive traffic calming (chicanes, humps, road narrowing, etc.)		DKK 5.0 – 20.0 million per km	

The quoted contractor prices are at 2011 levels and are used to estimate and calculate cycling infrastructure prices. 20-80% should be added to cover preliminary studies, projecting, inspection, administration, and unforeseeable expenses.



of other projects.

As a rule most new construction and major renovations are carried out individually, for example one cycle track at a time. However, there can be economic and communications benefits to be gained by implementing many minor improvements at once, such as traffic signs, road markings, etc. The majority of the set-back stop lines for cars at signalized intersections in Copenhagen were implemented at the same time.

Finally, there are "special option projects". An area may be physically reserved for the cycling infrastructure pending a future allocation. If the project is temporarily established to a low standard, supplementary funding may later permit an upgrade to a higher standard. One example of a special option is when cycle lanes are installed along roads where the aim is to establish cycle tracks at a later date. Another, in rural areas, is to reserve an area on one side of the road for a two-way cycle track. Urban development areas also contain many options for long-term projects.

When construction projects are sketch planned, the cross-profile and the intersection design, for example, should be determined, and a price estimate should be drawn up. When a project has been approved on the basis of an idea or sketch project and a price estimate, a detailed project should be drawn up including a more precise price estimate. The local authority will often hire a consultant to plan the actual construction project. It is crucial to describe the project in detail from the outset and clearly define the task and the level of ambition.

When a construction project has been through the political process and funds have been allocated there will usually be a round of competitive bidding in order to implement the project as cheaply as possible. Open bidding typically means a lower price than closed bidding. In open bidding it is vital to ensure the firm's financial solidity.

Operations should be priced too. A city street with cycle tracks will often be more expensive in terms of operational economics than a street without cycle tracks, partly because there are a number of rain water gullies. There should be a distinction between the cost of maintaining asphalt, etc., and the maintenance cost of cleaning/ snow clearance (which requires narrower machines). Major expenses should be

anticipated for both categories when establishing cycle tracks.

It is often impossible to get extra funding for operations, but this is a must in the long run and when there are many cycle projects if general maintenance is not to be adversely affected.

ESTIMATES AND PRICE CALCULATIONS

The price of implementing a major cycling infrastructure plan can be roughly estimated on the basis of local, experience-based unit prices (e.g. cycle track per km incl. intersection renovation). For example, the unit price for a cycle track on one side of the road in a given area in the countryside may be DKK 5 million /km while elsewhere it may amount to DKK 8 million. An entire plan can cost as much as DKK 100 million. Exchange rates at the time of writing, €1 = DKK 7.4, £1 = DKK 8.9 and \$1 = DKK 5.6.

The price estimate of concrete construction projects can be calculated on the basis of a sketch project. All prices in the table on the opposite page are indicative contractor quotations and do not include a number of other expenses. For purposes of estimation 20-80% should be added to the contractor quotation, covering preliminary studies, planning, inspection, administration and unforeseeable expenses. Add to that area acquisitions.

The differential lies within the range of the Danish Road Directorate's appropriations requirement for construction estimates. It includes adjustment supplements of up to 80% added to contractor expenses (physical estimate) and unforeseen risk events of simple municipal projects (contractor expenses plus 20%); it does not include area acquisitions, and projection, inspection and administration are severely limited. In other words the 20% primarily covers unforeseeable expenses.

A good rule of thumb for planning or sketch planning purely municipal projects is to add a total of 50% to contractor expenses.

20% covers preliminary studies, planning, inspection and administration.

30% covers area acquisitions and unforeseeable expenses. As the planning process progresses and the questions that have been in doubt are cleared up, unforeseeable expenses can be written off and usually end up as 10-15% at the start of the contract.

Contractor expenses may have risen in the meantime, however, and there may also be increased expenses for preliminary studies, planning, administration and area acquisitions.

Prices depend on the amount or scope of the project to be carried out, and there are regional differences (up to 20-25% between the capital area and Northern and Western Jutland). This is reflected in the price interval.

When there is competitive bidding on a project, calculations are much more detailed, including price per square meter, price per running meter, etc. The price quote is partly dependent on the amount of new construction that has to be done. (Small projects are thus relatively more expensive). The current state of the construction industry also has a significant impact on the price, and price is further dependent on whether contractors are hungry for work.

9

DESIGNING THE CYCLING INFRASTRUCTURE

For cyclists, a well-designed circulation area is easily passable, secure and safe. In order to choose the right design it is essential to first identify the problems that need to be addressed and prevented, and to make sure that the proposed solution does not create new problems.

A good design should be functional and easily understandable. For safety reasons the traffic system must be designed so as to minimize the possibility of making mistakes, and if accidents do occur, to minimize the consequences of such mistakes in order to prevent serious casualties. What road users do naturally must be safe.



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APPROPRIATE DESIGN

As a basic principle, road design should be self-explanatory. Everyone should have a clear perception of his or her natural place in traffic at all times. The road's design should be determined by road user speeds and traffic composition; road surface, signage and road markings are not the same in a pedestrianized zone as on a country highway. These basic principles combined with the fact that roads and paths have a diversity of functions means that designing circulation areas appropriately is an extremely complex process.

Segregated paths

Segregated paths are established for the sole use of cyclists and walkers. Cyclists do not like hills or stops so segregated paths should be designed without too many inclines and stops. Cyclist passability is increased in lightly trafficked areas when the cycle path continues through the intersection and cars have to give way to cyclists.



Cars have to give way to a segregated commuter path



Bicycle traffic boosts retail sales.



Speeds here are naturally low.

Shopping streets

Adequate space for pedestrians is the key element on shopping streets. If walkers cannot move securely and without hindrances, there won't be a great deal of shopping. On shopping streets where pedestrians can cross the road without difficulty car speeds should be 30 km/h maximum. Cycle tracks are seldom necessary in such cases. When there are many motor vehicles, the street becomes divided into two separate shopping areas for all practical purposes. A compromise solution in shopping streets will often be possible, involving cycle tracks, traffic calming, and integration of crossing pedestrians.

Residential roads

Security is the key concept here, and low speeds are a must. Many issues in residential areas can be resolved without having to resort to cycle tracks if planners have a thorough knowledge of traffic calming measures and car parking facilities.

Primary roads

The city as traffic machine is determined by its primary roads, i.e. the major traffic arteries whose prime function is to facilitate the smooth flow of motor and bicycle traffic. However this is where approx. 70-80% of urban traffic accidents occur, this is where major conflicts between safety, the environment and passability arise, and this is where details are crucial. A thorough knowledge of road markings, intersection design, etc. is needed to address such issues appropriately.



Segregation of road and cycle track.

Cycle tracks are often an essential part of the solution.

Highways

In high speed areas it is crucial to segregate cyclists from motor traffic. On such roads the optimal cycling solution is to establish cycle tracks and shoulder lanes. Safe cycling facilities are a prerequisite for increasing bicycle traffic over greater distances.

MIXED TRAFFIC

Cyclists often feel insecure in mixed traffic, especially when there are large numbers of cars and lorries traveling at high speeds. Safety levels partly depend on speed levels, parking facilities and road width. Consequently, bicycles and cars should only be mixed on road sections with little motor traffic and suitably slow speeds.



It's a good idea to reduce speed here, by a speed hump, for example.

6 out of 10 cyclists experience conflict situations especially in mixed traffic. On roads with cycle tracks only one third of cyclists experience conflict situations. In mixed traffic the behavior of other road users, parked cars, and intersections are the situations in which cyclists most commonly experience conflicts. On roads with cycle tracks the main problem areas for cyclists are at intersections and side streets. 9.1

Cross profile

The width of the carriageway has little impact on the cyclist's experience of the road in urban areas, according to an American study. 9.2 Danish studies support this; urban road width has little or no impact on cyclist safety whereas cyclist risk in open country drops as lane width increases. 9.3, 9.4

When the road width in urban areas is less than 6.5 m, the motor traffic speed limit should be 30-40 km/h maximum. If motor traffic speeds are higher, the traffic lanes should be wider. At speeds higher than 40 km/h traffic calming measures or segregated facilities should be considered.

On roads where motor vehicles pass cyclists at 30-50 km/h while oncoming traffic passes by in the other direction, the choice between segregating cyclists from cars or allowing cyclists and cars to mix on a widened traffic lane depends on traffic volumes, parking conditions, space, etc. The presence of children and elderly cyclists argues in favour of a segregated cycle track.



It is a good idea to segregate motor vehicles and cyclists when traffic volumes are high and there are many parked vehicles.

Parking

Cyclists often perceive parked cars as a problem in mixed traffic, and the accident risk for cyclists in mixed traffic is increased even when car- and bus bays have been established.

Parking manoeuvres and opening car doors can injure passing cyclists. Scattered parking along the road may make cyclists less visible to other road users. Parking should either occur in a parking lane or else speeds should be slowed to approx. 30 km/h.

When parking is angled or perpendicular car speeds should only be 10-20 km/h. This is not an appropriate solution, however, when there are many cyclists and traffic is mixed.

Parking restrictions result in an approx. 20-25% drop in the casualty rate even though parking restrictions may mean that cars drive faster. However, the traffic pattern may be modified by parking restrictions, which may cause more accidents.

With one-side parking the accident risk is higher than on both sides since one-side parking leads to dangerous parking manoeuvres and limits the cyclist's line of vision. Sometimes, however, it may be necessary to limit parking to one side so as to create space for a cycle track.

Bus stops

In mixed traffic, bus bays prevent confrontation accidents between cyclists and cars. Cyclists don't have to look back and check for busses and cars; in fact, cyclists rarely look back.

In streets with many parked cars, the parking and waiting prohibition at bus stops can be supplemented by a pedestrian refuge. Cyclists often find kerb extensions at bus stops inconvenient in mixed traffic.

Traffic calming measures

Physical traffic calming is often necessary in mixed traffic to improve road safety and make cyclists and other vulnerable road users feel secure.

At road narrowings or speed humps it is important that there is a designated, independent cycling area such as a cycle gap, cycle track or cycle lane. Cyclists feel more secure passing speed humps and road narrowings in a cycle gap than without a cycle shunt. 9.8, 9.9 10-15 m should be kept clear of parked vehicles before and after the cycle gap, by means of islands or 30- 40 m long cycle lanes. The cycle gap should be wide enough for a legal bicycle, minimum 1.4 m.

When an area is traffic calmed and speeds are reduced, this results in increased pedestrian and bicycle traffic, particularly among children and the elderly. 9.10

Kerb extensions and shrubberies keep parking under control.



An English accident study of 72 slow-speed areas shows a 60% drop in the number of accidents. The drop was highest for motor vehicles and pedestrians and lowest for cyclists. The average speed of motor vehicles was reduced from 40



Parking lanes prevent slaloming.



A good cycle gap is 1.4 m wide. If the gap is too narrow cyclists use the carriageway and if it's too wide, cars may use the gap.

km/h before speed reduction to 26 km/h after. Speed reduction measures do not have nearly the same beneficial effect on cyclists as on other road users, partly because most cycling accidents take place at intersections. 9.11 In Denmark the total safety effect is typically 30%, vs. approx.10% for cyclists. 9.12



Speed humps are a particularly effective traffic calming measure. The hump can be installed over the entire width of the road without a cycle gap, which in this case is best for cyclists and cheaper to install.



To prevent squeezing, cycle tracks or cycle lanes can be established by a median divider.



Cycle gaps, manhole covers, debris, and parked vehicles are an unfortunate combination.

CYCLE LANES

Cycle lanes are primarily used in urban areas. Cycle lanes are a good alternative to cycle tracks when space and funding make it difficult to install cycle tracks. Cycle lanes may also serve as a transition phase before establishing cycle tracks with kerbs.

Cycle lanes are more common abroad and are used to mark the cycling area, using what funds are available, rather than establish what Danes would call a “proper” cycle track.

Wide cycle lanes result in significant accident reduction on road sections, but may cause safety issues at intersections. Three different studies show a rise of 10% in the number of cycling accidents when cycle lanes are installed in urban areas. The total increase in the number of accidents covers a major drop on road sections and a major increase at intersections. 9.13, 9.14, 9.15 A more recent study in Copenhagen shows a 5% accident increase on road sections and intersections, and a 15% increase in personal injuries. During the same period, bicycle/moped traffic increased by 5-7% while motor traffic remained unchanged.

Studies indicate that accidents on road sections involving parked cars are not addressed by installing cycle lanes. Accidents in which cyclists are hit by cars from behind continue to occur due to narrow cycle lanes. 9.17, 9.18

Left-turning cars are a major issue on roads with cycle lanes; the most serious intersection accidents take place when cyclists turn left. Mini-roundabouts, clearly designated cycle tracks, and motor traffic speed limit reduction are measures which seem to prevent some intersection accidents on roads with cycle lanes.

Danish bicycle counts show that installing a cycle lane on a single road has a negligible effect, a mere 0.5% increase. 9.19, 9.20 If, however, an entire network of cycle lanes is established in an urban area without cycle tracks the number of cyclists will increase. This is also the case in New York where the cycling infrastructure is primarily based on cycle lanes. Cyclists feel more secure and perceive the cycle lane as a genuine improvement of the service level compared to being forced to bike in mixed traffic. 9.21

Installing cycle lanes

A cycle lane is marked on the carriageway by a 0.3 m wide, solid white line, and painted cycle symbols placed at intervals of approx. 100 m, and after each break in the solid white line (after intersections). Painted cycle symbols



Cycle lanes are often used to park unlawfully.



Cycle lanes combined with speed humps are reasonably safe and secure.

may be replaced by a bicycle track road sign at intersections. Cycle lanes should be established on each side of the road so that cycling is one-way. Cars may not park on the cycle lane, but may use the carriageway outside the cycle lane, unless parking is prohibited.

Cross profile

Cycle lanes should be at least 1.5 m wide including a 0.3 m solid white line. When the lane is narrower than 1.5 m, overtaking cyclists often use the carriageway. A more acceptable width for passing is 1.7 m. The white line itself should be solid, but may be profiled to increase driver vigilance. Thermoplastic is an excellent road marking material due to good visibility, durability, friction and cost. 9.23

Cycle lane surfaces can be installed using contrast colours, such as red or brown, to emphasize the cycle route's continuity. The coloured surface can be continued through intersections, marked as a cycle path with a wide, dashed line and the cycle symbol. The effect of coloured surface treatments is not known, however.

Coloured surfaces mean cyclists experience fewer disturbances from motor vehicles; cyclists' feel positively about coloured surfaces. 9.24 A coloured surface is important when cycle lanes are wider than 1.8 m as the cycle lane can otherwise be mistaken for a carriageway or a parking lane. The safety effect of coloured cycle lanes is not documented. The coloured surface should be regularly maintained to prevent it from becoming unsightly and unattractive.

Several studies indicate that narrow cycle lanes are unsuitable on mixed traffic road sections from a safety point of view. 9.25 When the width of the cycle lane is increased, the distance between the cyclist and the car increases, and the number of cyclists briefly using the car lanes drops.

Parking

Parking should be prohibited on roads with cycle lanes when there is a large turnover of parked cars, for example on shopping streets or streets with blocks of flats. Parking should always be designed so that the spaces cannot be used for other purposes than parking, i.e. cannot be used as an extra lane at peak hours for example.

When the parking area is placed between the cycle lane and the carriageway, a 2 – 2.5 m wide cycle lane enables cyclists to overtake safely and makes it easier for them to dodge open car doors and pedestrians. A 1.0 m wide island or painted barrier should be established between the cycle lane and the parking lane if possible. Otherwise it's a good idea to place islands along the outer edge of the cycle lane. If the interval between the islands is small, the cycle lane can be considered a cycle track. Signage or cycle symbols should be used to make the area's traffic function clear.



Parking occurs even when it's prohibited.



Parking on the cycle lane can put cyclists in a dangerous position.



The parking bays here are too narrow. A car door is 0.9 m wide.

Parking between the cycle lane and the pavement requires a wide parking lane of 2.5 m so drivers do not open car doors onto the cycle lane. Cycle lanes on the other hand needn't be wider than normal, but the white line should be dashed. Frederiksberg is testing this solution. As a general rule it's better to park cars on the outer edge of the cycle lane.

Only parallel parking is acceptable on roads with cycle lanes. Angled and perpendicular parking increases the accident risk so significantly that such parking is only acceptable when there are special parking bays, and on minor local roads where cycle lanes are unnecessary.

Bus stops

At bus stops, depending on the amount of space available, a bus bay, a short cycle track or a waiting area between the cycle lane and the carriageway can be installed. In this way bus passengers needn't negotiate high steps when entering or leaving the bus. The kerb lane outside the bus bay should be marked by wide dashed lines on each side and extra cycle symbols. If the passenger area is placed alongside the carriageway other traffic must wait while the bus stops for passengers.

Aalborg is testing a project combining cycle lanes on straight road sections with cycle tracks at bus stops, car parks, crossings, etc. to prevent conflicts and improve passability.



This is not going to work!



A cycle lane isn't worth much with this kind of gully.

SHOULDER AND KERB LANES

The Danish term "kantbaner" is in this publication called shoulder lanes when used in rural areas and kerb lanes when used in villages and urban areas. They are often narrower than ordinary cycle lanes and parking is permitted. Shoulder lanes allow cyclists to bike more comfortably and provide pedestrians with a more solid foundation for walking. Furthermore, wide shoulder lanes reduce carrying capacity issues along the shoulder. 9.26 The wider the shoulder lane, the better cyclists like it. Motor vehicles are allowed to park on the shoulder lane. Narrow shoulder lanes are not advisable as cyclists will then use the carriageway, and drivers are not prepared for this.

Shoulder lanes are established by changing the road marking or physically expanding the traffic lane. It is not recommended to expand the road in order to install a shoulder lane; build a cycle track instead. Road expansion costs the same as a cycle track 9.28 but does not improve the level of cyclist service or road safety to nearly the same degree. On the other hand shoulder lanes do increase motorist safety.

Lane marking may result in higher driving speeds. 9.29, 9.30 A number of the accidents that occur on roads with shoulder lanes occur when cyclists turn left. Shoulder and cycle lanes in themselves do not generally reduce the number of left-turn accidents. 9.31 One option is to establish a left-turn lane on the right side of the road, which has been done on several highways in Funen.

Cross profile

The guide-line width for kerb lanes in urban areas is 1.5 m including a 0.3 m solid white line; if this much space is available, a cycle lane is a better alternative. In rural areas the guideline width for a shoulder lane is 1.2 m including the line, but should be no narrower than minimum 0.9 m. The 0.3 m wide white line should not be used unless the shoulder lane is min. 0.9 m wide, including the line. Otherwise the line should only be 0.1 m wide. The line should be solid.



A shoulder lane is better than nothing.



A cycle track with a verge is excellent on highways and on road sections without side roads

Shoulder lane width has a crucial safety impact in rural areas. Overtaking, cycling abreast, and bicycle trailers don't work on narrow shoulder lanes. Motorists are startled when cyclists use the carriageway even for a short period of time. On roads with cycle tourists and roads with over 100 cyclists over a 24 hour period the shoulder lane should be 1.5 m wide, but a proper cycle track or cycle lane is preferable.

A Danish before-and-after study shows that the number of accidents on country highways drops as shoulder lane width increases. The drop is greatest among vulnerable road users. 9.32



A separated, shared-use path can work when there are few cyclists and pedestrians.



A cycle lane delineator like this one can work on roads with very few crossing pedestrians. It's cheaper and doesn't require drainage facilities.

Parking

Wide kerb lanes in urban areas particularly are often subject to undesirable parking, which means that waiting and parking restrictions and prohibitions are advisable. In urban areas one should always consider designing kerb lanes as cycle lanes with painted cycle symbols. This is a good way to prevent parking in the lane.

It is easier to implement kerb lanes than cycle tracks and cycle lanes since kerb lanes place no limits on parking. In villages with a long through-road, parking is usually only possible on the through road. Here kerb lanes combined with traffic calming would be a sensible solution.



The traditional Danish cycle track with a kerb provides excellent segregation between road user groups.

ONE-WAY CYCLE TRACKS

One-way cycle tracks should be established along roads with high motor traffic volumes and/or fast moving traffic. The standard Danish solution is designed so that the cycling area has its own level between the carriageway level and the pavement level, segregated by a kerb on each side.

Choice of cycle track category and width should not be solely dependent on such criteria as road safety and funding, but also on passability, security, comfort and general enjoyment. Cycle tracks reduce the number of accidents between cyclists and motorized traffic on road sections. When roads are dimensioned for speeds of over 50 km/h, cycle tracks help reduce the severity of cycling accidents.

There are four main categories of one-way cycle tracks along roads, defined on the basis of differences in funding, space requirements, drainage, and perceived level of service.

When it comes to cycle tracks in open country, wide tracks have a greater safety effect than narrow tracks. 9.33 The cyclist accident rate is reduced by half when cycle tracks are established on highways 9.34, 9.35 while the effect in urban areas partly depends on traffic volumes: the greater the number of cars, the greater the impact. 9.37 A Copenhagen study showed that cycle tracks increase the total number of accidents by 10%, but that this covers a drop in road section accidents and an increase in intersection accidents. Furthermore, bicycle traffic on road sections increased by 20% and motorized traffic dropped by 10%.

Apparently cycle tracks have a modest, speed reducing effect on both cyclists and motorists. In cities, cycle tracks may be used to create a narrower road profile, better crossing options, etc., and thus have a broad safety impact. Motor traffic speed reductions of approx. 1-5 km/h can be anticipated depending on traffic lane width and whether the number of lanes is reduced. Cyclists ride approx. 1-2 km/h slower on cycle tracks compared to mixed traffic. This is partly



Trees may be placed between the pavement and the cycle track.

due to the fact that cyclists feel more secure and therefore reduce speed, and partly because the smaller area gives them less room to manoeuvre.

Cyclists prefer cycle tracks along the road (or segregated, off-road cycle paths), and they like them to be well lit and to have an even road surface. When cyclists experience cycle tracks negatively this is primarily due to uneven surfaces, man-hole covers, gullies, confusing intersections, a narrow path profile or poorly designed bus stops.

A Danish and a non-Danish study each show that for cyclists the perceived level of service provided by cycle tracks is significantly higher than for cycle lanes. 9.39, 9.40 Counts carried out before and after the establishment of 25 km of cycle track along 10 Danish highways showed a jump of 37% in the number of cyclists. 9.41

Cross profile

The guideline width for one-way cycle tracks segregated from the carriageway by a kerb, verge, or lane delineator is 2.2 m in both urban and rural areas with a guideline minimum width of 1.7 m. In practice, however, it is not recommended to go under 2 m.

When a cycle track is part of a shared-use path the guideline width is 1.7 m and the guideline minimum width is 1.5 m.

Studies show that the risk of cyclist accidents

drops as cycle track width and verge width on highways increases. 9.42

A cycle track width of 2.2 m makes it possible for cyclists to overtake safely. Since cycling speeds vary greatly, overtaking is very common among cyclists. In cases of large numbers of cyclists it may be necessary to create space for 3 cyclists to cycle abreast, with a minimum width of 2.8 m, preferably 3.0 m.

Wide cross profiles are worth considering in areas with many cargo bikes and bike trailers.

Verges

A verge between the cycle track and the road is a good solution on roads with high speeds and few intersections per km of road. Verges are used primarily in the countryside, thereby making kerbs or drainage facilities unnecessary. Verges should be avoided in cities with closely spaced intersections for safety reasons.

Grass verges along the carriageway are assessed positively by cyclists for reasons of security and comfort. 9.43 Danish experience shows that the positive impact of verges on perceived service levels occurs at speed levels of 60 km/h and up. To prevent parking on the verge and to improve drainage, a kerb is advisable between the verge and the carriageway on city streets.

Verge width should be determined on the basis

The verge should be dropped well before the intersection to make cyclists more easily visible.



of an overall assessment of desirable planting, line of sight requirements, distance to solid objects, and space. In the countryside 1.5 m wide verges are normal whereas the figure varies greatly in cities. In the countryside, solid objects such as trees should not be placed on the verge in the interests of driver safety on impact.

Verges with trees between the cycle track and the carriageway should be at least 2 m wide in urban areas. Trees between the pavement and the cycle track may be planted on a 1 – 1.5 m wide verge. A grass verge should be at least 0.6 m wide.

Crash barriers are normally established on the outer edge of the carriageway since placing them between the carriageway and the cycle track requires a wider verge and also hampers and raises the costs of mowing and snow clearance, etc. Crash barriers on the verge prevent the verge from functioning as a breakdown lane.

Divided tracks

Divided tracks should be established when there are few cyclists and pedestrians and little space is available. However, the risk of accidents between pedestrians and cyclists is greater when the cycle track and pavement are on the same level, only separated by road markings or different road surfacing. Pedestrians will use the cycle track more or less consciously if the areas are not clearly designated. The narrower the cycle track, the more likely that cyclists will bike on the pavement. One alternative to a divided track is a shared-space track where cyclists and pedestrians freely share the area.

Cycle lane delineators



Narrow, divided tracks can be a problem despite their different surfaces.

The use of cycle lane delineators rather than kerbs may be practicable for economic reasons. The basic idea of a cycle lane delineator is to achieve the benefits of a cycle track without the drainage and construction costs of a kerb. Cyclists generally feel more secure on tracks with cycle lane delineators than in mixed traffic. The reaction to a cycle lane delineator may be negative if the delineator is not clearly visible;

crossing pedestrians will often trip over it. Cycle lane delineators are available in a wide variety of shapes and materials including rubber, plastic, concrete, asphalt and stone.

The delineator can be made visible by starting as a traffic island in an intersection. Painted lines and different road surfacing may be used to clearly indicate the delineator on road sections. At driveway entrances and exits, delineators made of concrete or asphalt and barrier kerbs should be provided with ramps. Other types of delineator should be dropped entirely during the interval.

Delineators may be damaged by the tire pressure of lorries and buses. Drainage should take place through min. 30 cm wide holes in the delineator. The holes should be placed 1 m upstream from the gully or at even intervals in non-sewered areas. The impact of delineators on the number of cyclists has not been established. [9.44](#)

Delineators should not be used where many pedestrians cross the road. Like kerbs, delineators should be approx. 10 cm high to achieve good segregation to the carriageway. Delineators hamper winter maintenance as they are easily damaged on impact.

Creative solutions for the future might involve such measures as computer controlled lighting sequences placed along cycle lane delineators.

Other physical segregation

Other types of physical segregation are available, such as bollards. However, it is important to set

them 30 cm back into the pedestrian area rather than at the normal kerb line so that bicycle baskets and pedals don't hit the bollards.

Standard cycle tracks

The kerb height to the carriageway on road sections should be 7 cm min. and 12 cm max. Between the cycle track and the pavement, the kerb height on road sections should be 5 cm min. and 9 cm max.

The stated kerb heights offer a number of benefits:

- Most drivers of motor vehicles refrain from parking on cycle tracks.
- Motor vehicles exiting and entering building areas do so very slowly.
- Drainage can function perfectly well.
- Cyclists rarely bike on the pavement; thanks to the kerb pedestrians are aware that they are leaving the pavement.

The given heights are based on a balanced assessment of positive and negative factors such as cyclist and pedestrian falling accidents and mobility for the disabled.

Drainage facilities involve gullies on the carriageway and the cycle track. If gullies on the cycle track are to be avoided, the entire road bed needs to be lowered. Gully grates on cycle tracks do not seriously affect the section of the cycle track that is used by cyclists since cyclists maintain a safety margin to the kerb. However, depressions around the grate pose a problem.

The area between pedestrians and cyclists is only segregated by bollards.



When the transverse inclination is towards the pavement, side-entry gullies may be established that do not take up space on the cycle track surface. This is particularly important if the cycle track is very narrow.

Parked cars

On sections where there is a high demand for waiting and parking, a longitudinal island can be placed between the carriageway/parking lane and the cycle track, with a recommended width of 1.0 m. No kerb is necessary between the island and the cycle track. The island and the cycle track should have different surfaces. Alternatively, the cycle track may be widened 1 m.

Cycle tracks result in a major drop in the number of accidents between cyclists and parked cars. In Denmark motor vehicles are not allowed to wait or park on cycle tracks.

A pedestrian refuge between the cycle track and the carriageway at pedestrian crossings improves pedestrian safety on roads with parked cars without a cycle track, and means that pedestrians don't have to wait on the cycle track. Another option is to remove a number of car parking spaces and establish a median refuge area in the pedestrian crossing.

Bus stops

Cycle tracks may increase the number of bicycle accidents at bus stops if no safety measures are taken. Accidents involving bus passengers leaving



Be careful with drainage construction. The hole here around the grate is much too deep.

the bus primarily occur when the waiting area is narrow or lacking, while accidents involving passengers entering the bus occur at bus stops with wide waiting areas. At bus stops without waiting areas, virtually all accidents are between passengers leaving the bus and cyclists.

Studies of bus passengers and cyclists at bus stops without a waiting area have shown that zebra crossings significantly reduce cycling speeds while the bus is waiting at the bus stop and that the number of serious conflicts between cyclists and bus passengers is reduced. Give-way markings, rumble strips, and road surface markings do not provide the same benefits as zebra crossings. [9.46,9.47](#)

However, according to the Danish road standards, it is no longer legal to establish zebra crossings on cycle tracks. Dreams of the future involve intelligent lights on buses that project zebra crossings onto the cycle track, or vehicle actuated

bus stops that can morph into waiting areas and zebra crossings.

It's a good idea to establish a section of standard cycle track, i.e. with a kerb, between the cycle track and the pavement at bus stops on roads with lane delineated cycle tracks.

Bus stops before intersections should be placed at least 20 m from the intersection. Otherwise waiting buses will negatively affect cyclist safety and make cyclists less visible to other road users. Bus stops must never be placed directly before the stop line at signalized intersections since waiting cyclists block the way for passengers

Bus stops with a waiting area make it easier for passengers to cross the cycle track without coming into conflict with cyclists.



If there is no waiting area, a special surface at the bus stop can indicate the crossing point.



The cycle track runs behind the waiting area.



The pedestrian refuge between the cycle track and the carriageway enables pedestrians to cross the street more safely.



getting onto or off the bus. Bus stops should preferably be placed after the intersection, allowing the bus easier passage.

A waiting area should be at least 1.5 m wide and should be made of another surface than the cycle track. At bus stops with many passengers entering and leaving the bus, a 2.5 m waiting area ensures that the waiting area doesn't become overfilled and that passengers with prams can safely enter and leave the bus.

The second most dangerous traffic situation is entering and leaving the bus, say elderly pedestrians along Frederikssundsvej in Copenhagen. Around half the elderly frequently experience problems with cyclists at bus stops.

9.48

Designing the start and the finish

The cycle track's start and finish is a key element of the detailed project design. Ramps to and from the track should provide a smooth transition between the road and the track, which is best done by continuing the cycle track surface but dropping the segregating kerbs. Existing kerbs, formerly often used to mark the end of the track, may usefully be removed.

Terminating the cycle track in mixed traffic can be done by a 15-20 m wedge shaped traffic lane expansion. A solid white line should be painted 15-20 m into the traffic area from where the

cycle track terminates. When a cycle track is continued as a kerb lane or a cycle lane the kerb lane width should remain the same as the cycle track width; cyclists should be able to continue straight ahead without having to move sideways. When a cycle track terminates abruptly motorists should be made aware of this by signage and an approx. 1 m wide island, which can prevent overtaking accidents.

When cyclists need to enter and exit a cycle track from a side street, provisions must be made so that wide bicycles and trailers can turn the corner. The city of Copenhagen has begun to paint approaches white to make them easier to find.

TWO-WAY CYCLE PATHS

Two-way cycle paths may be established through recreational areas, as a short cut between cities, as a cycle path system in residential areas, or along major roads with few intersections.

Two-way cycle paths often function as a shared-use path for pedestrians and cyclists. Two-way paths have a self-contained cross profile independent of adjoining roads.

Two-way paths can be divided into two main groups:

1. Two-way path along a road.
2. Segregated off-road cycle path or greenway through green open spaces, residential areas, etc.

Two-way path along a road

Two-way paths along roads should only be established after a safety assessment of conditions in the area. The assessment should include options for other solutions for vulnerable road users. Two-way cycle paths should only be established in exceptional cases, but may be the right solution if a school, ball field, etc. is located outside the city, and a two-way path would eliminate the need to cross the road in open country.

Two-way paths give the individual cyclist more space, but are not as safe as one-way tracks at intersections and driveway entrances and exits. Two-way paths are cheaper to install than one-way cycle tracks.

Two-way cycle paths along the road should not be placed where there are many side roads or driveway entrances and exits crossing the path, e.g. through cities. Safety issues arise when the two-way path crosses a side road because motorists often don't realize that there may be cyclists coming from the "wrong" side. The solution here is to establish a one-way cycle track on each side of the road instead.

Two-way paths in the countryside should be established on densely trafficked roads with ample space, for example along motorways and heavily trafficked highways. From the safety point of view it is often best to place the two-way

Uncomfortable, dangerous, and unlit.



This smooth transition and logical continuation of the path is preferable.



Two-way cycle path along the road segregated by a crash barrier.



cycle track on the side of the road with the least amount of side roads and driveways. On the other hand, if cyclists use the side roads it may be safest to place the two-way cycle track on the same side as the side road. The need for traffic islands, etc. should be considered where the two-way path terminates.

Segregated, off-road cycle paths

A segregated off-road cycle path usually means that it is far away from motor traffic. Paths through recreational or residential areas offer shorter, safer, more scenic and more secure routes where the focus is on cycling and cyclists. In residential areas the paths create favourable conditions for children and elderly cyclists in particular. Pedestrians are also allowed on such paths.

Small children can use a segregated off-road cycle path without adult accompaniment provided the path doesn't cross major roads on the same level. The paths may also be used to provide cyclists with shortcuts between primary destinations such as schools and shopping sites. Segregated, off-road paths may be included in a general traffic plan for the separation of traffic modes, forcing motor traffic to make a detour in relation to cycle path traffic. Segregated, off-road paths may also be established with a view to boosting cycle tourism and recreational activities.

A segregated off-road path occasionally means that the cyclist has to make a detour. Cyclists

Segregated, off-road path.

often have the give-way duty if the path crosses a road, which makes the path less passable for cyclists. Paths can have a smaller curve radius on horizontal and vertical curves than roads.

Segregated off-road paths should be well lit and airy, and be clearly visible from the road or residential area in the interests of crime prevention and security when it's dark. This is especially important at tunnels.

Cross profile

The path should be dimensioned so that two cyclists with trailers can pass each other. If space for pedestrians is required, the width should be increased. A two-way shared-use path should be 3 m wide minimum and (according to road standards) a two-way cycle track 2.5 m wide minimum with a separate walking area alongside. Path width is crucial to cyclist comfort and passability. The given widths allow two people to cycle abreast and chat during the journey.

In urban areas the verge between the carriageway and the two-way path should be 1.0 m wide minimum.

The verge along highways should be 1.5 m wide minimum. The recommended verge width along primary roads is 3 m. For narrower verge widths a crash barrier is recommended. If the two-way path is closer than 15 m to a motorway or expressway, crash barriers should be installed between the path and the road. **9.50**

Horizontal and vertical radii

On two-way paths, bends in the road must be designed with a clear line of sight to oncoming path users in order to prevent dangerous situations. This also applies to bends at tunnels, intersections with other paths, etc. If mopeds are allowed on the path the curve radii should be dimensioned for the moped line of sight.

If it proves impossible to establish an adequate line of sight, the two directions of travel should be segregated by a median, verge, etc. A cheap solution is a painted barrier separating the two directions.

A horizontal curve (to the right or to the left) should be passable at 30 km/h for bicycles and mopeds. When the horizontal curve is combined with a vertical curve it may be necessary to dimension the area for higher cyclist and moped speeds so cyclists can get around the curve without crashing. In horizontal radii of less than 50 m a transverse inclination toward the bend's centre may be necessary.

As a minimum there should be a clear line of sight to oncoming traffic in vertical bends (upwards and downwards) on two-way cycle paths. On cycle paths and tracks with moped traffic, track dimensions should be based on mopeds.

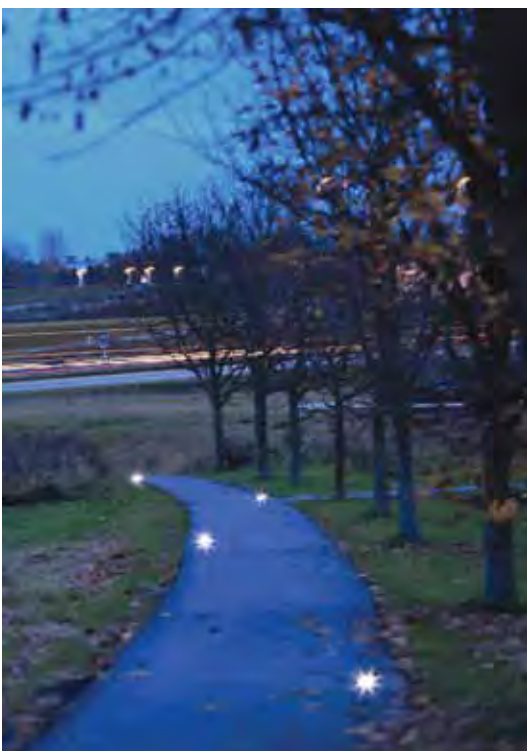
Gradients

As everyone knows, cyclists have to provide the energy needed to propel the bicycle forward themselves. Steep gradients on the path have a tremendous impact on the number of cyclists using the path. Furthermore, cyclist safety is closely linked to the steepness of the gradient. It is therefore necessary to calculate a maximum gradient factor on cycle paths.

The amount of energy expended by a cyclist going uphill defines the limits of the length of the incline and the gradient. It is economically feasible to design segregated off-road paths in such a way that the longitudinal inclination poses no problem for cyclists. The gradient of the cycle path should be steeper at the bottom of the hill than at the top.

Cyclist safety drops if a steep incline is combined with a sharp horizontal curve. At a gradient of 50 ‰ the path should be dimensioned for 40 km/h and at a gradient of 30 ‰ for 36 km/h. Extreme care should therefore be taken with tunnels and bridges especially.





When there is no street lighting solar powered LEDs can be an excellent means of indicating the course of the path, here outside Aarhus.

Intersecting paths

Intersecting paths have hitherto been a neglected area in Denmark. When paths intersect each other the line of sight is important so that cyclists and moped riders can see oncoming traffic. Planting along the road, should be trimmed regularly so it doesn't get in the way of the line of sight. Clear give-way rules are crucial when there are many cyclists and a clear line of sight cannot be established.

When speeds at cycle path intersections are too high, either because the intersection is at the bottom of a hill or because cyclists don't observe the give-way rules, traffic calming measures for cyclists can be used, such as speed hump crossings or ramps. Paths where the cyclist has to give way can be designed by establishing

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

an uphill incline to the primary path. Since the purpose of cycle paths is to improve cycling conditions, bicycle traffic calming should only be used when there is a real problem.

Intersections between paths and roads

At intersections between paths and roads, and when cycle paths terminate, conflicts arise between motor traffic and cyclists. It is particularly important that those who have the give-way duty recognize the conflict. A sight line that is equally clear in both directions is crucial.

When motorists have to yield, physical traffic calming or signalization is needed to make motorists realize and observe their give-way duty. If motorists are not affected by traffic calming or signalization, cyclists must be compelled to give way instead for safety reasons.

Segregated off-road paths can be designed in many different ways to encourage cyclists to



The cycle path crosses the road on a raised surface, and motorists have to give way to cyclists.

observe their give-way duty in situations where the cycle path crosses a road. When the cyclist has the give-way duty, the distance between the road-cycle path intersection should be at least 30 – 40 m from any other intersection. Various stop signs, compulsory give-way signs, or give way-lines may be used in connection with other solutions. Speed humps, ramps or rising inclines to the road may be installed. Another option is to establish an actual crossing like at side roads, where a pavement or verge is designed with a raised surface consisting of flagstones, sett paving, etc.

In Odense and Aarhus solutions were tested in which cycle path barriers were replaced by speed humps, bollards and give way lines. The speed humps were generally experienced positively by cyclists who found them more comfortable and less inconvenient. On the basis of the pilot project it is being considered whether to raise the arrow height to 15 cm minimum. The city of Aarhus has decided not to replace barriers with speed humps on school route sections and when the path intersects a road. Cycle paths are signed as shared-use paths; there should always be a difference in level and an asphalt ramp where the path joins the road.



The traffic signal is activated by detectors on the path so cyclists rarely have to stop for other crossing road users.

Finally, barriers may be used to compel cyclists to observe their give-way duty. This is effective, but inconvenient for all path users. Sometimes barriers are used to prevent motor vehicles from entering the path, but bollards with reflectors are equally effective.

Barriers should only be used in the rare cases where cyclists risk serious injury from collision. The barriers should be placed approx. 15-20 m from the edge of the road so that the cyclist has ample time to manoeuvre into position. The first barrier should always be placed on the right as Danes drive on the right side of the road. Barriers and bollards should be well lit and be visible from the path at a distance of 30 m minimum. When barriers are necessary, they should be placed in such a way that cargo bikes and bicycles with trailers can pass through at low speeds without having to stop.

Many two-way paths along highways terminate at the city outskirts. The termination may be combined with traffic calming measures at a town gate. A median island enables cyclists to cross the road in two phases. Since it is important to avoid unsuitable, two-way bicycle traffic along the side of the road in urban areas, cyclists should be able to cross the road easily at the termination of the two-way cycle path. On heavily trafficked roads tunnels and bridges may be the right solution.

The transition from one two-way path to two one-way tracks is solved by a median traffic island that helps cyclists get to the other side of the road.



Barriers are set up to reduce moped speeds.

When segregated off-road cycle paths terminate at a through road section, motorists should not be compelled to give way. The same design should be used as when cycle paths cross a road. Segregated off-road cycle paths may usefully terminate at the end of a dead end road.

Many cyclists will try to bypass speed humps, ramps, barriers, etc. Such attempts are best thwarted by installing 10-15 cm high kerbs on

both sides of the path or by erecting a railing. The kerb and the railing should be constructed in such a way that the cyclist would have to bike approx. 20 m from the path itself to avoid the barrier.

A good alternative to a barrier is to install short cyclist speed humps to make cyclists give way. This reduces cycling speeds without forcing the cyclist to stop.

Other measures

Cyclists seldom use unlit segregated off-road paths and greenways in the dark. They use the road network instead, or they don't bike at all. Bike lights do not light up the path. Lighting on segregated, off-road cycle paths should therefore illuminate the entire path in such a way that a cyclist riding at 25 km an hour can easily distinguish the path from the surrounding area; otherwise the lighting is worthless. If funding is not available for proper path lighting, solar powered LEDs provide a reasonable alternative.

Safety

Segregated off-road cycle paths are very safe for cyclists and make them feel secure. The typical bicycle accidents on this type of path are solo accidents or collisions with pedestrians, mopeds and other cyclists. A number of accidents are due to slippery roads, high speeds, sharp bends, poor lines of sight, and unclear give-way rules at path crossings. It should be noted that the vast majority of accidents on segregated off-road cycle paths are not registered by the police, perhaps as many as 95-99%.



Two-way paths along roads are the cause of far more safety issues. On paths along primary roads the problem is that left turning motorists from the primary road and right turning motorists from the secondary road do not see the cyclist coming from the “wrong” direction. This causes accidents, although they are rarely very serious. Blue cycle crossings and signage rarely address the problem. Better solutions are raised surfaces, roundabouts, separate signal phasing, and cycle path tunnels and bridges, or else cyclists should

simply be compelled to give way to motorists. If the separate signal phase for cyclists doesn’t follow the pedestrian phase, there is the risk that cyclists will go when the light is green for pedestrians.

A more radical solution is to set the two-way cycle path stop line approx. 30 m back from the intersection, compel cyclists to give way to motorists and help them cross the road by installing a median refuge island.

and smooth road surfaces are a key element.

New cycle route concepts are emerging such as the cycle superhighway or super route, which aim at giving preferential treatment to cycle commuters over greater distances. Some routes involve segregated, off-road paths. Other routes give cyclists special priority on one-way cycle tracks.



Rocks are dramatic in daylight, but difficult to see in the dark.

Cycling promotion

If segregated off-road cycle paths are to be used to boost cycling, it is crucial to realize that cyclists are the target group. Cyclists should receive preferential treatment in cycle promotion projects which means that motorists will often be compelled to give way to cyclists. Cycle paths should serve as shortcuts for cyclists while providing an enjoyable experience. Furthermore, cyclists should be able to ride fast (no sharp curves or narrow passages); wide cross profiles

Accidents involving cyclists coming from the “wrong” direction often occur in signalized intersections like this one where there are two-way cycle tracks; motorists overlook cyclists and cyclists don’t always follow the rules.



GIVE-WAY REGULATED INTERSECTIONS

There are two types of give way controlled intersections, i.e. duty to give way to the right, when the road user has to give way to traffic coming from the right, and duty to give way, when the road user coming from a secondary road has to give way to all traffic on the primary road. Intersections regulated by a stop sign are a third option.

Stop signs have an approx. 10 times greater traffic safety effect than the duty to give way. Stop signs and give-way-to-the right intersections are rare in Denmark. The duty to give way is considered preferable to giving way to the right because giving way to the right results in more accidents. Some road users ignore the duty to give way to the right while others find the rules confusing. Giving way to the right is more common abroad. It may be an option to replace the duty to give way to the right with the duty to give way.

The most serious cyclist casualties in give-way regulated intersections are crossing collisions and left turn accidents. Serious cyclist accidents occur primarily when cyclists are crossing a primary road. [9.51](#)

Visibility and give-way rules

It is crucial that give-way rules at intersections are very clear. This can be done by road marking,

traffic islands or clearly marked traffic calming, for example crossing treatments.

Line of sight at intersections depends on bends, planting, lighting, etc. Line of sight at intersections is crucial to the traffic safety of all road users. It is essential that the line of sight is equally clear in both directions since otherwise road users are so focused on traffic from the direction where the line of sight is impaired that they forget to look in the other direction.

Parked cars close to the intersection make it difficult for road users to view traffic clearly. This can be a problem for road users coming from secondary roads as well as for road users on primary roads. Cyclists on the primary road should be visible both to road users coming from secondary roads and to motorists turning off the primary road at least 20 m before the intersection. When there is a longitudinal incline on the primary road the distance should be greater, e.g. 24 m at 20 % and 30 m at 50 m %. This may affect parking facilities in the vicinity of the intersection.

The intersection should be easily recognizable. It should be noted that buildings, planting and parked cars can be visually perceived as an unbroken line, which makes it difficult for cyclists to realize that there is an intersection ahead. Intersections can be made more visible by prohibiting parking, removing some planting, and by road markings.

The verge between the cycle track and the carriageway should be removed at a reasonable distance before the intersection, partly to make cyclists more visible and partly to ensure optimal line of sight from the secondary road.

At major give-way controlled intersections, for example where the primary road has 4 lanes, left turns are difficult. There is a relatively high risk that a left turning motorist may overlook cyclists. Road marking can remind motorists that cyclists are present, but there are other solutions as well, such as roundabouts or traffic signals.

Continuous cycle tracks through intersections

At intersections with small amounts of traffic on the secondary road, the cycle track should be continued through the intersection. A continuous cycle track has a traffic calming effect on motor vehicles entering and leaving the intersection on secondary roads since they are compelled to cross the cycle track and frequently the pavement as well. Crossing in this fashion makes it easier for road users on secondary roads to understand and observe the give-way rules. A study of cyclist safety in minor intersections further showed that the number of bicycle accidents dropped by up to 50% when secondary roads were crossed on continuous cycle tracks and/or pavement. [9.52](#) A more recent study showed a drop of up to 25% in the number of bicycle accidents as well as major benefits for pedestrians. [9.53](#)

Parked cars are part of daily life.



A safe crossing with an excellent line of sight is produced by shortening the cycle track, adding a blue cycle crossing, and continuing the pavement.

To make the cycle track more visible as it runs through the intersection, the cycle track can be made of another surface, or cycle symbols, checkered patterns, etc. can be painted on the road surface. Behavioural studies indicate that motorists and cyclists are more vigilant of each other with a white checkered pattern through the intersection. 9.54

Shortened cycle track

At intersections with greater amounts of traffic the cycle track can be dropped to the level of the carriageway before the intersection. A shortened cycle track is more dynamic since turning traffic can drive faster. On the other hand cyclists are on the same level as motor traffic in the intersection, but this may get everyone up on their toes.

A shortened cycle track can be continued as a cycle crossing through the intersection so as to clearly identify the cyclist circulation area. In high risk areas for cyclists and moped riders the cycle crossing may be marked in blue.

At give-way controlled intersections in open country the cycle track is almost always shortened. Right turn lanes should be avoided because right turning motor vehicles interfere with secondary road users' line of sight. However, with high volumes of motor traffic, right turn lanes may be established by painted barriers or traffic islands between the right turn lane and the carriageway. The verge should be removed from such intersections.

Shortened cycle tracks that continue into the right turn lane are not generally recommended for give-way regulated intersections. Instead, traffic turning off the primary road should be compelled to go very slowly. However there are a few positive examples of shortened cycle tracks in give-way regulated intersections where cycling speeds are high.



Small curve radii may encourage turning motorists to reduce speed when the cycle track is not continued across the side road.

Cycle lanes

When a cycle lane along a primary road continues to the intersection, a marked cycle crossing



Blue cycle crossing on give-way controlled, continuous cycle track.

should be established through the intersection. An accident study of bicycle accidents in give-way controlled T intersections in urban areas showed that accidents were less severe when an existing cycling facility continued through the intersection as a cycle crossing. 9.55. To prevent crowding between cyclists and motorists the cycle lane may be indicated by a profiled, 30 cm line on the last section before the intersection. A continuing pavement would also improve cyclist safety.

Set back cycle track

In intersections with dense traffic on the primary road it's a good idea to set the cycle track 5-7 m back from the road and run the track over the secondary road on a raised surface. Setting

the track back makes it easier for road users to and from the secondary road to be prepared for conflicts with cyclists and also provides them with a clear line of sight to the intersection. The track should be set 5-7 m back so there is enough space for a standard passenger car to wait without inconveniencing other traffic. The raised surface compels motorists to respect their give-way duty and prevents them from waiting on the cycle track. If this solution is chosen, it must be made very clear to motorists that they have to give way to cyclists. Set-back cycle tracks should not be established where many lorries use the secondary road as there isn't enough room for them to wait in the waiting area outside the cycle track.

Set-back cycle track. The bend means that cyclists can't bike through the intersection faster than 20 km/h; motor vehicles have a waiting area on the outer edge of the cycle track.



Mixed traffic

In mixed traffic it's a good idea to establish crossings on secondary roads by continuing the pavement through the intersection. 9.56, 9.57 In addition, curve radii should be relatively small. Pavement crossings do not seem to affect cyclist safety but have a highly favourable impact on pedestrian safety.

Two-way cycle tracks

Two-way cycle tracks and give-way controlled intersections are a bad combination; they cause safety issues that are difficult to address when the track runs along a primary road. If the track runs along a secondary road instead and crosses the primary road, the problem is smaller.

When two-way cycle tracks are established along primary roads, the conflict at the intersection must be made very clear to cyclists and motorists alike. Two-way cycle tracks should always continue to the intersection. 9.58

Space permitting, the cycle track should be set 5-7 m back from the primary road and cross the secondary road on a raised surface.

The alternative is to set the track 30-40 m back from the primary road and compel cyclists to give way to motorists. This means that cyclists have to give way to all traffic on the secondary road. This solution is not particularly cyclist friendly but may be necessary for safety reasons and from the point of view of motor traffic flow. It's necessary to set the track 30-40 m back from the intersection since it's impossible for a cyclist to relate to traffic coming from all directions at once when actually at the intersection. There are intersections, however, where a 10-15 m setback has proved sufficient.

Traffic calming

The intersection may also be constructed on a raised surface. However, it is uncertain whether a raised intersection affects cyclist safety. Raised, give-way controlled intersections may make the give-way rules appear unclear, so the appropriate give-way rule should be clearly marked.

In rural areas especially, traffic calming islands make it easier for road users to see the intersection.



SIGNALIZED INTERSECTIONS

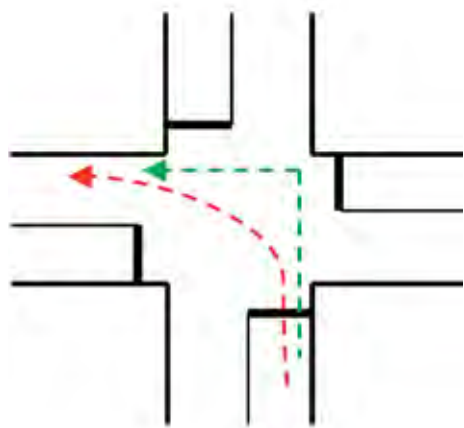
Signalized intersections are often established to improve traffic flows, road safety and security. When cross traffic streams are separated by timing intervals, the likelihood of crossing collisions is reduced. On the other hand a traffic signal means a concentrated time interval of conflict between turning road users and road users that are going straight ahead, which is usually not resolved by regulating the signal. 9.59

The typical cyclist casualty in signalized intersections involves left turning and right turning cars and crossing collisions when cyclists cross on red. Signalization has a highly favourable impact on safety outside the intersection; in urban areas the beneficial effect is approx. 1.5 times greater than the benefit in the intersection itself. 9.60

Cyclist visibility partly depends on the geometric and visual size of the intersection. Parked cars and waiting buses near the intersection may reduce cyclist visibility.

Right turn/left turn arrows for motor vehicles

At intersections without a separate cyclist signal, cyclists have to use the motor vehicle signal. Arrow signals apply to all road users who wish to travel in the direction the arrow indicates. According to the Road Traffic Act, however, cyclists in Denmark may not follow the motorists' left turn arrow since they have to turn left in two phases: first they have to proceed to the opposite corner of the intersection and only then may they complete their left turn when it can be done without inconveniencing other traffic, independently of whether the signal is green or red. 9.61 This rule is not commonly



When an intersection has a compulsory left turn signal for motor traffic, the number of accidents between left turning motorists and on coming cyclists in major intersections with many traffic lanes is reduced.



Separate left turn phase for cyclists while cyclists going straight merely observe the give-way rules.

known, however, which is why cyclists need space at the intersection's corners where they can wait for the green signal.

Cyclist signals

At intersections where cycle tracks or cycle lanes continue to the stop line, a separate cyclist signal may be installed. In this way cyclists have their own signal phase, wholly or partially. Cyclist signals can be used for pre-green for cyclists several seconds before motor vehicles. This gives

cyclists who have been waiting for red a head start in relation to motor vehicles, rendering them more visible. The aim is to reduce the number of conflicts between motorists and cyclists.

In addition, cyclist signals are used to shorten the green phase for cyclists in order to make the intersection more easily passable for motor traffic. In intersections with separate cyclist signals cyclists must always observe the cyclist signal.

Pre-green for cyclists may reduce the number of accidents occurring in the initial part of the green phase.



In intersections with two or more turn lanes traveling in the same direction from an approach leg, the turn lanes should have a separate turn phase as it can be difficult to see cyclists. This shortens the green phase for cyclists going straight or turning left.

In Denmark cyclist signals with a countdown function have not yet been tested. Perceived waiting time is significantly reduced, and a countdown signal might counteract cyclists' tendency to cross on red, as it does in the case of pedestrians.



Dutch count-down signal for cyclists.

Detecting cyclists in vehicle actuated traffic control systems

In vehicle actuated systems the length of the green phase is controlled by traffic coming from different directions. Motor vehicles activate the signal by a loop or wire buried in the road. Bicycles may be detected by loops, or manually by pressing a pushbutton. In some areas pedestrians and cyclists press the same pushbutton; elsewhere they may have separate posts.

The optimal solution for cyclists is both a magnetic loop and a separate, manual cyclist pushbutton, which should be mounted on a low post at the stop line. When a cyclist has been detected a small light on the post flashes. If contrary to expectation the light doesn't flash, the cyclist may then activate the signal by pressing the pushbutton.

If loops are laid in the cycle track/cycle lane well in advance of and up to the stop line, cyclists will be detected in ample time for the signal to change from red to green or to prolong the green phase so that cyclists don't need to stop.

In some intersections left-turning cyclists can only be detected by placing loops before the stop line. To prevent crossing cyclists from falsely activating the signal, the loop has to be kept covered for at least 2 seconds.

The advantage of magnetic loops is that cyclists only have to wait for shorter periods and don't have to press a pushbutton. Manual detection has the disadvantage that not all cyclists are aware that they have to press a pushbutton and may become impatient and cross on red. The disadvantage of automatic cyclist detection is that cyclists have to stop within a well-defined area in order to be detected. This area should be marked if a self-explanatory solution proves too difficult.

Only vehicle actuated systems will be used in future, according to coming Danish road standards. Coordination will be possible, however, but not an actual timer controlled system. The new road standards are expected to be passed in 2012.

Bypassing traffic signals

In signalized T-intersections when the cycle track continues to and through the intersection and there is a set-back stop line for cars, cyclists going straight ahead may be allowed to ride past the traffic signal. This reduces the number of stops and passability is improved.

The traffic signal post should be on the left of the cyclist going straight ahead. Otherwise a "Cyclists excepted" sign should be placed under the traffic signal on the signal post.

This may be combined with a left turn lane for cyclists. Cyclists must give way to pedestrians in the pedestrian crossing so this solution is most suitable where there are few crossing pedestrians. Another option is to install an island between the cycle track and the carriageway to clearly indicate the different give-way rules (traffic signal vs. pedestrian crossing). An island may also make it possible to remove the pedestrian crossing area from the cycle track.



Cyclists going straight ahead pass the traffic signal, while cyclists turning left have their own signalized lane.

In signalized intersections with ample space, a right turn lane for cyclists may be established behind the traffic signal post ("shunt"). In this way right turning cyclists don't have to stop for red. This solution is very popular among cyclists, but not always popular among pedestrians so it's best to use it where there are no major pedestrian streams.

Right turn allowed for cyclists

Danish studies show that approx. half the right turning cyclists that arrive at a signalized intersection on red, turn right on red. Cyclists may be allowed to turn right on red by changing the signage and road marking. The solution makes it clear to motorists that they must give way to the remaining cyclists crossing on green. Denmark doesn't have enough experience with the solution to be able to draw conclusions as to the safety effect. On the face of it however, it would seem that a more flexible traffic regulation might encourage cyclists to be more law abiding.

Continuing the cycle track/cycle lane up to the intersection

In signalized intersections where cycling speeds are not particularly high, the basic rule is continue the cycling facility to the stop line, and then mark out a cycle crossing through the intersection. When cyclist speeds are high because of an incline, for example, and there are no right turning lanes for motor vehicles, it is safer to continue the cycle track or cycle lane to the intersection than to shorten it. Set-back stop lines for cars and blue cycle crossings enhance safety further. The advantage of continuing the cycle track/lane to the intersection is that it meets cyclist requirements to have their own area and makes them feel secure.

In intersections with many right turning lorries, however, one should proceed with caution before continuing the cycle track/lane to the intersection as lorry drivers have a blind spot on the right and have difficulty perceiving cyclists. ^{9.63} Many safety issues with lorries can be addressed by setting the stop line for motor vehicle traffic 5 m behind the pedestrian crossing and establishing a cycle crossing through the intersection.



Cyclists can take a short cut to the right, past the traffic signal.



Cyclists are always allowed to turn right here, but mind the pedestrians!



Set-back stop lines do not generally reduce intersection car capacity.



Shortened cycle track continued as a narrow cycle lane up to the stopline.



Safe crossing for pedestrians across the cycle track.

When a cycle lane continues to the intersection, squeezing between cyclists and motorists may be prevented by separating the cycle lane from the carriageway by a profiled white line.

In order to make room for a right turn lane and create better interaction between right turning motorists and cyclists going straight ahead, a wide cycle track/lane may be continued as a narrower cycle lane for the last 20-60 m before the stop line. This may reduce cycling accidents with right turning motor vehicles, but in situations with high volumes of bicycle traffic capacity may be reduced if the solution is not combined with a bike box before the right turn car lane.

Shortened cycle track/cycle lane

In signalized intersections with fast moving cyclists, for example when the cycle track has a steep incline, it is usually significantly safer to shorten the cycle track/lane. The cycle track should be shortened 20-30 m minimum before the intersection (the distance depends on the number of right turning motor vehicles; a long combination vehicle is 25 m long). In this way cyclists and motorists move on the same level, are physically closer to each other, and are both responsible for any conflicts that arise. To make sure that motor vehicles as well as cyclists have ample space, the right turn lane should be 4 m wide or more. This solution is also appropriate where there are many mopeds. However, if the only way to make room for a right turn lane for motor traffic is to drop the cycle track/lane, the safest solution is probably to establish a right turn lane and shorten the cycle track.

In intersections with a shortened cycle track there should be no driveway entrances and exits on the "shortened" section before the intersection. Shortened cycle tracks/lanes should not be used in intersections where there are many children since it is an insecure solution, and children bike slowly. Insecure solutions may mean that fewer people feel like cycling on that section.

Set-back stop lines

It is recommended for all signalized intersections to set motor vehicle stop lines in all traffic lanes 5 m back from the pedestrian crossing or the cyclist stop line. Set-back stop lines increase pedestrian and cyclist visibility when signals change and allow vulnerable road users to enter the intersection first, thereby preventing a number of conflicts. An accident study found a drop of 35% in the number of accidents between right turning cars and cyclists going straight ahead, and a drop of 50% in the number of cyclist casualties in this type of accident. ^{9.64}



In fatal accidents, when a bicycle/moped is hit by a right turning vehicle, 90% of the time the other vehicle is a lorry. 9.65 Set-back stop lines render cyclists, particularly, more visible to lorry drivers. At the time of writing a new study of set-back stop lines is being prepared.

Cycle lane between motorists' right turn lane and lane for straight ahead traffic

At large signalized intersections a cycle lane may be established between the motorists' lane for straight ahead traffic and the right turn lane. The idea is to replace the conflict between right turning cars and cyclists going straight ahead with a less dangerous merging situation before the intersection. This also renders cyclists going straight more visible to oncoming, left-turning motorists. This measure may be combined with a cycle track in the intersection area. An accident study has not been able to document a safety effect, however. 9.66



Cycle crossing between motor vehicles' right turn lane and lane for straight ahead traffic.

Mixed traffic

At approaches to signalized intersections with mixed traffic, a short, narrow (1.5 m) cycle lane may be established the last 20-50 m before the intersection. Cyclists thus have their own area for entering the intersection, which makes the area more easily passable and makes cyclists feel more secure. We don't know whether this is better than nothing from a safety point of view. The solution makes it possible to mark a cycle crossing through the intersection. A cycle crossing may be marked through an intersection even if there is no cycling facility directly before the intersection.



There are too many blue cycle crossings here.

Cycle crossings running through intersections

A cycle crossing may be established when it is deemed necessary to draw attention to potential conflicts between cyclists going straight ahead and turning motorists. In addition to clearly indicating the conflict area, the cycle crossing visually separates cyclists going straight from motorists and makes cyclists feel more secure.

In Denmark there are four types of cycle crossings: one is blue, others consist of white, dashed 0.3 m wide lines. Cycle crossings are always marked with cycle symbols.



Blue cycle crossing at signalized intersection where there are major streams of oncoming, left turning motor traffic.

An accident study of cycle crossings in signalized intersections showed that cycle crossing marking has resulted in a 36% drop in the number of bicycle accidents and a whopping 57% drop in the number of serious cyclist casualties. The study further showed that when cycle crossings were established in major intersections the greatest

reduction occurred in accidents between left turning cars and cyclists going straight ahead. It seems that motorists move part of their focus from pedestrians to cyclists since there was a rise in pedestrian accidents. 9.67 Another

study indicated that 1 blue cycle crossing per signalized intersection produces a safety benefit, but 2 blue cycle crossings should only be established exceptionally, and only in signalized T intersections. 3 and 4 blue cycle crossings actually

increase the number of accidents. The blue cycle crossings should be placed where most of the accidents between cars and cyclists take place.

9.68

Bike boxes

Bike boxes may be established at signalized intersections by painting the cycle symbol in front of the motorist stop line in turning lanes. This enables cyclists stopping at red to get ahead of cars. It has the advantage that cyclists stopping at red are more visible to turning cars, and cyclists enter the intersection before cars. Bike boxes before left turn lanes may only be marked on secondary roads in signalized T-intersections (not in 4 armed intersections). At the time of writing a special dispensation from the road standards is needed to establish a bike box in Denmark.

A study of left turning cyclists in bike boxes in Copenhagen showed that bike boxes make cyclists feel more secure and more satisfied. All the cyclists interviewed felt that the bike box renders them more visible to motorists and that the bike box makes circulation easier. 9.69

However bike boxes should be used with caution when there are many heavy vehicles. A lorry driver cannot necessarily see cyclists directly in front of the lorry.

Channelising cyclists at intersections

In intersections with a large modal share of cyclists, cyclists may be usefully channelised into separate right turn lanes and lanes going straight ahead. The advantage of channelisation is that it places cyclists in the best position for entering the intersection. The cycle lane should be wide enough for two cyclists to stop abreast of each other, i.e. at least 1.85 m. 9.70 Without channelisation there is the risk that cyclists will use the pavement or stop ahead of the stop line, in the pedestrian crossing, or in front of cars. On the other hand, a right turn cyclist lane should not be established where there are relatively few right turning cyclists.

In intersections with mandatory right turn signals or separate right turn phases, cyclists should always be channelised. In practice it may be difficult to find sufficient space for cyclists waiting at the intersection to prevent the queue of cyclists from becoming so long that the last cyclists can't make it through the first green phase. When there are many right turning cyclists, an island between the right turning cyclists and the cyclists going straight ahead is a good idea; cyclists turning right don't necessarily need a traffic signal; the duty to give way will do.



Bike box in front of right turn lane.

In signalized and give way T-intersections, a left turn lane on the cycle track opposite the intersecting road is always a good idea.

Warning: right turning lorries

Pilot projects have tested electronic cyclist warning devices in relation to right turning traffic, especially lorries. A project in Aarhus has had positive results, but there is still no definite conclusion as to the traffic safety effect.

The city of Copenhagen and Aabenraa municipality have tested a system by which LEDs along cycle tracks just before the signal warn right turning lorry drivers of cyclists coming from behind.

If warning measures are to function properly, it is essential that they are supportive and do not lull road users, cyclists as well as right turning motorists, into becoming irresponsible or less vigilant. Technology can fail to work!



The sign lights a warning to cyclists that they risk meeting a right turning lorry in the signalized intersection ahead.

ROUNABOUTS

In Denmark, roundabouts are often used to enhance road safety in the countryside and in cities. A roundabout may also be used as a traffic calming measure and often improves traffic flows when it replaces a signalized intersection. There is no risk of left turn accidents or crossing collisions in a roundabout. However, roundabouts do not always reduce the frequency of bicycle accidents. On the contrary, all Danish and non-Danish studies show that when an intersection is converted into a roundabout or a mini-roundabout the frequency of bicycle accidents increases and that such accidents are no less serious than before. For the vision impaired navigating a roundabout is especially difficult. The majority of bicycle accidents involve vehicles entering the roundabout.

Roundabouts may be designed with one or more lanes in the circulation area and in the approach and exit lanes. Bicycle traffic is not recommended within the roundabout when there is more than one lane in the circulation area or the approach or exit lane; bicycle traffic should be directed to the perimeter in this case. There is not sufficient experience with signalized roundabouts in Denmark.

It is not a good idea to establish a two-way cycle track adjoining the circulation area when motorists have to give way since motorists often think that all circulation in the roundabout is one way.

Generally speaking, the approach lane width should be no wider than 3.5 m, preferably narrower in small and medium sized roundabouts. Exit lanes should be no wider than 4 m. Crossing areas made of sett paving towards the centre of the roundabout may make it easier for lorries and busses to get through, but may mean increased speeds through the roundabout.

Roundabouts in open country

In open country roundabouts are usually relatively dynamic, which means that circulating cars can move relatively fast. This is made possible by a large central island of 20-40 m in diameter and triangular and trumpet shaped splitter islands at the legs of the roundabout.

In dynamic roundabouts cyclists should not circulate in the roundabout itself. Instead cyclists should have a path set back approx. 10 – 30 m from the circulation area, and they must give way to motor vehicles when crossing the road. The path may be two-way so cyclists don't have to take the long way round. Another solution is to establish a cyclist tunnel. This is a good idea for crossing heavily trafficked roads with 4 or 6 lanes.



This roundabout is designed for speed - at least for cars.

When the roundabout is less dynamic, with a central island of 10-20 m in diameter and parallel or small triangular islands at the legs, cyclists may ride in the roundabout itself. In this type of roundabout it is essential that cyclists should have a one-way cycle track on the perimeter of the circulation area, and the approach and exit lanes should have cycle tracks.

The cycle track and islands in less dynamic roundabouts should be designed for traffic calming. It is common practice in Denmark to establish one-way cycle tracks in the circulation area. Denmark has no experience with one-way cycle tracks set 3-7 m back from the circulation area. Swedish, German and Dutch experience indicates that it is safer to establish a verge of approx. 5 m between the cycle track and the circulation area. The cycle track should be one-way and motorists must give way to cyclists. [9.71](#), [9.72](#), [9.73](#), [9.74](#), [9.75](#)

City roundabouts

In cities, car speeds are generally slower so city roundabouts are normally smaller than in the countryside and significantly more traffic calming. There are more vulnerable road users in city roundabouts, and roundabout design should take this into account. The maximum capacity is 25,000 motor vehicles per 24 hour period in a one lane roundabout, and 40,000 in a two lane. Design and traffic composition may reduce capacity.

Cycle lanes in roundabouts should be used with

caution since a cycle lane increases the circulation area and may be used by motorists to drive faster. In addition there is a greater risk that cyclists will be squeezed in the approach and exit lanes than when they are physically segregated.

In lightly trafficked roundabouts on roads with a 30-50 km/h speed limit, cyclists should mix with motor traffic in the one lane circulation area. The roundabout should be traffic calming. The central island should be only approx. 10 m in diameter, and there should be no splitter islands at the legs. Placing the entire roundabout on a raised surface is worth considering.

In major roundabouts with a central island of 15-30 m in diameter a one-way cycle track may be established. It is probably best to set the cycle track approx. 5 m back from the one-way circulation area, but this cannot be documented due to a lack of statistical material. It is crucial to ensure that no one can be in doubt as to the give-way rules.

If there is not enough space for a cycle track in a roundabout with less than approx. 8,000 motor vehicles within a 24 hour period, it is worth considering establishing a circulation area with no cycling facilities or with a cycle lane and a narrow circulation area for motor traffic. When there is little space and greater traffic volumes, a small central island or signalization are possible solutions.

In larger roundabouts with central islands of 20-30 m in diameter, traffic volume is generally so great and driving speeds so fast that cyclists should not mix with motor traffic at all. A one-way cycle track set back 5-7 m from the circulation area should be established in roundabouts with a one lane circulation area and approach and exit lanes. It's worth considering whether this type of cycle track should be on a raised surface. Again it's crucial to ensure that the give-way rules are absolutely clear.

Mini-roundabouts

In a mini-roundabout it is possible to drive over the central island. The capacity of a mini-roundabout is up to 15,000 cars per 24 hour period. Mini-roundabouts are used when the signed speed limit is 30-50 km/h. A mini-roundabout costs roughly only one tenth of a standard roundabout and the diameter of the circulation area is only 15-25 m. Mini-roundabouts are usefully established as a traffic calming measure in urban areas or on primary roads. Mini-roundabouts are not appropriate for heavy traffic, such as bus routes. This is because the bus or lorry fills the entire mini-roundabout, blocking the circulation area for the duration.

Give-way rules must be clearly marked in the mini-roundabout. There is a safety benefit in constructing the mini-roundabout on a raised surface.

In lightly trafficked mini-roundabouts cyclists should mix with motor traffic in the circulation area. The mini-roundabout should be highly traffic calming.

In mini- roundabouts with over 6-8,000 vehicles per 24 hour period a one-way cycle track should be established; it is probably best placed at approx. 5 m from the circulation area.



A large mini-roundabout; the cycle lane is probably not suitable.



A mini-roundabout can be a boon for cyclists.

PEDESTRIAN AREAS, SQUARES, AND OTHER URBAN SPACES

In Denmark pedestrians, cyclists and motorists are often completely segregated so that each traffic mode has its own area. Motor vehicles, cyclists and pedestrians rarely share the same area. In a pedestrianized zone where driving is allowed, motorists and cyclists must be vigilant and show due consideration to pedestrians; motorists and cyclists must always give way to pedestrians. Cyclists may be forbidden to enter a pedestrianized zone by using appropriate signage.

Many cyclists do their shopping in town and therefore circulate as cyclists as well as pedestrians. It may be a good idea to allow cyclists to enter traditional pedestrianized zones to a greater extent than is the case today. In some pedestrianized zones, however, there is so much pedestrian traffic that this would inconvenience cyclists and pedestrians alike. The disabled and the visually impaired should also be taken into consideration.

Cyclists in pedestrianized zones

As a general rule bicycle traffic is not allowed in pedestrianized areas in Denmark. When cycling is allowed in a pedestrianized area and there are no cycle tracks or cycle lanes, cyclists must always give way to pedestrians. Rather than totally prohibit bicycle traffic in a pedestrianized zone, cycling may be allowed at certain times of the day, for example outside business hours, when there is often very little pedestrian traffic. Experience from Odense shows that pedestrians appreciate the fact that there are more people on the street in the evening.

When there is ample space and an appropriate number of pedestrians, a cycle track may be established in a pedestrianized zone. This reduces

The pedestrianized zone is a shortcut for cyclists from 9 p.m. – 9 a.m



The crossing is raised to pavement level.

the number of conflicts between cyclists and pedestrians. The drawback of a cycle track is that it may function as a barrier to crossing pedestrians. A cycle track is a major obstacle to the physically disabled, whereas the visually impaired can orient themselves more easily by following the edge of the cycle track.

In pedestrianized zones different surfaces and perhaps variation in level (2-7 cm) make road users aware of different use of areas. A low kerb should be vertical.

Designing squares/urban spaces

The concept of squares and other urban spaces ranges from major, centrally located squares and marketplaces to small, intimate spaces. The recreation of the central market place as a meeting and market area is a central element of many traffic calming projects.

Many squares and spaces have been made wholly or partially car-free, parking spaces for cars have been removed, and new surfaces and planting have been installed. Street furniture and benches have been set up on most squares and spaces and there are often outdoor cafés. Cycling is often automatically prohibited. Bicycle traffic should be factored in when renovating and establishing squares and spaces.

Cycling across a square can be prevented by ensuring that the square does not offer cyclists a shortcut. Otherwise the surface should make cycling difficult, for example by cobble stones, or a railing may be set up. It is difficult for the police to enforce cycling prohibitions if the square or space is a good cyclist shortcut. Bicycle stands

should be set up regardless of whether or not cycling is allowed to prevent cyclists from parking unsuitably.

The principle of "shared space" means that all road users may circulate together on the same surface, and the rules are reduced to a minimum. Some cyclists and pedestrians feel somewhat insecure in such areas, but on the whole road user vigilance is increased.

Slow-speed zones and living streets

There are good examples of shared space areas for all road users in Denmark. Pedestrians, cyclists and motor vehicles share slow-speed zones ("sivegader"), but pedestrians always have the right of way. Slow-speed zones may have a speed limit of 15 km/h and be one-way for motor traffic. There are many slow-speed zones as well as living streets or home zones ("opholds-og legeområder") in Denmark, based on the Dutch concept of woonerf. In Denmark there should be no segregation between the carriageway and the pavement in living streets, and there should be no continuous height difference in the road's cross profile. The section of the road that is suitable for motor traffic may be marked by a change of surface, for example.

Bicycle streets

There are no official bicycle streets in Denmark as yet since the legal requirements have not been fully established. The idea is that motor vehicles are allowed but have to give way to cyclists. The city of Aarhus intends to establish bicycle streets using a cycle track sign showing that motor traffic is allowed. The project has been approved by the police.



Well designed bridge.



Dark, narrow tunnel.



BRIDGES, TUNNELS, HILLS, AND STAIRS

Bridges

High railings and crash barriers are necessary to protect pedestrians, cyclists and help lorries on bridges. The recommended railing height is 1.2 m. Cyclists should not be able to skid under the railing. A windbreak is useful to cyclists on windy, gusty bridges. There is no recommended height for windbreaks due to lack of experience. Another option is to place cycle tracks indoors.

Tunnels

Lighting is crucial inside and outside tunnels. A number of tunnels are lit 24 hours a day. It should be possible to see what's going on in the tunnel from the outside, preferably throughout the entire tunnel. Window openings should be installed in new tunnels to let essential daylight shine on cyclists.

Pedestrians and cyclists should always be segregated in tunnels whenever possible. Barriers, bollards and sharp bends should be avoided inside or directly outside the underpass.

Opening of new cycle tunnel. The sides slope outwards and there are roof windows to let in daylight.

Stairs

Stairs are not intended for cyclists, but should always be passable. Cycle ramps are a good idea for stairs, particularly near stations, bicycle parking basements, bridges and tunnels. Almost all cyclists push their bikes on their right side. When the area is narrow, the upward cycle ramp is the most important. A ramp on each side of the stairs is useful since it makes it easier to go up and down stairs with a bicycle. At stations, etc. a wide, double stairway with a railing in the middle is the best solution. If the ramp is to be used by prams, etc., it should be designed appropriately.

Cycle ramps should be 0.3 m wide and the railing should be placed so that it doesn't get in the way of a cyclist pushing a bicycle. Where there are many cycle tourists a width of 0.5 – 0.6 m is a good idea so cyclists don't have to remove their panniers before using the ramp. However, wide cycle ramps are not necessarily the best solution everywhere. When the incline of the stairs is small or moderate there is the risk that cyclists will bike down a wide ramp, which is very dangerous!

A groove can be built into the cycle ramp for bicycle wheels making it easier to push the bicycle. The incline of the stairs should be no greater than 25 degrees, otherwise the bicycle is



Combined bike and pram ramp.

difficult to push and control on the way down.

Cyclists generally tend to avoid elevators.

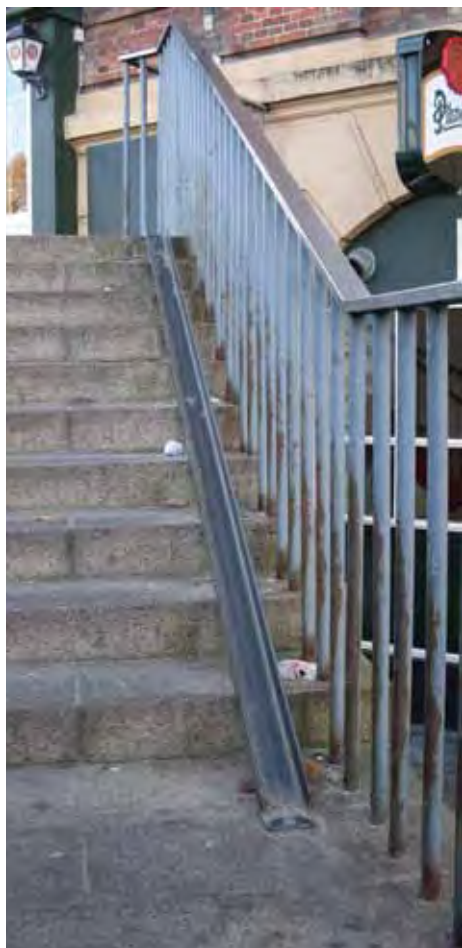
Hills

Steep hills often have a limiting effect on cycling. A small hill doesn't affect urban transport habits, but ridges and larger hills of only 50 m actually have a major impact on bicycle traffic. Cities should not be expanded into hilly areas; the focus should rather be on densifying cities in flat areas whenever possible.

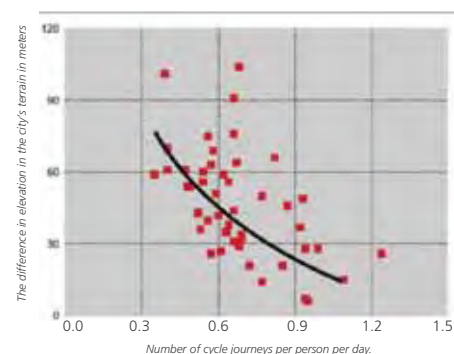
When paths and roads are planned properly, even major hills and eminences can be avoided, although minor detours may prove necessary. When hills are particularly steep it may be a good idea to signpost alternative cycle routes or resort to more expensive methods such as bike lifts, escalators or elevators. This is extremely expensive and vulnerable in relation to operation failure. It may be more realistic to boost e-bikes.



The hill was just too steep.



A simple metal track can make a huge difference.



The relation between terrain and choice of transport mode in Danish cities with a population of 10,000-70,000. Terrain is in fact the most significant factor for the number of cyclists.

ONE-WAY STREETS

There are many traffic destinations in city centres, which means that being able to cycle in both directions on all streets is highly convenient. If the street is wide enough, contra-flow cycling can work in one-way streets without hampering traffic flows or presenting safety problems. Special attention should be paid to intersection design.

In Denmark one-way streets are primarily aimed at reducing motor traffic volume by establishing two parallel one-way streets in opposite directions, or at enabling parking. In contrast to Spain or the US, for example, no Danish city has a network of major one-way roads aimed at improving traffic flows.

Cross profile

When cyclists have a separate, contra-flow area they move somewhat faster. It is a moot question whether a separate area improves cyclist safety since cyclists will be less vigilant, but on the other hand motorists on the one-way street will be more aware of contra-flow cyclists. But then again vehicles passing parked cars may create problems for the contra-flow cyclist.

A separate area for contra-flow cyclists is not necessary on very lightly trafficked, one-way streets. On more heavily trafficked streets a contra-flow cycle track or cycle lane may be established. The position of the police is often very clear on this.

The cycle track should be 1.7 m wide minimum



The sign draws motorists' attention to the fact that there are contra-flow cyclists about.

while the cycle lane should be 1.5 m wide. If cars are parked immediately outside the cycling facility, the cycling facility should be at least 2.0 m wide. The cycling facility is usefully made of a contrasting surface material.

When parking is on the left side of the street, a cycle track or cycle lane should be placed on the left of parked cars since motorists parked on the left have trouble seeing oncoming cyclists on the right of their car.

A solution on small streets for preventing unlawful or inappropriate parking is to erect bollards, but not too many. There should be no

kerbs on such streets so that cyclists can easily bike around cars blocking their path. Such streets may be signed as 15 km/h streets ("opholds-og legeområde", or living streets).

Intersections

Traffic islands or kerb extensions are sensible solutions particularly in intersections with speeds of 40 km/h or more. This makes it easier to prevent parking close to the intersection and makes cyclists moving in the "wrong" direction visible. Contra-flow cyclists may thereby safely enter and exit the one-way street.

At slow speed intersections, road markings, contrasting surface materials and bollards may be sufficient to prevent parking close to the intersection so as to improve the line of sight.

Safety

A German study concluded that contra-flow cycling is safer than cycling with the flow on one-way streets. The city of Copenhagen attempted to analyze accidents in relation to contra-flow cycling but there were no accidents in the police register.

Cycling promotion

Contra-flow cycling on one-way streets clearly favours cyclists by shortening their route compared to motorists and legalizing unlawful, daily contra-flow cycling at the same time.

If contra-flow cycling is to be safe, there should be no parking on the left side of the road



MANAGING MOTOR TRAFFIC

Permanent road closure

Permanent road closures in Denmark are primarily aimed at removing through motor traffic. Road closure is increasingly used to reduce the total amount of motor traffic in central city areas in order to improve road safety. When road closures divide urban areas into separate zones, short car journeys become less attractive.

Roads are often closed at intersections when fewer arms are required, for example. Motorists, however, need to turn on one or both sides of the road closure, which makes design a challenge. The “Dead end” sign should be clearly visible from a distance to prevent time consuming turning manoeuvres. Cyclists should have easy access to a closed off road since the road closure rarely aims at preventing cyclists from entering.

There should be two passages for cyclists, each 1.3-1.4 m wide. However, widths of less than 1.6 m mean that sweeping and snow clearance have to be done manually. Another option is to establish adjacent cycle shunts separated by a removable bollard. This facilitates cleaning and maintenance in the closed off area. It is crucial that there is no parking in front of the cycle shunt.

Planting, bollards, bicycle parking facilities and high kerbs without ramps enhance the purpose of the road closure.

Intelligent and timer-controlled road closure devices

The urban environment may be significantly improved if no commuter traffic or through traffic is allowed into central city areas. Retractable bollards and access cards are one way of keeping undesirable motorists out of an urban area. Access cards may be given to inhabitants, ambulances, police, waste disposal collectors, shop owners, etc. Delivery vans may access the area by keeping the bollards lowered for a few hours a day. Conversely, the bollards can remain raised during peak commuting periods. Exit areas should be designed so that cars can always easily leave the area and no one is shut in. Unfortunately substantial maintenance costs may be anticipated.

Bus sluices

The aim of a bus sluice, similar to a road closure, is to reduce motor traffic and give greater priority to pedestrian, bicycle and bus traffic. Bus sluices help buses keep to schedule avoiding delays. Like road closures, bus sluices can of course be intelligent or time controlled.



The road is closed to cars but allows cyclists easy access.

The simplest type of bus sluice merely consists of signposting “No entry except buses”. Physical obstacles are often necessary to prevent other motor traffic from entering, such as barriers or bus-actuated rising bollards. Another and often better solution is to install wheel gauge obstacles so that only wide vehicles traveling at slow speeds can pass through. Bus sluices should always be provided with a 1.3 -1.4 m bicycle shunt on each side of the road. When roads are closed off by bus sluices, this should be clearly marked, particularly during the start-up period, to prevent motor vehicles from inadvertently entering the bus sluice because they are used to using the road as a through road.

Sluices can be established for other purposes as well, such as light rails, lorries, etc., but always remember the bicycle sluices.



Parking regulations

In areas where there is a large demand for waiting and parking facilities, signage prohibiting stopping, waiting or parking is not always enough.

Many motorists know that they are not allowed to park within 10 m from an intersection in Denmark, but they park illegally nevertheless since the prohibition is seldom marked. A discreet but visible marking is the best solution. The Copenhagen authorities have implemented this over the entire city; painted yellow triangles starting 10 m from the intersection help motorists remember to keep their distance.

Parking is illegal on cycle tracks and cycle lanes in Denmark and is extremely unpopular among cyclists. Parking on narrow, heavily trafficked roads, double parking, and parking on cycle tracks and cycle lanes cause potentially extremely dangerous situations for cyclists.

This lorry sluice is difficult for cyclists to pass through and may mean that cyclists choose the left-hand pavement instead even though it's illegal.

Double parking issues may be addressed by making the road narrower and introducing time limited parking. Attractively placed cab stands near major hotels, traffic terminals, pedestrianized zones and restaurants, cafés, nightclubs, and bars are often an excellent solution. Kiss-and-ride spaces at schools, institutions, traffic terminals, etc. may also prove necessary.

Shop owners on shopping streets are often advocates of parking due to the necessity of unloading delivery goods. An alternative option is to establish loading zones outside relevant shops. Loading and unloading should only take place in specially designated bays which at other times may be used as a pedestrian area. The city of Copenhagen has tested dual-use parking bays for cars or bicycles depending on the time of day.

20-25 cm high kerbs or concrete blocks are the last resort when preventing unlawful waiting and parking. Bollards and high kerbs make cyclists feel insecure and increase the risk of solo accidents with solid objects. Road safety should be carefully assessed and the distance between bollard and cyclist should be at least 30 cm.

Costs

The following experience-based guideline prices may be helpful when establishing a cycling infrastructure budget:

2011 prices	
Extensive traffic calming (chicanes, speed humps, road narrowing, etc.)	DKK 500-20,000 per RM
0.3 m wide thermoplastic line	DKK 25-50 per RM
0.1 m wide thermoplastic line	DKK 10-20 per RM
10 cycle symbols	DKK 10-20 apiece
Crossing with full cycle track and pavement	DKK 50,000-150,000
2.2 m wide blue, thermoplastic cycle crossing	DKK 400-800 per RM
Red powdered asphalt	DKK 250-400 per RM
Road closure	DKK 5,000-75,000
1 speed hump on existing roadway, Kerb to kerb incl. marking	DKK 15,000-30,000
1 mini- roundabout	DKK 100,000-1.500,000
Roundabout with 1 circulation lane and splitter islands at legs	DKK 1,500,000 – 4,000,000
Cycle track shunt around traffic signal	DKK 50,000-100,000
Shortened cycle track by 30 m	DKK 50,000 - 250,000
Pedestrian refuge in intersection Cyclist signal in signalized intersection	DKK 50,000-250,000 DKK 50,000-200,000
Cycle path signage incl. contractor costs	DKK 1,500 -10,000 per signpost
€1 = DKK 7.4, £1 = DKK 8.9 and \$1 = DKK 5.6.	





BICYCLE PARKING

Any bicycle journey ends with a parked bicycle, and since over 5 million bicycles are in regular use in Denmark this means that many bicycles need to be parked every day.

Although car parking has been a central issue in area planning for the past 50 years, little attention has been paid to bicycle parking in urban planning and construction projects. However, regardless of whether it is a question of new construction, conversion, renovation, improvements, etc., bicycle parking should be an integral part of any project from the outset; if people are to be encouraged to cycle, they need space to park their bicycles.

This can be done in a variety of ways. The present section offers good advice and a number of recommendations for establishing suitable bicycle parking facilities that cyclists will actually use.



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Bicycle Parking Manual, Danish Cyclists' Federation, 2007.

THE BICYCLE PARKING MANUAL OUTLINES A NUMBER OF SIMPLE, BASIC PRINCIPLES FOR PLANNING AND ESTABLISHING BICYCLE PARKING FACILITIES

1. Attract attention
2. Choose the right location
3. Outline a solution that works
4. Make sure there are enough spaces
5. Identify the right racks and stands
6. Make parking safe
7. Consider operation and maintenance
8. Spoil the cyclists

THE BICYCLE PARKING MANUAL

There is a fight for space going on in modern cities. This challenge has to be met by establishing bicycle parking areas since superior bicycle parking facilities help create order and space in public and private areas. Good bicycle parking facilities also reduce bicycle theft and boost cycling since an area in which there is room for parked bicycles signals that cyclists are welcome.

Bicycles are welcome to park anywhere in Denmark. According to the Danish Highway Code bicycles are allowed to park on cycle tracks, foot paths and pavements (although evacuation zones must be kept passable). It is thus illegal to effectuate the "Bicycles left here will be removed" sign.

It is not allowed, however, to lock a bicycle to municipal property or to a building entrance as this will generally inconvenience other traffic.

Cyclists are often perceived as anarchists who park wherever they like no matter what. However, this is often because there are too few spaces of inferior quality in the wrong places.

If bicycle parking facilities are to be used, bicycle parking must be factored into all types of projects from the outset or in connection with renovation. Whether or not bicycle parking is a success often proves to be a question of planning.

In 2007 the Danish Cyclists' Federation published the Bicycle Parking Manual. The manual contains a number of recommendations, a technical instructions section, and a collection of examples for inspiration. The following recommendations are largely based on the Bicycle Parking Manual. It is highly recommended, however, to supplement the present outline with the manual itself, which is very useful as a reference work.



A message from the Aarhus police from former times. It reads "Do not place bicycles at the kerb."



Cyclists are threatened all over town, although it is not legal to carry out the threats. (The sign reads: "Bicycles will be removed and melted down - Use the bike stand around the corner.")



Not all shops are "cycle hostile". TANK in Aarhus welcomes cyclists as customers. (The sign reads: "Welcome cyclist. You can park here.")



ATTRACTING ATTENTION

Bicycle parking facilities cost money, for the local authority or the private developer.

Convincing arguments must be made for the necessity of bicycle parking investment to make it a winner. For example, it is a good idea to write bicycle parking costs into the construction budget as a natural part of the project from the outset.

Here are a couple of good arguments to convince the local decision makers of the crucial importance of bicycle parking:

- A good cycling infrastructure is needed to boost cycling as a transport mode.
- Good bicycle parking facilities mean less obstruction for pedestrians and the handicapped, and enhance the city's esthetic appeal.

Here are a couple of good arguments for developers, companies, and organizations:

- Good, visible bicycle parking facilities give the enterprise a responsible profile.
- Good bicycle parking facilities encourage staff to cycle, which reduces the need for and the pressure on car parking spaces and results in a healthy, energetic and satisfied working staff.

LOCATION

The location of bicycle parking facilities must be carefully considered before setting up the stands. If the location is wrong they will not be used.

Here are a number of basic rules for positioning bicycle parking facilities:

- The bicycle parking facility should be a natural place to park en route to the final destination.
- An acceptable distance from the parking facility to the destination depends on the parking duration.
- The bicycle parking facility should be visible to cyclists.
- Access to the bicycle parking facility should be in direct continuation of the cyclist traffic flow.



Bicycle parking facilities in Odense create orderly conditions and easy access.



The lack of parking facilities close to the Aalborg bus terminal means that cyclists park in the path to pedestrian crossings.



Bike stands at the Randers bus terminal are placed close to the destination. The result is orderly conditions and free pedestrian paths.



The bicycle parking facility at the Copenhagen Metro is not easily accessible.

AREA DESIGN

When the right location has been found the area needs to be designed so that cyclists can easily reach the rack with a bicycle, place it in the rack, continue on foot and pick up the bicycle later.

The following basic principles should be applied:

- Direct access – obstacles such as stairs, doors, steep ramps, etc. may mean that cyclists do not use the bicycle parking facility.
- Access lanes should be wide enough to manoeuvre a bicycle.

CAPACITY

When planning bicycle parking facilities it is crucial to establish an adequate number of spaces. Rather 10 stands too many than 10 too few. Experience shows that good parking facilities increase demand and it is therefore recommended to factor in a minimum of 25% extra stands with a view to possible future expansion.

Too few spaces at Magasin, Aarhus create a state of bicycle chaos.



The need for parking facilities can be partially based on the number of parked bicycles. It's a good idea to conduct a count and chart the results on a map showing the existing number of bicycle parking spaces supplemented with the number of parked bicycles at peak periods inside as well as outside the bicycle parking facility.

Required capacity should be calculated on the basis of short-term, one hour, all-day, and all-night parking to establish the need for each individual standard. It is a good idea to register the number of parked bicycles at the individual bicycle parking facility on a regular basis, both day and night, so as to keep an eye on

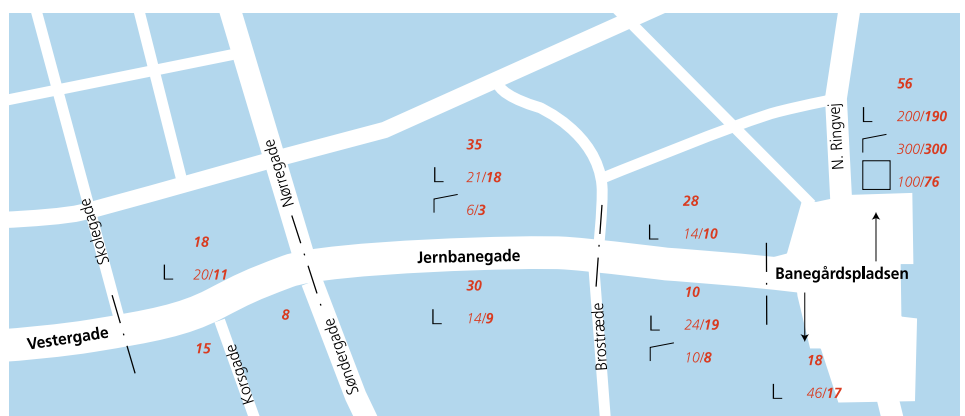
developments and catch overcrowding before it gets out of hand.

When many bicycles are parked outside the stand, this is perceived as overcrowded and messy. Overcrowding may occur even when the parking facility as a whole is not overcrowded, for example if some spaces are perceived by users as being too far away leaving the closest spaces jam-packed. Placing covered stands furthest from the destination is one way of spreading cyclists over the whole area.

Day-time occupancy counts are best taken between 10 a.m.-12 noon and night-time counts between 9 p.m.- 6 a.m. In shopping areas Friday afternoons or Saturday mornings are often peak periods while the peak period for entertainment and sports facilities are the times with the highest visitors' rate.

There will often be a lack of sufficient space at primary travel destinations such as stations, shopping centres, centrally located employment nodes, etc. Here are 4 options for addressing the issue:

- Change the area distribution to give preferential treatment to cyclists, for example by changing car parking spaces into bicycle parking spaces either in the car park, which frees up a large area, or at the kerb, where there is typically space for 8-10 bicycles per parking bay.
- Compress bicycle parking, e.g. two-tier parking, underground bicycle parking facilities, automatic facilities, etc.
- Use angle or staggered parking.
- Tidy up regularly so abandoned bicycles do not take up space



Example of bicycle parking mapping in a central city area. The following was registered during one afternoon peak time period: a) number of stands distributed over 3 standards (stand; covered; locked/monitored) b) peak time loads for 4 standards (no stand; uncovered stand; covered bicycle parking facility; locked/monitored bicycle parking facility). The figures in bold indicate the number of stands in use.



Capacity was doubled at the Aarhus railway station by replacing 500 ordinary perpendicular, front wheel spaces with 1000 two-tier spaces.

It is tempting to place bicycle parking spaces close together to provide more spaces but this often means that only every other space is used.

It is recommended for perpendicular parking on the same level to allow 60 cm between stands to make room for different types of equipment, luggage carriers, etc. If perpendicular stands are staggered (alternately up and down), the space between stands can be reduced to 40 cm. If 45 degree angled parking is used, an interval of 35 cm is sufficient.

Municipal parking norms

It is recommended that the local authorities draw up a politically approved norm for the establishment of bicycle parking at: new construction; additions to and conversions of existing construction; squares and other urban spaces; workplaces and institutions; public transport terminals; shops and pedestrianized zones in residential areas; and blocks of flats.

A municipal bicycle parking norm ensures that bicycle parking is factored into the planning phase of all projects. Bicycle parking thus automatically becomes an integral part of the construction project itself with its own budget.

Bicycle parking is especially important to residents of large blocks of flats. The larger the block of flats, the more critical it is to address parking issues since bicycles are out of sight and thus subject to vandalism and theft.

Bicycle parking in sheds, basements, etc. where the bicycles are kept under lock and key and protected from the elements should be standard, and should be written into the local plans. Bicycle parking costs are often lower than car parking costs even though there should be 2-12



Covered bicycle parking facility at Viborg student residence combined with a rubbish disposal facility.

AREA USE	BICYCLE PARKING NORM
Block of flats, youth housing	2 per dwelling
Professional	1 per 100m ²
Factory, storage and workshop sites	½ per 100 m ²
Daily and durable goods	1 per 100 m ²
Theatres, cinemas, etc.	2 per seat
Sports facilities	3 per 3 seats
Schools and educational institutions	5 per 10 students
Public transport centres e.g. railway and bus stations	An appropriate number based on passenger figures

Bicycle parking norm proposal, Viborg Municipality

BICYCLE PARKING NORMS IN THE CITY OF COPENHAGEN, MUNICIPAL PLAN, 2009

BICYCLE PARKING

In order to achieve the vision of Copenhagen as the world's best city for cyclists, optimal bicycle parking facilities must be provided. To that end the following norms for establishing bicycle parking facilities at new construction sites are established:

- As a starting point at least 50% of bicycle parking spaces should be covered, placed in a specially designated shed or as an integral part of the construction.
 - Dwellings: 2.5 bicycle parking spaces per 100 m² residential area, or 2.5 bicycle parking spaces per dwelling. At student residences and other youth housing 4 spaces per 100 m² and at assisted living facilities or sheltered housing units for the elderly 1 per 100m² per resident (plus 0.5 per staff). There must be space for space demanding bicycles (1 per 1,000m²).
 - Workplaces: 0.5 bicycle parking space per office employee, the equivalent of 1.5 spaces per 100 m².
 - Educational institutions: 0.5 bicycle parking spaces per student and staff.
 - Retail, etc.: 3 bicycle parking spaces per 100m² shopping area and 0.5 spaces per staff (normally 1 employee per 30 m² shopping area.) Space must be set aside for space-demanding bicycles, 1 per 1,000 m². The concrete situation is assessed by the shopping centre.
- Norms for bicycle parking facilities at other functions must be included in all local plans on the basis of a concrete assessment.

In addition to stating the required number of spaces, there can be requirements as to placement, function, etc.

times as many spaces for bicycles as for cars in Danish housing blocks. Uncovered stands are also needed for cycling guests and short term residential parking.

At single family houses, row houses and dense low-rise housing the situation is less critical. The individual household's bicycles can be contained relatively safely within the garden gate in a more or less organized fashion.

CHOICE OF STAND OR RACK

The choice of stand is important. The quality of the material, function and design all play a major role which determines whether the stand will be used and whether it fits into the local surroundings and environment.

The parking solution should largely depend on the size of the destination and the length of time the bicycle needs to be parked.

There are 5 basic standards for bicycle parking facilities:

- No-stand
- Stand
- Lockable stand
- Covered stand
- Lockable/monitored covered stand

No-stand bicycle parking

At destinations where few bicycles need to park for a short period of time, bicycles can be propped up on their kickstands or leaned against another object. No-stand parking is relevant if there is a large variation in the demand for bicycle parking and there is enough space. However the parking area needs to be marked, for example by painting, and protected by windbreaks, for example, to prevent bicycles from being knocked over by the wind.



No-stand parking facility tested in Copenhagen. It reads "Place your bicycle here" on the ground.



- For short term parking of less than 30 minutes it should be possible to use the kickstand or a stand next to the primary entrance. The bicycle does not need to be locked to the stand.
- For parking of between one and four hours it should be possible to lock the front wheel and frame to the stand. Covering should be considered.
- All-day parking at workplaces, educational institutions and terminals should be covered and it should be possible to lock the bicycle to the stand; monitored, lockable areas should be considered to protect against theft.
- All-night parking at dwellings and terminals should take place in a covered, lockable facility.

The City of Copenhagen initiated a pilot project in 2011 combining no-stand bicycle parking and car parking in front of a secondary school. Students park their bicycles in the flex area from 7 am-5 pm and the area is used for car parking from 5 pm-7 am when there are no students. The scheme will be assessed with a view to making it permanent and using it at other city schools.



Stand parking

At destinations where many bicycles need to be placed for a shorter or longer term, it is recommended to install bike stands. The stand should support the bicycle without damaging it and should be convenient and easy to use.

The Butterfly rack

The most common solution in Denmark is the so-called butterfly rack, in which the bicycle's front wheel is placed. The Danish Cyclists' Federation recommends vertical butterfly racks in which the front wheel is held in place by a wedge and thus fits all tire widths. Butterfly racks may be supplemented by locking devices.



One-sided butterfly rack by the wall of a residential building, Aalborg.



Two-sided butterfly rack, Frederiksberg. The stand is vertical and wedge shaped to fit different tire widths without damaging the tires.



"Bicycle enclosures" were chosen in Randers. There are typically 5 spaces per enclosure. The enclosures were installed all over the city where bicycle parking was considered necessary (here at the old Town Hall). This means that in Randers bicycles are no longer parked every which way; cyclists park in the enclosed stands.

In Fredericia a stand was developed from which a wire can be pulled out and the bicycle can be locked to the stand by means of a Basta-ock (typical Danish lock that is attached to the bicycle).



In Odense butterfly racks have been supplemented by a locking mechanism in the shape of a wire pulled up from the ground.

The hoop stand

Stands in which the bicycle leans against the stand are another option. One of the benefits of the hoop stand is that the bicycle frame can be secured to the stand. This is why hoop stands are primarily used abroad where bicycle theft makes it necessary to secure both the wheel and the frame.

Hoop stands have the drawback that the bicycle may be scratched by the stand and if the stand is too narrow the front wheel often gets turned around making it impossible to park on the other side. In fact it is very common that only one side of a hoop stand is in use.



Hoop stand at the Royal Library, Copenhagen

The musician, David Byrne, has designed a number of amusing bicycle stands shaped as musical instruments or here as a high heeled shoe. The stands have been installed in New York and elsewhere.



The New York city council organized a design competition which was won by two Danish designers. The stand "HOOP" is now installed in central areas in New York.



Many countries outside Scandinavia typically use the so-called "Sheffield stand" in which the bicycle is leaned against a thick metal bar and the frame and wheel secured by a bike chain lock.

Hoop stand, Odense



Hoop stand, Aarhus





Underground, two-tiered bicycle parking facility, Odense.

Two-tiered stands

Another option is the so-called two-tiered stand, in which bicycles are parked on two levels.

Two-tiered stands make it possible to compress a large number of bicycles into a small area, but it can be difficult to lift your bike to the upper tier. A sunken floor level at the bottom tier makes it easier to lift bicycles. Most two-tiered stands provide various options for auxiliary devices to help place bicycles in the upper tier.

Mobile stands

Temporary stands are useful for keeping bicycles under control at concerts, town fairs, renovation and conversion projects, etc. Aarhus Cycle City uses triathlon stands as a temporary measure at such events. This is a cheap and simple way of creating a large number of spaces.

Shelters and covered stands

When bicycles need to be parked for most of the day, a covered facility and a means of securing the bicycle need to be considered so as to protect the bicycle from the elements and make it more difficult to steal.



Aarhus Cycle City installed 3000 temporary parking spaces at Northside festival in Aarhus, 2011.



Temporary bicycle parking facility installed at the Royal Gardens, Odense.

A covered facility at stations, educational and cultural institutions, workplaces, etc. is a clear signal that cyclists are welcome and that their choice to cycle rather than drive is important.



Covered bicycle parking facility at railway station



Covered bicycle parking facility at block of flats



Covered bicycle parking facility at Kinopladsen, Odense, at night.



The City of Aarhus has established a Park and Bike facility at Egå Engsø in northern Aarhus. It primarily targets automobile commuters who wish to take the last section into central Aarhus by bike rather than be stuck in traffic on the way to work. In addition to 100 bicycle parking spaces it provides water, a bicycle pump, and an area for bicycle repairs.



Lockable parking

At locations where bicycles need to be parked all night or locked for several days at a time, covered parking facilities should be provided, preferably indoors. This creates a sense of security in relation to bicycle theft. However it is crucial to ensure that the bicycle parking facility is safe at night or in the evening.



If there is not adequate space for a lockable bicycle parking facility above ground it can be established underground. In this automated Spanish facility, 92 bicycles can be parked underground. The system protects the bicycles from the elements and from theft, and there is also space for the cyclist's luggage.



Lockable bicycle parking facility, Randers. Solar cells on the roof power LED lighting in the facility.



New solutions

New types of stands and solutions are constantly being developed. So check out the market and discuss with colleagues in other communities what works best.

A Dutch stand. The bicycle is secured by the pedal.



In Aalborg bicycles are hung on the rack in an attempt to better utilize urban space.



Another good idea is to have different users test out a prototype or specimen before installing the entire system. This makes it possible to test the solution in practice and assess it in terms of space, accessibility, etc.

It has not yet been established whether the most user-friendly means of securing the bicycle is by the wheel, the saddle, the frame or the handlebars.

In Copenhagen 25% of all families with 2 or more children have a cargo bike, which requires a great deal of space when parked. The City of Copenhagen has consequently installed several brightly coloured bicycle parking facilities for carrier bikes, at the same time demonstrating that where there was only room for one passenger car before, there is now room for 4 cargo bikes.



There is a fight for urban space. In Seoul, Korea, building gables are utilized for bicycle parking.



Prices

There are many suppliers and all kinds of different models and qualities are available. The Bicycle Parking Manual published by the Danish Cyclists' Federation assesses a number of the stands and racks on the market.

One bicycle space costs approx. DKK 1,000 per butterfly rack, approx. DKK 2,000 per hoop rack, approx. DKK 5,000 per covered space.

SECURITY AND SAFETY

As mentioned above, the cyclist's security is important in a parking situation since the cyclist is much more vulnerable to attack than on the journey itself. This means that the facility should be well lit and easily visible to passersby and others in the area, in taxis, shops, etc. Bicycle parking facilities should therefore be placed where people pass by naturally.

An underground parking facility or any other lockable facility should be easily viewed in its entirety, have several entrances and exits, and the area to be walked should be short. In addition it can be monitored by either manned or video surveillance.

OPERATION AND MAINTENANCE

It is crucial to factor operation and maintenance into bicycle parking plans from the outset. A bicycle parking facility has to last for many years and should not only look good when new but also many years later. For example, finish and paint peel off when they come in contact with bicycle frames or wheels. In addition facilities should not become run down because of lack of cleaning and sweeping, or because of graffiti and abandoned bicycles. Attention should also be paid to the appearance of the design and materials when the facility is empty.

Clearing up

As mentioned at the start of this section it is not legal to remove bicycles in Denmark, not even if they get in the way and are very likely lost property.

If bicycles are to be removed the bicycle's owner must be so advised. Many local authorities do this by tagging bicycles, stating that the bicycle will be removed at a given date 4 -5 weeks later if the tag is not removed.

According to the lost property act section 4 anyone who removes a bicycle after tagging must keep the removed bicycle for 3 months after which the bicycle is to be sold at auction unless it is obviously worth nothing. The auction is held

so as to be able to prove that the bicycle was sold at the highest price in case the owner turns up. Another option is simply to clear up regularly, moving bicycles out of the way.

Aarhus Cycle City hired two so-called bicycle parking inspectors in 2010. Their job was to raise overturned bicycles and move bicycles blocking the way for pedestrians.

Copenhagen has a similar system called "bicycle butlers". In addition to tidying up they service bicycles with air and lubrication. Citizens have reacted very positively.

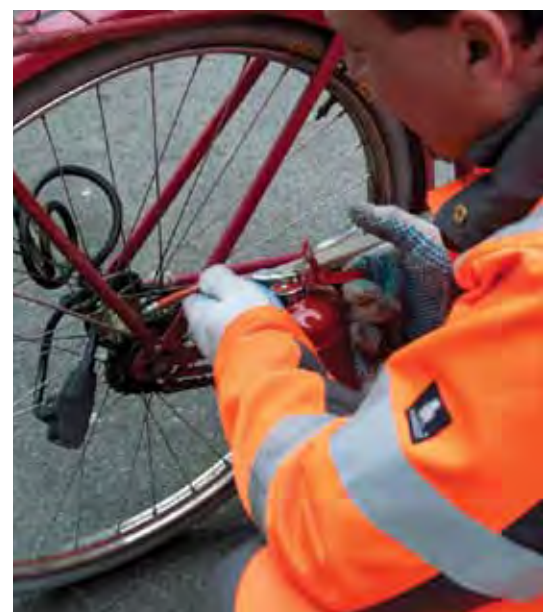
It can be difficult to get rid of your old bike if you live in a city and don't have a car. This means that many old bicycles are abandoned because owners don't know how to get rid of them. The local authority can establish a scrapping system by which you receive DKK 100 for handing in an old, worn-out bicycle. The bicycles can then be donated to organizations that repair them and send them to developing countries.



The area in front of Aarhus railway station before and after the bicycle parking inspector's visit.



Bicycle tag, Odense



Bicycle butler at work, Copenhagen.

SPOIL THE CYCLISTS

Bicycle parking is not the only way to spoil cyclists; they can be spoiled with extra service facilities to show them that their choice of cycling as a transport mode is important. Many communities in Denmark have installed various types of bicycle pumps (with or without a compressor), drinking water, and mini bike workshops.

In addition to such services as air and water, some authorities have made cycling easier and more fun by installing angled rubbish containers and foot rests at intersections.

BICYCLE PARKING PLAN

A bicycle parking plan is a really good investment, or at least make a map of existing bicycle parking facilities and an analysis of future demand within central sections of the municipal area.

Overall goals, guide lines, design formats, etc. for future investments and projects can be established on the basis of mapping.

Get different stakeholders and users actively involved in municipal bicycle parking planning. Arrange meetings to promote the exchange of ideas, innovation, cross collaboration between the different authorities, administrations, institutions, and stakeholders.

It is absolutely mandatory to factor bicycle parking into all building and construction projects, physically, functionally and economically. Norms, standards, building regulations, local plans, etc. should be focus areas.

Today's Danish building regulations do not specify parking norms for automobiles and bicycles; there is a clear tendency to use the old rules for automobile parking because there is uncertainty as to the alternative.

CHECK LIST

The following box shows a check list for establishing attractive bicycle parking facilities. The check list is based on studies and experience, and is ordered according to the cyclists' own prioritization of their needs and wishes. Not all bicycle parking facilities need to meet all the requirements but it is a good idea to take all points into account so as to have an adequate planning basis.

The concept "easy to find" is particularly important. It is crucial that the bicycle parking facility is visible to cyclists from a distance. It's a myth that cyclists want to be able to bike directly to the entrance. What they want is to be able



The city of Copenhagen makes it easier for cyclists to hit the rubbish bin by placing it at an angle.



Cyclist footrest, Copenhagen.



Bicycle pump, Aalborg



Bicycle pump, Fisketorvet, Odense

to bike directly to the bicycle parking facility and preferably into it. If the facility is visible from a distance, cyclists will head for it, park there and continue on their way – but only if it's placed right!

GOOD BICYCLE PARKING FACILITIES MUST:

- Be very close to the destination
- Have an adequate number of spaces
- Be easy to use
- Be safe and easily viewed in the entirety
- Be easy to find and visible at a distance
- Be safe and secure when entering and leaving
- Be designed to support the bicycle without damaging it
- Be locked, or enable the bicycle to be locked
- Be attractive, fit in with the surroundings and preferably enhance the local environment
- Protect the bicycle, particularly the saddle, from rain and snow
- Be solid and sturdy as well as maintenance and cleaning friendly



Bicycle parking garage with indoor and outdoor parking and bike shop, Næstved.



You can park your bike indoors at Schiedam station, Amsterdam, with or without surveillance and repairs

BICYCLE SERVICE

In Denmark during and after the Second World War, bicycle surveillance at railway stations was common, and the local bicycle repair shop was frequently located next to the station. The local bicycle repairman kept an eye on the bicycles and provided service and repairs while people were at work.

There are not many such bicycle centres left in Denmark today, but there are more than a hundred in Holland.

It should be possible to provide bicycle surveillance and repairs today by rethinking and coordinating bicycle parking with other functions, such as ticket sales, bike shops, cafés, kiosks, take aways, shops and car parks, etc. In Germany "bicycle stations" are being tried out: manned cycle centres at formerly unmanned stations as an employment project.

Bicycle service could be coupled with a commuter pass or the like at stations with locked bicycle parking facilities.

In several cities one-man businesses have specialized in mobile bicycle service, setting up shop at large companies, on squares, at

supermarkets, etc. and servicing bicycles while the cyclists are at work or doing other business.

BETTER COORDINATION WITH PUBLIC TRANSPORT

If cycling is to be encouraged it must be easily combined with public transport. Bicycles, buses and trains go hand in hand, partly because public transport enables cyclists to travel over greater distances.

Railway station, Aarhus.



The Danish Transport Authority published a collection of ideas in 2009, *Bedre samspil mellem cyklen og den kollektive trafik*, (Better integration of cycling and public transport) based on a number of focus group interviews with railway commuters from major Danish cities.

The commuters would like:

- More stands close to the station
- High quality stands
- Wider interval between parking spaces
- Covered spaces
- Locking facilities
- Clearer lay out

In 2009 DSB (Danish State Railways) and the Danish Government earmarked DKK 1 billion for better parking facilities at stations, including bicycle parking. It is thereby possible for a municipality to enter into a collaborative agreement with DSB to establish more bicycle parking spaces at stations.



RECREATIONAL BICYCLE PARKING

Not only daily cyclists need to park their bicycles; many people take out their bikes on weekends or holidays and use them as a recreational transport mode.

Bicycle parking should be factored in at recreational destinations such as beaches, museums, etc. where cyclists need a safe place to park their bicycles, preferably with luggage facilities.

Innovative thinking is in order here so as to coordinate parking solutions with other options, e.g. a port facility that includes bicycle parking, toilets, and showers, or a parking garage for bicycles close to the tourist office.



It is important to establish bicycle parking facilities at recreational destinations.

FUNDING

A clear division of responsibilities must be established between the State, the municipality, the transport services organization, and the private sector when it comes to bicycle parking funding, and project managers and coordinators within the individual organizations must be clearly identified. In addition, different funding options should be considered.

Bicycle parking funds

Currently in Denmark car parking funds may not be legally used to expand bicycle parking facilities. Nor may bicycle parking funds be established (since bicycle parking does not rank alongside car parking inasmuch as bicycle parking occurs in the immediate vicinity of the main door). New construction should include bicycle parking facilities from the outset and it should not be possible to circumvent this by paying into a parking fund.

State funding

Public and private stakeholders may apply for co-financing of bicycle parking facilities to the Danish Road Directorate's cycling promotion fund which is available through 2013 at the time of writing.

The State and DSB have allocated funds to boost bicycle parking at railway stations (the DSB

parking fund). Local authorities may enter into collaboration with DSB to improve and expand bicycle parking facilities at local stations.

Funding through advertising

Street furniture funded by advertising is becoming increasingly popular in many communities. This may be an option for funding bicycle parking facilities.

Another option is to motivate businesses, institutions, shops, trade associations, cultural and entertainment venues, transport services organizations, etc. to sponsor bicycle parking facilities. The sponsorship may include advertising at different events.

User charges

Bicycle parking in Denmark is traditionally free. However at locked bicycle parking facilities, for example at stations, users often pay a small annual fee for a key or a key card to the facility. The price varies from almost free of charge to DKK 300 annually. The most common price is between DKK 100-200 annually for outdoor, locked, covered or underground bicycle parking. Stands are available on the international market that also serve as parking meters. Coin or card payment releases a device to lock the bicycle to the stand. The stands may be installed individually on pavements or squares. None have yet been installed in Denmark.



Bicycle parking can be indicated in many different ways. (The sign reads: "Parking reserved for bread powered vehicles.")



Bicycle parked at Åen canal, Aarhus.



ROAD SIGNAGE, MAPS, CYCLE ROUTE PLANNERS, AND ITS

Signage and information are an essential element of the concept offered to cyclists. Infrastructure, signage and information should be planned and implemented as an integrated whole.

Cycle route maps, in addition to providing an excellent overview of cycling options, highlight the municipality's efforts to promote cycling. This also applies to cycle route planners on the internet, which is the newest way of helping cyclists find their way. On-line cycle route planners are developing by leaps and bounds, and more products are expected to be put on the market. Cyclists themselves can even help develop some of them.

ITS, Intelligent Transport Solutions, provides new options for improving cycling facilities. This field is undergoing rapid development as well.



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SIGNAGE

Cycle signposts are the connecting link between segregated off-road cycle tracks, paths along roads, minor municipal roads, wooded roads, etc. Routes that consist of many different elements should be signposted as a continuous route by uniform signposting. Cycle signposts should provide the same high level of service as road signs. Cycle signage should be clear, fit in with the surroundings, and be easily distinguishable from road signs so that there can be no doubt as to the targeted road user.

The latest version of the Danish road standards for “signage on cycling, equestrian and hiking routes” and the accompanying government directive 11.1 covers signage for pedestrians and horse riders as well as cyclists. The rules define terminology, lay down principles for signage design, and formulate requirements to the national cycle routes. The procedures for route modification are also described. A number of the regulations laid down in the road standards are codes of practice, such as types of signage, cycle symbols and colours.

Signposting cycle routes

The road standards’ signage regulations make it possible to develop local, regional and national cycle routes. Today there are several thousand kilometers of signposted cycle routes in Denmark.

The road standards divide cycle routes into 3 categories by number:

- National routes 1-15. White number on red field with white border (the national colours).
- Regional routes 16-99. White number on blue background with white border.
- Local routes 100-999. White number/name/logo on blue background with white border.

In addition there are:

- European routes. May be marked by a sign placed under the national route sign.

The two European cycle routes in Denmark are part of a comprehensive network developed by the European Cyclists’ Federation. 11.2

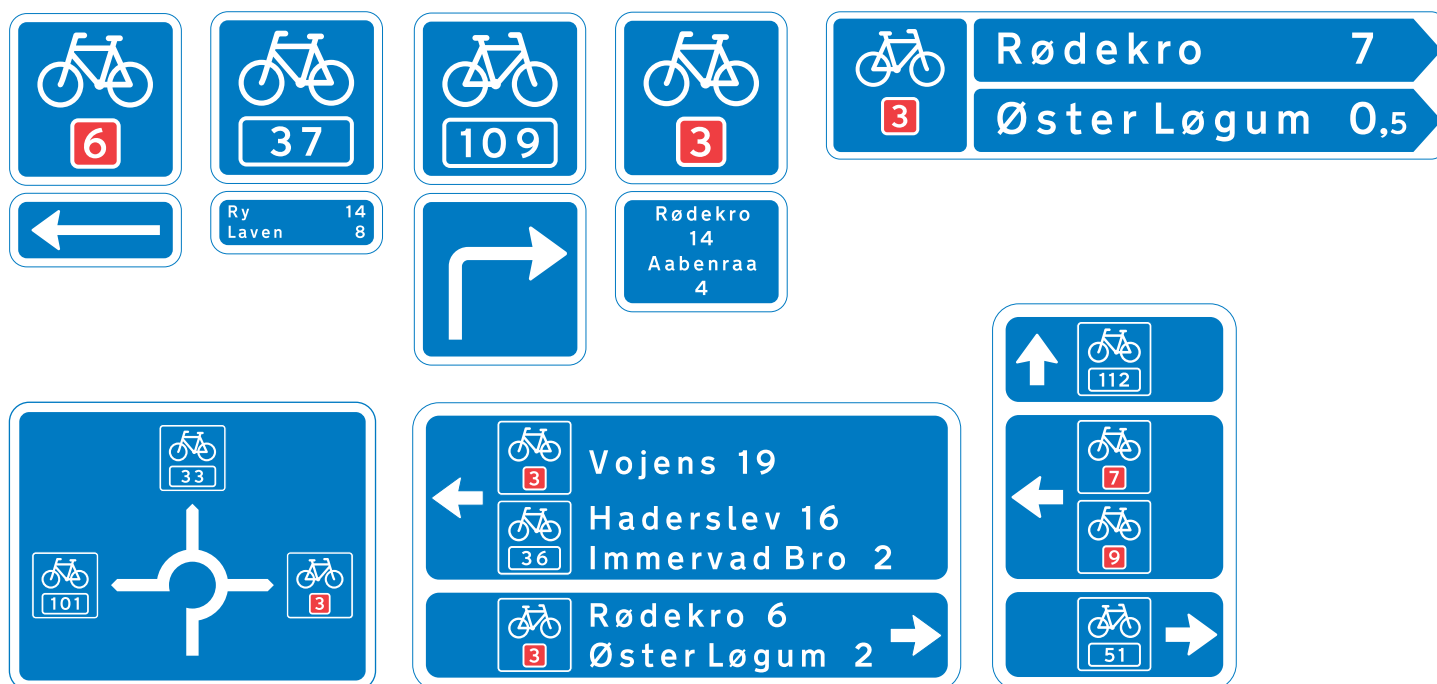
Danish cycle route numbers may be supplemented by a name. For local routes just the name is enough, or even a logo (for example a pig indicates the “Pig route”). Logos have to be approved by the Danish Road Directorate. Local routes in city centres are often called “commuter route” or “centre route”.



Standard road standard signage in the field.



Danish signage has been inspirational for signage standards in other European countries, as here in Lithuania.



A cycle route is identified by a cycle symbol and a route number/name/logo. Arrows and the like may not be placed within the border. The route identification is used consistently on all types of signs, including directional signs.

Directions are given to far-off as well as near-by destinations. Examples of far-off destinations are market towns, major cities, ferry sites, and points of support to out-door activities. Examples of near-by destinations are minor towns, villages, urban neighbourhoods, woods, lakes, beaches, and points of local interest.

The most frequently used signpost is the cycle route sign which is usually square, 40X40, 30X30, 20X20 cm down to 10x10 cm, in wooded areas, for example. The signpost is used to confirm that the cyclist is on the right route, and in minor intersections where the sign may be placed a short way down the right road. An arrow may be added under the sign, and geographic destinations and distances may be indicated on a separate sign under the cycle route sign.

The directional arrow sign is the simplest type of sign, and is used in major intersections and when the route changes direction and it's necessary to indicate several geographic destinations. Tabular signs and diagram signs are used for more complicated situations.

Special service signs are only used when cyclists use other routes than cars. Service signs for cyclists have hitherto not been in extensive use, apart from campsite signs for non-motorized road users.

The road standards require that signs should be placed on signposts or hangars. In cities the sign may have special shapes, such as bollards.

Sign size and placement

The consistent use of the colour blue accustoms cyclists to the fact that a blue sign means cyclist information. Information is more easily grasped when signs are consistently placed on the same side of the road and at the same height. This makes it possible to minimize the sign's size while ensuring that it is easily seen by cyclists.

Since most cyclists sit in a bent forward position with their eyes on the ground ahead the signs should be placed low. On the other hand they shouldn't be so low that they can be covered by grass or other plants in the summer or snow in the winter. Cycle signs are best placed on the right side of the road at a height of approx. 1 m.

The size of the sign should be based on the speed of the cyclist and the amount of information on the sign. Reading distances and the height of uppercase letters have been tested in practice.

Campsite signs are the most frequently used service sign.



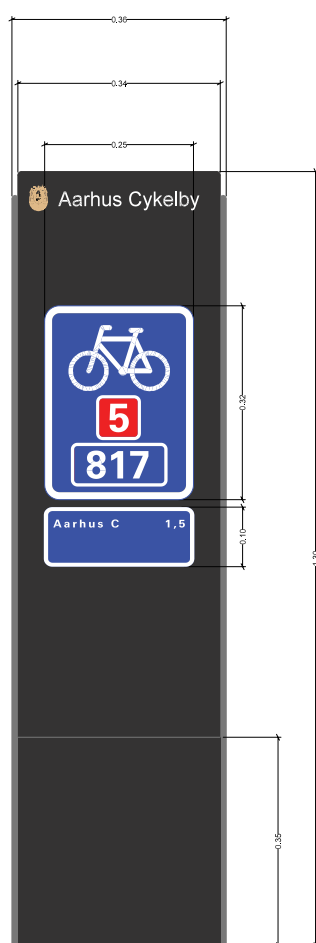
The choice of sign and its design are further described in the road signage standards 11.1.

Courses in cycle route signage are regularly offered in Denmark.

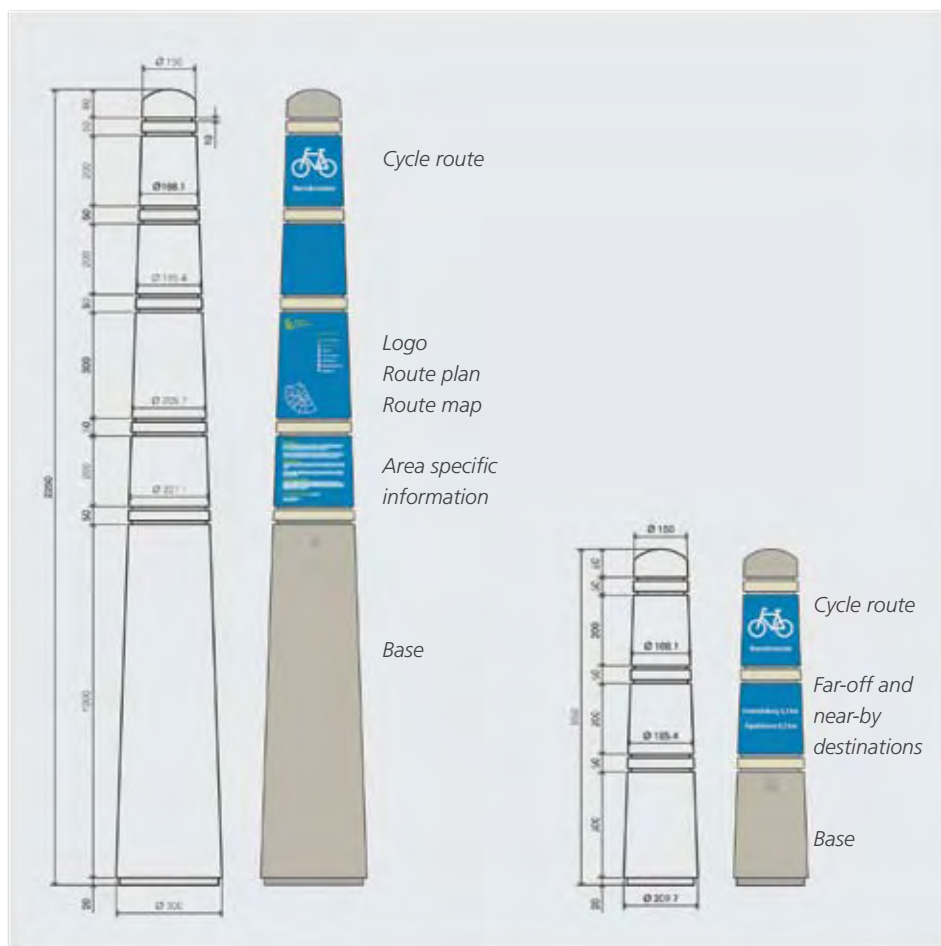
Special urban signage

Signposts and hangars are not appropriate in cities. Consequently, modified bollards may be used without special dispensation from the Danish Road Directorate. Copenhagen 11.3 and Odense have developed their own designs in collaboration with the Road Directorate. Most recently Aarhus introduced new signposts 11.4. The basic principles and the choice of colour and pictograms for the new urban signs remain unchanged, however.

It can be difficult to signpost cycle routes through narrow, winding streets in city centres. Pictograms may be used in cyclist circulation areas but not in mixed traffic lanes. In practice, it appears that cyclists have difficulty understanding pictograms, for example on a ring route around the city centre. Furthermore maintaining the signage over a period of years can prove difficult.



New cycle route signpost in Aarhus 11.4.



The city of Copenhagen developed a special sign system consisting of posts and bollards to signpost green cycle routes 11.3.

Odense followed by Aarhus in 2011 changed the signage to arrow signs on signposts along routes in the city centre 11.5.

CYCLE MAPS

Publication of cycle maps should be an integral part of any municipal strategy to boost cycling. In fact many local authorities do this more or less regularly. Experience shows that there is a huge user demand for cycle maps. Cycle maps help highlight municipal cycling initiatives.

When communicating cycle route information it is important to bear in mind the different types of users (holiday cyclists, Sunday cyclists, and daily cyclists including commuters) and their different needs. All groups can use cycle route maps to plan their route and to find their way. Sunday cyclists and holiday cyclists, in addition to information on cycle tracks, routes, etc., need a certain amount of practical information on services such as accommodation, restaurants, shopping and bicycle repairs. A cycle map also helps tourists recall the journey later.

Odense 11.6 and Roskilde distribute their cycle maps door-to-door, and Copenhagen sent its

pocket cycle route map to 5,000 newly arrived citizens in 2011 as a pilot project 11.7. Many local Danish authorities publish updated cycle maps on a regular basis. They are generally free of charge.

The Danish Cyclists' Federation publishes a nation-wide series of guidebooks with accompanying maps on a scale of 1:10,000. 11.8 In addition, the Danish Road Directorate's digital maps of the national cycle routes are available online 11.9. Guidebooks are available for some of the national cycle routes (published by an Austrian publisher, available in Danish and German) with maps 11.10. In some tourist areas (for example northern Funen and Langeland) local cycle maps are available on a scale of 1:50,000, showing local routes and suggestions for circular journeys in addition to the signposted national and regional cycle routes. Such maps are also highly popular among the local population.

1:50,000 is an excellent scale for a map covering an average Danish municipality. A city map should be more detailed, for example 1:25,000 or even 1:10,000 in the city centre. The map



should show the names of the primary roads and preferably all roads especially in central urban neighbourhoods 11.11.

In addition, the map should show the major local and tourist destinations. The Danish legend should also be given in English even though the map is aimed at the local population. In some areas German is relevant as well.

A cycle map of urban areas is essential to inhabitants and newcomers who are not acquainted with the cycling infrastructure. Motorists who are just beginning to bike will tend to take the same route by bicycle as by car. A map that shows the shortcuts for cyclists is particularly useful to them. Cycle maps should show the way, motivate people to take their bikes, and provide opportunities for an enjoyable experience. The maps can provide ideas for testing different routes, for example for daily commuting, and can be used for Sunday cycling out of town. Maps can also show the location of locked/monitored/good bicycle parking facilities so a cyclist needn't be concerned about theft on a journey to town.

It should be possible to print out map sections from the municipal homepage. Special software is available for designing printable maps. In theory a digital map can always be kept updated. Since very few cyclists can afford a plotter, a digital map cannot replace a printed map. A printed map is rarely as frequently updated as a digital map, but it provides a far better overview than the A4 sheet that you can print out yourself.

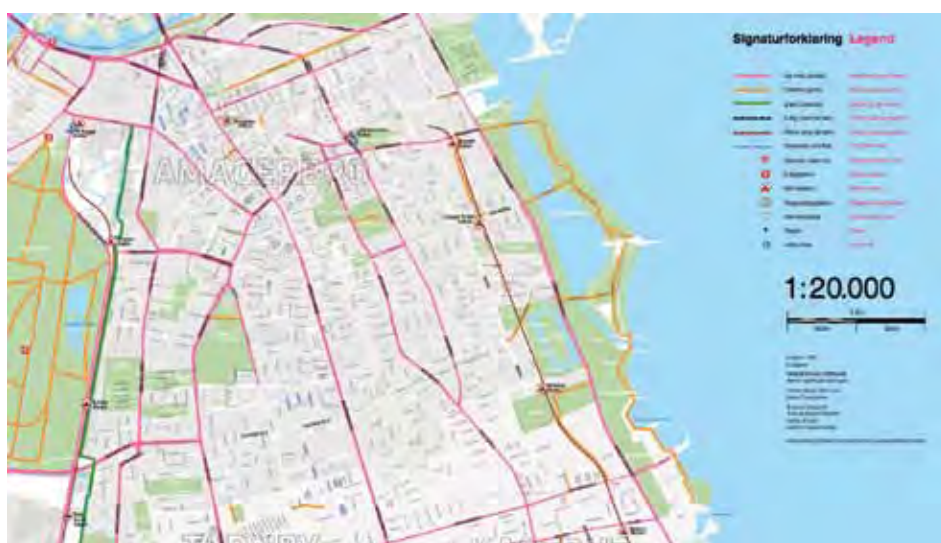
Maps are usually produced on the basis of GIS registration. When maps are updated, both the GIS data and the map theme should be updated.

The road standard 11.1 contains guidelines for cycle maps. It is highly recommended to systematically follow its recommendations for marking and communication. Users find it tremendously helpful when the same type of symbol is used consistently. It is simply common sense that the map legend and colours should resemble the signage out in the field. The map should show the cycle route signposting. This creates a link between the map and the real world. The road standards' legend guidelines are always worth considering when designing cycle route maps. However, there may be local reasons for choosing other legends and designs.

Since local authorities often subscribe to the National Survey and Cadastre maps, it will usually be possible for municipalities to publish cycle maps without special charges.



Gribskov municipal map 11.12 is 1:50,000; the base map is reduced from 1:25,000. This makes the map appear more neutral so the added legend is more clearly visible than on the 1:50,000 National Survey and Cadastre maps. The adapted map is reproduced here on a smaller scale.



The Copenhagen cycle route map 11.13 shows the cycling infrastructure in a simplified form. Cycle tracks on both sides of the road are indicated as "road with cycle track". There is a special legend for "cycling shortcuts". The scale is 1:20,000. Reproduced here on a smaller scale.

CYCLE ROUTE PLANNERS

The internet, cell phones, smart phones, and GPS devices (and doubtless future technologies as well) are new options for providing cyclists with information on choice of route, points of interest, etc. Cycle route planners are also known as journey planners or trip planners. They are developed for several different platforms, not merely the internet, but also smart phones, for example, to accommodate different user groups and generations of cyclists.

Cycle route planners can simplify cycling, making it more accessible to daily cyclists and tourists. They raise the status of cycling and in the long run may even encourage more people to cycle if continuous cycling routes are integrated with public transport.

Odense has offered cyclists an on-line cycle route planner for several years. It shows the shortest and safest route and includes many fixed destinations. Aalborg has a similar, first generation cycle route planner 11.15 with a good route calculator. However, it is being shut down (at the time of writing) since the graphics and flexibility are not up to current standards. The firm which developed the cycle route planner updated the cycling infrastructure on a regular basis for a fee.

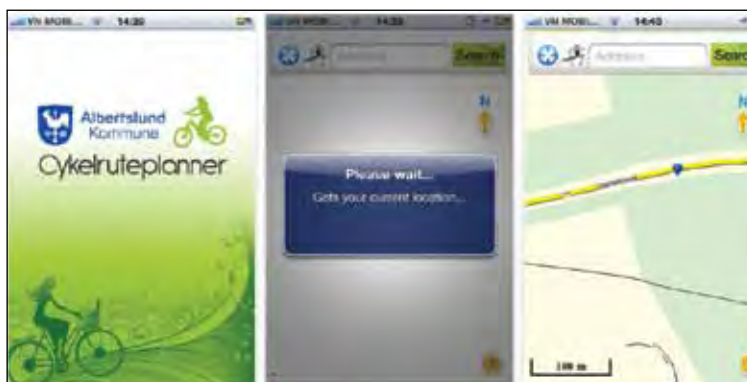
In 2011 Fredericia began offering a cycle route planner which updates automatically, based on Google Maps. 11.16

Some cheap versions of cycle route planners are also available on-line in Denmark. They are usually based on a motor vehicle journey planner; motorways are merely deactivated and motorway cycle tracks are not shown, rendering them rather useless.

Developing cycle route planners

When a local authority wishes to offer a cycle route planner, the available products and their function should be carefully considered. Several consultancies would like to enter the cycle route planner market, but are not usually able to provide the full package.

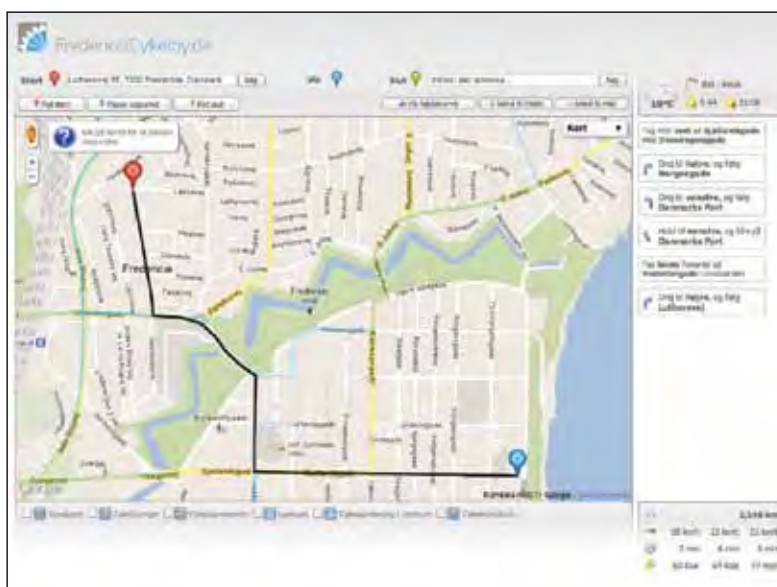
Since the field is undergoing rapid development it is worth considering the free cycle route planners that are expected to be put online (Google, Naviki, etc.) as an alternative to the more traditional planners.



Albertslund cycle route planner for cell phones uses Android. 11.14



Aalborg cycle route planner, now outdated. 11.15



Fredericia's newly developed cycle route planner, 2011. 11.16

TIPS ON CYCLE ROUTE PLANNERS

When you're choosing a cycle route planner, or if you wish to develop one yourself, the focus is often on the user interface. However, it is essential to consider cycling infrastructure data, route calculations, operations as well as user interface.

Gathering infrastructure data

It is crucial that cycling infrastructure information is correct from the outset. Basic data on the cycling infrastructure should be collected or developed by the individual municipality. At best, existing GIS data can be updated. Road authority systems in Denmark can also contain cycling infrastructure data. Extra knowledge gathered from users in OpenStreetMap can be used as a quality control. There should always be a control procedure to make sure the geometry fits, including the link to neighbouring communities across the municipal boundary.

Types of cycling infrastructure

The cycling infrastructure includes cycle tracks, cycle lanes, mixed traffic, contra-flow cycling and segregated off-road cycle paths. Signposted routes (e.g. the national cycle routes) consist of different kinds of infrastructure, but a cycle route planner should be able to process them as a continuous route as well as by their individual elements; a continuous route is of great value to cyclists. Whenever cycling infrastructure data is updated this should be done in GIS and the cycle route planner at the same time.

Road data

FOT, (Standardized Danish mapping - National Survey and Cadastre) 11.17, and Det Digitale Vejnet 11.18 (the digitization of the Danish road network is in its initial phase in 2011) are initiatives to standardize geodata across the country and to provide continuity and standardization of Danish road data. In the long run they may also help standardize cycling infrastructure registration and classification as well. However, the project's initial focus is the overall road network; independent cycle tracks, etc. will not be addressed until later, so there is a long way to go before the data can be imported by cycle route planners. At the time of writing the local authorities can't wait for a "state-of-the-art" data base to be implemented before they can start developing cycle route planners.

Who owns the data and what does it cost?

The question of who owns the bicycle theme data (and the cycle route planner, for that matter) is important, as is the question of what it costs to develop and establish a data processing system. Who owns the base map, and should there be a charge for using it? Can free open source maps be used, or the municipal map, or should the National Survey and Cadastre maps be used free of charge, since the local authorities usually subscribe to them? Users should be able to print out maps free of charge without having to worry about rights.

Route calculation

Well-functioning route planning software is already available on the market. Some is commercial, others open source. It's a good

idea to grant user access to the server hosting the software since this makes it easier for other stakeholders to develop applications.

Users should be able to correct data

Users of the cycle route planner should be able to correct the product, and there should be a procedure for this. This is already an integral part of OpenStreetMap. Correction procedures should be integrated with municipal "bicycleGIS"). A cycle route planner must be dependable, credible (i.e. include short cuts), and updated. User feedback should be addressed quickly so users can see they are taken seriously. The route planner should be stable and fast.

Text and base map

Preliminary versions of the cycle route planner should be tested in a testing phase; it should be made clear that this is not the finished product. The design and function of the interface display on the monitor should be carefully considered. The cycle route planner may be based on one or more base maps depending on the zoom angle. This makes it possible to increase the level of detail while zooming in; perhaps the municipal map should be used as the base map for the most detailed view.

Getting from point A to point B

It should be possible to select and enter a starting point, a destination and via points. The result of the search should be made visible as a line on the map, and it should be possible to display distance (preferably in times and km). A route description is desirable too.

Best route

In addition to the shortest or the fastest route, there should be an alternative suggestion, such as "best route". The best route can focus on sections with cycle tracks, signposted cycle routes, etc. even when this involves a (minor) detour. It is too risky for a public authority to propose a "safest route". Many conditions might be of interest, such as cycling weather. Other real time information, such as current air pollution, may turn out to be extremely time consuming to install and maintain.

Service information

Supplementary functions can be added to the cycle route planner for daily use in town (e.g. restaurants or cinemas) and for recreational use on Sundays (e.g. tourist information.)

Integrating cycling and public transport

Ideally, it should be possible to integrate a cycle journey with public transport based on the principle of seamless travel, which for cyclists often involves combined journeys.

Never underestimate operations

Operation of the cycle journey planner is crucial. Who is responsible for updating information and what does it cost on an annual basis? As a rule municipalities will not enter into financial obligations for more than one fiscal year at a time, which makes it difficult to develop products in collaboration with neighbouring communities.

11.19, 11.20

Future perspectives in 2011

In 2010 the Danish Road Directorate received allocations from the national cycling promotion fund to draw up a proposal for a nation-wide cycle route planner. The government officials in charge of traffic policy thereby placed the Danish Road Directorate in a central position for determining future developments.

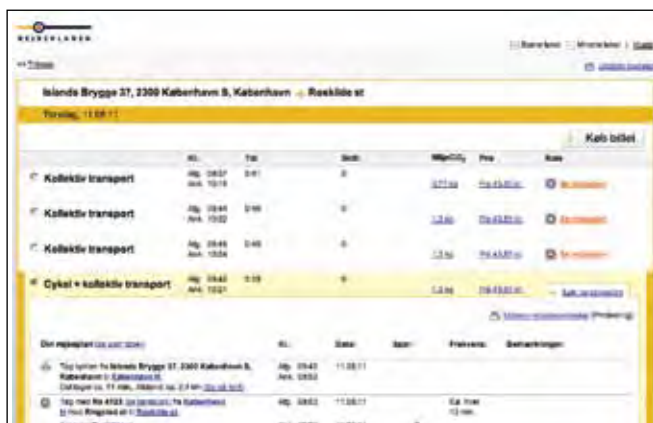
The Capital Region of Denmark is developing a cycle route planner in connection with the so-called bicycle super highways 11.22 in a large number of municipalities. The project Öresund som cykelregion 11.19 is investigating options for establishing one or more cycle route planners in the Öresund region i.e. the Greater Copenhagen Area and Skåne in southern Sweden. The most workable solution appears to be that responsibility for the cycle route planner online belongs to a region or the state while the municipality's role is to produce the data.

Several municipalities provide information on the cycling infrastructure free of charge to firms and organizations who wish to develop cycle route planners. The chance of a high quality product is increased when the local authority donates its cycling infrastructure theme; all potential developers are placed on an equal footing and innovation in the field is boosted. Special expertise is required to protect your interests when drawing up contracts with major international firms.

OpenStreetMap is an open source map developed by users, including data from firms donating aerial photos, for example. In the course of a few years OpenStreetMap has produced a useful map, which was chosen by the Danish Cyclists' Federation as the basis for its cycle route planner. OpenStreetMap is free, nation-wide, and uses the same format in Denmark as abroad. Users under the auspices of the Danish Cyclists' Federation are offered courses in mapping, and deliver location-based information themselves. The Danish Cyclists' Federation's primary focus is on cycle tourism. In 2011 the working title of the cycle route planner website was "Cyclistic". 11.23

"Cyclecopenhagen" is a student developed cycle route planner project 11.24 based on 5 options for choosing a route, such as shortest, green, safer, etc.

Skåne's cycle route planner Resejämföraren 11.25 is based on OpenStreetMap and covers the Copenhagen area as well as Southern Sweden. It's an open platform and shows time, distance, cost in local currency, and kcal for different transport modes on a specific journey.



Rejseplanen.dk, 11.21 which is owned by the public transport services organization, can show where bicycles are allowed on public transport, but cannot show an independent bicycle journey. There is an obvious expansion potential here for a nation-wide cycle route planner, all the more so as rejseplanen.dk already contains a hidden cycle route planner.



Cyclistic 11.23, developed by the Danish Cyclists' Federation. The focus is on cycle tourism.



Cyclecopenhagen 11.24 allows the user to define the route himself.



Resejämföraren 11.25 is Skåne's cycle route planner, and links up to Copenhagen.



Much can be learned from cycle route planners abroad. London, for example, has a cycle journey planner 11.26 and a journey planner for general transport 11.27. When the starting point and destination are entered, the journey planner shows the best choice of transport mode (which is often the bicycle). The cycle journey planner assumes that the user has already chosen the bicycle.

Naviki 11.28 is a route planner based on OpenStreetMap. It covers all of Germany and users can upload GPS registration of the route travelled, thereby automatically updating the map so others can see the route proposal. User route proposals also improve route choice calculations.

Planners in public administrations are often skeptical about basing a cycle route planner on OpenStreetMap, for example, as there is no guarantee that the map is correct or that it won't be sabotaged. It is true that there is no control over the map and the data, but experience from similar open source projects (e.g. Wikipedia) shows that they work perfectly well. Canada is studying how public data can be utilized in OpenStreetMap. The city of Copenhagen is considering whether the cycling infrastructure information in OpenStreetMap can be supplemented by the city uploading extra information, e.g. whether contraflow-cycling is allowed. The city could thereby contribute to raising the map's quality.

The alternative to a free, user controlled map such as OpenStreetMap is having to pay for map rights, etc. This does not merely apply to the start-up phase, but also to use and maintenance. There is a price to pay for the greater security which may be provided by a commercial base map.

There are many indications that in future cyclists will have many different types of cycle route planners to choose from. At the time of writing the field is undergoing rapid development and it is difficult to predict future developments.



Cyclejourneyplanner 11.26 is for people who have already chosen the bicycle as their transport mode.

Journeyplanner 11.27 is for people who want the best transport mode for a given journey.

Advanced options

Show me...

Select your preferred option:

- ☒ The fastest routes
- ☐ Routes with the fewest changes
- ☐ Routes with the least walking between stops

I wish to travel via:

Station or stop in:

☐ Post code ☐ Address ☐ Place of interest

For location help, try the following: [Tube map](#), [Street map](#)

Use any of these modes of transport

Deselect the transport modes that you don't want to use

☒ Rail ☒ DLR ☒ Tube ☒ Tram

☒ Bus ☒ Coach ☒ River

Tick the box below to include cycling routes. [Additional cycling options.](#)

☐ Cycle

My mobility requirements

☐ I cannot use stairs

☐ I cannot use escalators

☐ I cannot use lifts

☐ I use wheelchair accessible vehicles

Select any of the above statements that apply to you. For station access details click [here](#)

Cycling options

Select any which apply:

- ☐ I want a cycle only route
- ☐ I want to leave my bicycle at the station
- ☐ I want to take my bicycle on public transport
- ☐ I don't want to cycle for longer than minutes

Walking options

I don't want to walk for longer than minutes

My walking speed is:

☐ I'd rather walk if it makes my journey quicker

ITS - INTELLIGENT TRANSPORT SYSTEMS

ITS is an abbreviation of Intelligent Transport Solutions. The concept covers systems and technical equipment aimed at improving traffic flows and increasing economic efficiency, transport safety and environmental benefits.

The field is undergoing rapid development, but in 2011 there is as yet relatively little experience with bicycle traffic solutions. ITS has been in use for years for motor traffic, e.g. vehicle actuated traffic signals, and has greatly improved motor vehicle passability. Factoring this technology into solutions for bicycle traffic could have a similar impact.

Cyclists are often forced to accept unsuitable solutions such as having to press a pushbutton at a signalized intersection. Magnetic loops in the road are better, but new technologies for detection such as radar, new light sources such as LED lighting and flexible road marking make new innovative solutions possible.



Right turn lane with separate phase for turning motor traffic used to stop bicycle traffic going straight ahead, but with radar detection cyclists are now only stopped when there actually are vehicles in the right turn lane. Amager Boulevard, Copenhagen.



Lane lights in Odense Cycle City helped cyclists maintain the right speed. 11.29

Lane lights

Lane lights were invented for the project Odense as national Cycle City to help cyclists keep up a steady rhythm in relation to traffic signals (for example 15-16 km/h), and in some situations advise them to reduce speed so as not to have to come to a full stop on red. Lane lights show the optimal speed for steady cycling, even when this is under cyclists' average speed. Cyclists approve of the fact that they are being thought of.

Odense lane lights, which have been removed for other reasons, were green LEDs placed on bollards. It was a requirement that the lane light shouldn't confuse cyclists into crossing on red. For this reason the last three lights flashed yellow before the light signal changed from green to yellow. Half the cyclists in Odense felt positively about the lane lights and very few were negative. The lane lights fulfilled their function, and helped promote Odense Cycle City. 11.29

Lane lights are being installed in Copenhagen (2011) on an experimental basis in connection with an existing green wave for cyclists (four signalized intersections on Nørre Farimagsgade). The lights aim to help cyclists enter the green wave rhythm. Lane lights are installed in both directions before the first intersection included in the green wave. A number of lights are placed before each intersection. The lights are installed in the cycle track and are directed so as not to disturb other road users. The Danish Road Directorate has given dispensation to carry out the pilot project and has approved that the lights flash green.

Green wave

Green wave for cyclists was first introduced in Denmark in 2002 in Odense Cycle City 11.29. The wave included 4 intersections on a commuter route and the speed was set at 22 km/h. In 2004

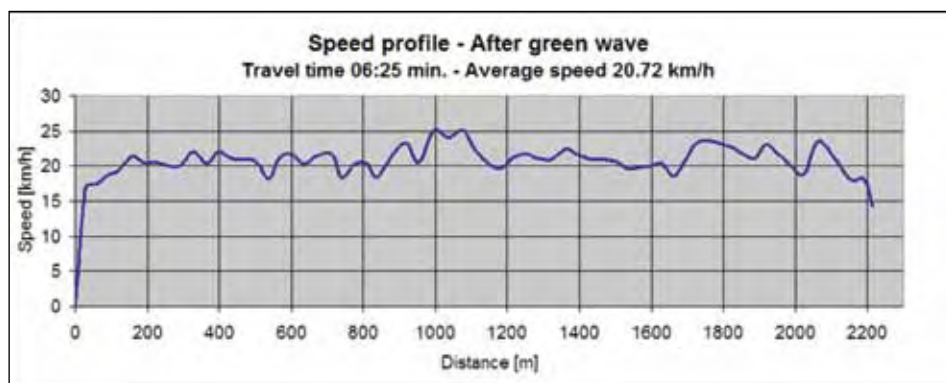
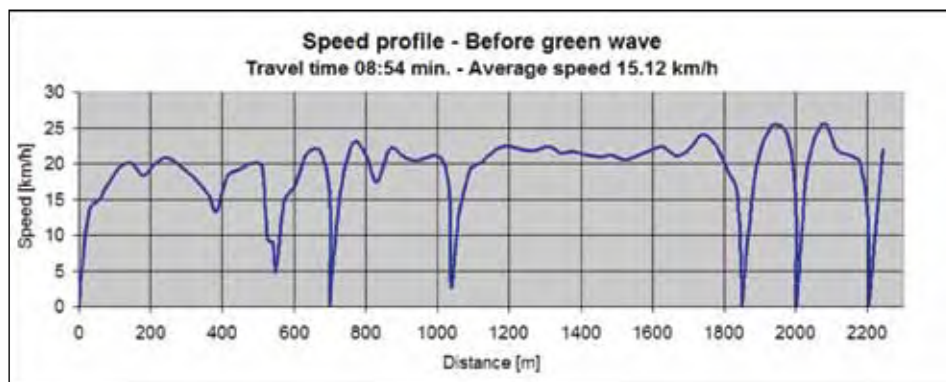


Nørrebrogade, Copenhagen. Signs and pictograms make cyclists aware of the green wave. The green wave is set for 20km/h in changing directions according to the time of day. 11.30

a green wave was established on an experimental basis on Nørrebrogade in Copenhagen 11.30 and included 13 signalized intersections with a speed of 20 km/h. Traffic engineers didn't think that green waves were feasible for bicycle traffic since speed deviation among cyclists is much greater than among drivers. However, after the completion of the pilot project it was concluded that the green cycle wave functioned well.

The green wave on Nørrebrogade was established by adjusting the existing signals which were already synchronized for motor traffic. The signals were synchronized toward the city centre in the morning and away from the city center in the afternoon corresponding to peak bicycle commuting times. The result was that after the installation of the green wave, cycling speed rose to 20.3 km/h compared to 15.5 km/h before it was installed. 11.30 Other traffic (motor vehicles and buses) were only affected to a limited extent. The green wave for cyclists has now been made permanent. In 2011 the plan is to fine-tune the green wave to accommodate bus transport, without breaking the green wave for cyclists. This may be possible using ITS devices. A few more green waves for cyclists have subsequently been installed in Copenhagen.

In principle it is not possible to establish a green wave for cyclists in both directions on the same street at the same time. Nor can green waves criss-cross the city since they would counteract each other, as is the case with motor vehicles.



Green wave, Nørrebrogade, Copenhagen. Above: Before the green wave was installed (when cyclists were stopped by many traffic lights). Below: After (non-stop.) 11.30



"Your speed" indicators

"Your speed" indicators, which were originally introduced by Odense Cycle City, have been installed in Copenhagen (Farimagsgade) along with lane lights discussed above. The speed indicators are intended as a supplement to existing 20 km/h green wave signage. "Your speed" indicators for cyclists were inspired by "Your speed" indicators for cars based on the idea that bicycle traffic is just as important as motor traffic, and that this should be made visible in the street scene.

Vehicle actuated signals

Vehicle actuated signals are nothing new since they have been in use for years for motorized traffic. Cyclists usually got the green time that was "left over" at such traffic signals. In intersections, however, magnetic loops in the road (and pushbuttons) are fairly common, whereby cyclists register their arrival and wait for green. The cyclist phase is only included in the signal circuit when a cyclist has been registered. New options for detection (radar, infrared, etc.) make it easier for bicycle traffic to activate signals.



LED reflectors on the edge of the cycle track warn motorists of right turn accidents in Copenhagen. H.C. Andersens Boulevard/Tietgensgade. 11.31

LED road studs counteract right turn accidents

LED studs are a warning system designed to prevent right turn accidents and particularly to warn right turning lorry drivers that there are cyclists on the cycle track. The system is being tested in Copenhagen. 11.31 The road studs are activated by cyclists when they cross on green and flash into the driver's side mirror so the lorry driver becomes more vigilant. Before and after

observations of cyclist and lorry driver behavior were carried out. Conflicts were halved in three out of four intersections. Afterwards cyclists and lorry drivers felt positively about the system. The idea is to follow up on whether lorry drivers become inured to the system and start ignoring it. Since some bicycles don't contain enough iron to be registered by magnetic loops in the track, combinations of different methods of detection are being considered. When the pilot project is completed, it has to be approved by the Danish Road Directorate before road studs can be installed on a routine basis to prevent right turn accidents.



Variable signs in Aarhus warn cyclists of right turning lorries. 11.31

Dynamic or variable signs

Aarhus has installed dynamic signs in an intersection on an experimental basis. 11.31 The signs flash and inform cyclists if there is a large vehicle in the right turn lane. In this case the system warns the cyclist in contrast to the system described above in which the system warns the driver. The variable signs have been assessed by behavioural studies including video registration and interviews. The number of conflict situations has dropped by 28%, and cyclists orient themselves more vigilantly than before. Cyclists are generally satisfied with the signs; 86% would rather cross the intersection with the signs than without them. Some cyclists, however, are confused about the sign's function, which means that road users should be better informed. There have been operational issues as well. The system must be highly reliable (and constructed so that road users don't get confused if it fails to function); this is a prerequisite for recommending the system. The city of Aarhus is further developing the system at the time of writing.

Countdown signals for cyclists

Countdown signals for cyclists can be based on the same principles as for pedestrians. The Danish Road Directorate and a number of municipalities in the Danish Capital Region are

Dutch example of countdown signal for cyclists. 11.22



at the time of writing discussing the feasibility of testing countdown signals for cyclists in connection with the bicycle superhighway project on the Albertslund route. 11.22 Red and green countdowns in the signal are under consideration as is a countdown system on a separate post 50 m before the signal, making it possible to "time" your arrival at the traffic signal.

Cycle tracks can be divided into a "fast lane" for fast riders and a "comfort lane" for slower ones. This would prevent the two groups from getting in each other's way. A wide cycle track is required for such a system. In 2011 the use of "dots" to mark the lanes is being discussed, so cyclists don't confuse the path with a two-way cycle track. The length of the fast lane should be at least 100 m and doesn't necessarily have to be continuous over a very great distance. Before such a pilot project can be approved by the Danish Road Directorate, the design of the starting and termination points in particular have to be clarified, in addition to the lane marking.

Idea contest

An ITS idea contest 11.32 arranged by the city of Copenhagen produced a number of proposals for how ITS can address some of the Danish capital's major traffic, environmental and climate challenges. The city focused on the fact that the ideas should be visionary, innovative and a visible part of the street scene. Many proposals involved cycling.

The winning proposal was the concept of the "super cycle track", aimed at putting a new focus on cycling and at significantly raising comfort and service levels. The proposal's elements were later developed and concretized in a plan for a super cycle track on Østerbrogade in Copenhagen 11.33. The concept further inspired a major project in the Danish Capital Region called the "bicycle super highway" 11.22 focusing on commuter routes. It is anticipated that this project will utilize new ITS solutions.

The “super cycle track concept” and some of its ideas

Some of the ideas developed by the super cycle track concept are being implemented at the time of writing while others are still merely ideas. Some of the proposals mentioned below require careful consideration. If they prove feasible, they will then have to be approved both by the Police and by the Danish Road Directorate as a pilot project.

INFO STRIPE

An info stripe is envisioned as a road marking (e.g. a 30 cm green stripe on the left side of the cycle track) indicating that the cyclist is on a super cycle track. The info stripe should show lane lights and pictograms indicating cycling times, e.g. to the next S-train station.

GREEN EXTENSIONS, ACTUATED SIGNAL CONTROL

Green extensions are already utilized for buses and cars. Groups of cyclists in the final part of the green phase may be able to get across with a green extension of perhaps 10 seconds.

BUS WAITING AREAS

When it is not possible to install a traditional waiting area at a bus stop, a virtual bus waiting area might help cyclists and bus passengers pass each other with fewer conflicts. The idea is that when the bus's arrival is registered, a waiting area becomes visible by changing an asphalt coloured stripe to white. The cycle track becomes visually narrower while the bus is waiting, but still allows cyclists to pass.

DYNAMIC TURN PROHIBITIONS

Dynamic turn prohibitions for motor vehicles can be established by a no turning sign that is activated at peak times, when there are many cyclists and many potential conflicts between cyclists going straight ahead and turning cars.

GPS

GPS, which is increasingly common in cell phones, can be used for GPS trailing in addition to telling you where you are. GPS technology can also be used in promotional campaigns. Several municipalities have presented 12-13 year olds with the GPS based cycle campaign “Can you bike around the world in 80 days?” 11.34 The students help the virtual circumnavigator,



CopenhagenWheel prototype. 11.36



Cyclists can see they're being counted while they're being counted. The picture shows a bicycle counter on a cold December afternoon in Frederiksberg. The counter shows this year's and last year's bicycle traffic as well as the number of cyclists on the given day. 11.35

Dr. Glob, circumnavigate 40,000 km around the world by cycling themselves. A GPS log controls the number of kilometers cycled, and uploads it to www.80dage.dk.

Bicycle counters

Bicycle counters or “bicycle barometers” are a way of showing cyclists that they count, and that cycling is a desirable transport mode. Odense Cycle City 1999-2002 11.29 developed the country's first bicycle counter, which shows cyclists and other citizens the number of cyclists passing and also serves as an automatic traffic counter. It provides useful information on bicycle traffic developments but is not as accurate as a manual count. Several other cities have acquired bicycle counters which are now available as a standard product in a couple of brands. Bicycle counters have become a Danish export item 11.35.

Copenhagen Wheel

Copenhagen Wheel 11.36 was developed by MIT (Massachusetts Institute of Technology) for the COP 15 climate conference in Copenhagen in 2009. The wheel can be mounted on any bicycle and transform it into an e-bike that regenerates braking energy, etc. The wheel contains a motor, 3 gears, batteries, sensors, GPRS, etc. A smart phone can be mounted onto the handle bars, and communicates with the wheel via Bluetooth. The phone can be used to lock the bike, switch gears, activate and deactivate the motor, and see real time information on air and noise pollution, congestion and road conditions. CO₂ levels, NO_xs, noise (db), relative humidity and temperature are measured. The data gathered can be used individually, but if data is donated to the city it can provide new information that can be used for planning, etc.





OPERATION AND MAINTENANCE

High quality operation of the cyclist circulation area is a primary factor in determining whether cyclists feel like cycling. Poor surfaces can distract cyclists and in some instances cause serious accidents. Low quality operation and maintenance help maintain the bicycle's image as a low status transport mode. Quality improvement is therefore highly recommended. An excellent way to start is by performing a major maintenance check of roads and cycle paths by bicycle every year.



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An even surface is crucial to cyclists.

PRIORITIZING OPERATIONAL RESOURCES

A Fredericia Cycle City study showed that 56% of citizens demanded better maintenance of paths and roads, a demand that exceeded all other demands. In Copenhagen only 50% of cyclists were satisfied with cycle track surfaces, but were even more dissatisfied with road surfaces. (Bicycle Account 2008).

Operational resources are prioritized according to several different technical and political parameters. Operation often has low priority in relation to new construction. All arguments should be consciously weighed against each other when establishing prioritization principles.

Cyclists are particularly sensitive to operation quality. Since a high percentage of Danish citizens are cyclists, there is naturally a great demand for high quality operation in the cyclist circulation area. Furthermore, it is often cheaper to improve quality on cycle paths than on traffic lanes, which means that prioritizing high quality cycle paths rather than traffic lanes might be an excellent idea.

It is crucial to cyclists that cycle tracks and other circulation areas are not rough or full of potholes. Cyclist comfort is significantly reduced by the unpleasantness of bumpy surfaces. In addition luggage can be knocked off the bicycle. Furthermore, a cyclist expends more energy on an uneven surface. Finally, a bicycle can be permanently damaged by biking over a pothole, particularly the spokes, tires and wheel rims. Cyclists often try to ride around potholes thereby getting in the way of other cyclists.

Bumps reduce cyclist safety since the cyclist risks falling and being injured. If the cyclist wobbles he risks hitting the kerb, pedestrians or other cyclists. In some cases the cyclist can land in front of a motor vehicle and risk serious injury.

Uneven road surfaces are primarily the result of badly executed road reinstatement after utilities construction, asphalt patching, ramps, manhole covers and tree roots. Add to this normal road

surface attrition caused by frost and thaw, salt, etc. All contractors should be informed that all asphalt repairs must be carried out in a workmanlike manner with no noticeable edges or differences in level to the existing asphalt. One option is to move the cables running under the cyclist circulation area to under the pavement. In addition, all patching should be across the entire width of the cycle track.

Cycle tracks should be repaired by using powdered asphalt if the thickness of the layer is less than 3 cm. When the base is made of crushed asphalt concrete it should be finished with powdered asphalt. Powdered asphalt should not contain flint chippings; granite should be used instead.

Machine laying is highly recommended for reinstating longitudinal cable trenches or as a machine repair of a large area. Reinstatement of transverse trenches should normally be performed manually. The different repair treatments are described in the Danish Road Directorate's road standards for the construction and maintenance of roads and paths.

When tree roots are the cause of the damage, repairs will have a temporary effect since the tree's continued growth will lift the asphalt and kerb further. It is occasionally necessary to remove individual roots, which should be cut off and dug up on the section under the circulation area. Since this is a serious procedure for the tree it must only be carried out under professional guidance.

The problem is more serious if the tree is planted in an area that is too small for its root system to develop properly. Cutting the tree down or replanting it are possible options depending on the tree's age and species. Good growing conditions prevent such problems, typically 30 cm topsoil on 80 cm well drained, non-compressed subsoil, which in turn should lie on loosened ground soil. Since the roots are usually of the same proportions as the tree crown, the area around the tree should be as large as possible. Alternatively, the tree crown can be pruned regularly which means that the root system won't need so much space. Special skeletal soils are available so that the roots can spread.

Roads and paths operation has become more costly following the Danish decision to prohibit the use of pesticides in public areas.



Potholes distract cyclists from traffic.

Maintenance involving heavy vehicles on thin path surfaces may result in longitudinal cracks where weeds can grow. Once weeds take hold, the surface deteriorates more rapidly. The spraying prohibition places new demands on cycle path construction, light-weight maintenance vehicles and cycle path inspection. In practice, unless extra funding is granted for operation, cycling will become more uncomfortable.

HIGHWAY CAPITAL VS. CYCLIST SERVICE LEVEL

Huge sums have been invested in road construction over time. Most of this value lies in the wearing surface of traffic lanes and cycle paths. The value, in the shape of the wearing surface, can only be maintained by the on-going maintenance or renovation of the protecting wearing surface as it inevitably deteriorates. There is a relation between annual expenses for wearing surface renovation and annual expenses for maintenance. If wearing surface renovation is reduced, maintenance expenses rise, and vice-versa.

Financially, the most cost-effective maintenance is to keep the total sum of wearing cost renovation and wearing cost maintenance as low as possible. This means that the wearing surface should be renovated at the precise time when renewing the wearing surface is cheaper than continuing to repair it.

However, since cyclists are highly sensitive to rough surfaces, caused by repairs for example, the state of cycle track wearing surfaces should have top priority even though it might seem more rational from an operational/economic point of view to continue to repair them. Minor roads with little bicycle traffic may be deprioritized. When new cycle tracks are being planned, it's worth considering whether stronger roadbeds should be established since this may reduce maintenance.

CYCLE PATH EVENNESS AND QUALITY

Quality criteria

Quality criteria may be based on subjective experience or objective registration. An example of a subjective assessment of bumpiness is an assessment of road conditions carried out by the operations personnel of a given district. The assessment is personal, and is primarily based on observations from daily inspection, as well as enquiries and complaints from citizens, interest groups, etc. This type of regular inspection, which is not systematic, is usually carried out by car, but it's a better idea to do it by bicycle.

Experience from Odense indicates that inspection by bicycle is a time consuming task that will typically be met with opposition among traffic technicians. In the long run, however, the technicians involved gain greater insight by experiencing for themselves what minor bumps, for example, may mean for cyclists. This means that more repairs may be anticipated than when cycle paths are inspected in a motor vehicle. However, it should be noted that the technicians involved gain a greater understanding of what it feels like to be a cyclist in traffic.

The Danish Cyclists' Federation is carrying out a new project in 2011 to develop a new method of cycle track inspection.

Systematic registration of the amount of damage should be performed once each spring by a major inspection. The major inspection of cycle paths should include a road technician riding through the entire network on a bicycle. Potholes, patches, subsidence, cracking should be registered and measured as well as the extent of work necessary to renew the wearing surface. The data should then be processed by maintenance software that selects sections for technical evaluation. The software prints out prioritized lists of wearing surface renewal and repairs, in accordance with the budget.

The "bumpmeter" bicycle provides a correct, objective registration of uneven surfaces. Alternatively, in many areas road surface measurements are carried out by a small laser equipped vehicle that registers a very precise longitudinal profile. This makes it possible to formulate quantitative objectives for the evenness

It's obvious when the cycle path surface has been there for many years.



An even surface is crucial to cyclists.

of each sub-section, which is an excellent instrument for funding prioritization.

Technicians in the city of Copenhagen have covered the entire cycling network with a bumpmeter bicycle and classified each section into one of three categories of surface quality, the appropriate number of categories for subjective inspection. Several local authorities, including





Cyclists use deserted sections too.

Copenhagen, now use laser devices to measure cycle track evenness.

The degree to which cyclists are adversely affected by uneven surfaces depends on the width of the cyclist circulation area, i.e. whether they can ride around potholes, cracks, depressions, etc.

Major renovation

Some poor quality cycle tracks are best improved by major renovation. Such renovation is costly as it may be necessary to replace the road base and drainage construction, reinstall kerbs and restructure pavements. Some major renovation can be carried out in connection with major utility construction.

It may be worthwhile to carry out extensive renovation using a construction account. This makes it easier to fund renovation costs by linking them to other road and path improvements carried out simultaneously.

It is always a good idea to improve cyclist safety and service levels in connection with any major renovation, so as to ensure a permanent improvement of cycling facilities. This is the most cost-effective means of utilizing available funds. Operation and maintenance should always be an integral part of schemes for roads, paths and bicycle parking.

The road inspector is ready on the company bike.



Roads without cycle tracks

Repairs aimed at improving cycling facilities should have higher priority on roads without cycle tracks. Such repairs include replacement of gully grates aligned the wrong way and reinstatement of uneven surfaces after utility construction; transverse gullies and asphalt patches are frequent issues.

Gully grates and manhole covers

Gully grates can get in the way of cyclists because of their placement, difference in level, or grating. Gully grates can be height adjusted so they are flush with the road surface, or moved in to the kerb. Grates with longitudinal slots should be turned 90 degrees or replaced with a more cycle friendly type of grate.

Older types of sewer covers that are fixed to the well frame are often unacceptable due to the difference in level to the wearing surface, and should be replaced by an adjustable model. The costs should be defrayed by the underground cable owner. Sewage wells are often inappropriately located, and moving them is a costly and difficult process.

Cyclists will often try to avoid cycling over manhole covers and grates in the cyclist circulation area and will be tempted to make a dangerous swerve. This behavior is due to fear of jolts or bumps even if the cover poses no real problem. This can be avoided by integrating the grate in the kerb with a side entry inlet. However, this type of gully is rarely used in Denmark and there is very little experience with it. The city of Copenhagen installed side entry gullies in one new construction project (2010) with very narrow

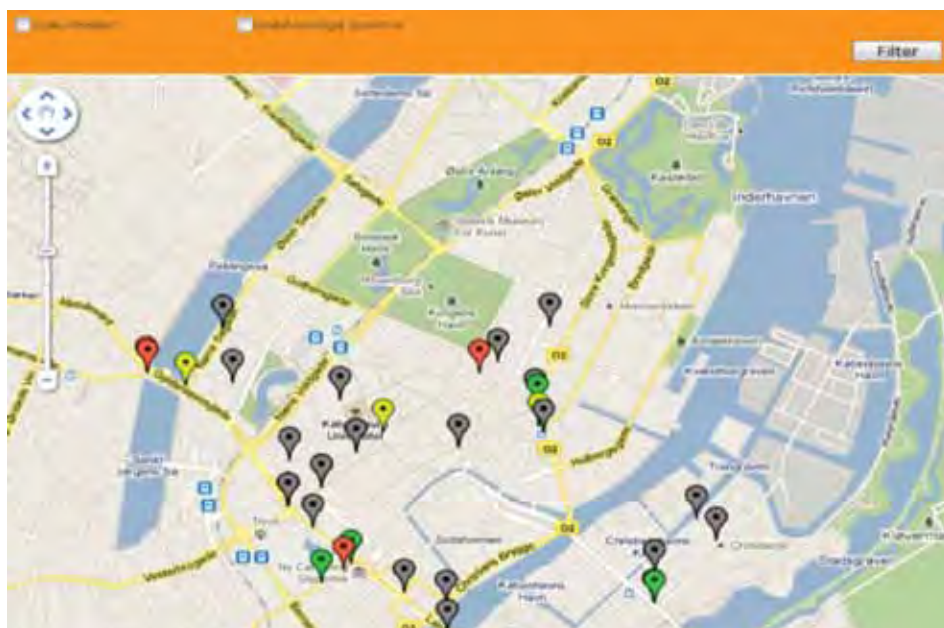
cycle tracks. The city is also carrying out a pilot project testing side entry inlets in areas where the road surface is slated for renovation or where cycle tracks are very narrow. One of the potential challenges here is that the inlet between the asphalt and the upper edge of the kerb is fairly narrow so the downpipe may easily get blocked by leaves, etc. Time will tell whether or not this poses a real problem.

Dialogue with citizens

The Danish Cyclists' Federation as well as ordinary cyclists are well able to contribute qualified opinions regarding operation and can even present proposals for other focus areas. It's a good idea to have a "hot line" to the Federation for minor damage, etc. This reduces the road authority's need for resource demanding administration and inspection. Furthermore, direct contact promotes mutual understanding.

A cyclist volunteer corps provides low cost, well-coordinated supervision of operation and maintenance quality. One simple solution is to enable cyclists to send text messages on flaws and deficiencies. Several local authorities have set up an internet function for reporting deficiencies on a map. Another variation is a system that can send photos and positions from a GPS enabled cell phone.

The funding of minor cycling improvements (as opposed to routine pothole patching) is often a problem, which is why the city of Copenhagen has introduced a "pebbles fund" for minor improvements in the grey area between operation and construction.



Tip us off ("Giv et praj") - the city of Copenhagen's trouble shooting website for maintenance purposes.



Different types of gullies.

Time lag after new construction

The normal practice for major road renovation and new construction is to wait until the year following the completion of all work before laying the wearing surface. The time lag between laying the base and the wearing surface is necessary due to the subsidence that occurs after work is completed; this is unavoidable in practice. When cyclists are informed of this, for example by writing "temporary road surface" directly on the road base, they are less likely to complain.

When the new cycle track road base is laid in the same quality as the road itself, the only reason to postpone the laying of the road base is winter frost.

WINTER MAINTENANCE

Aim and scope

A modern urban community can only function optimally if roads, tracks and paths are kept passable and safe regardless of season and weather conditions. It is therefore crucial to effectively address the inconvenience caused by snow and ice on circulation areas. The road authority is compelled, pursuant to the "law on winter maintenance and cleaning of roads", to remove snow and to take measures to address slippery surfaces on public roads and path areas.

Prioritization and service goals

Since roads and paths can be classified in a hierarchy according to their importance, one obvious solution is to handle them differently. This makes it possible to utilize resources to best advantage by creating a reasonable balance between traffic, environmental and financial considerations.

In practice roads and paths can be classified into 3 snow removal categories, A, B, and C, according to the importance of their function. Since year round cycling is a political priority it is crucial to give cycle tracks high priority in winter.

Category A contains primary segregated off-road cycle paths and cycle tracks along primary roads. It is essential that the service level on such paths is high since snow and ice are highly inconvenient for cyclists. Cyclists should not be tempted to use the carriageway instead of the cycle track. Such sections are so important for bicycle traffic, and in the final analysis for the entire community, that they should be kept open without major inconvenience 24 hours a day 7 days a week.

Category B includes school routes and feeder paths. Snow removal and de-icing treatments are only carried out during daytime, 7 days a week.

Category C includes shorter paths of minor importance. Snow clearance and de-icing treatments are only carried out exceptionally.

Recreational paths, with a gravel surface, for example, should not usually be included in winter maintenance.

De-icing treatments and snow removal

Icy surfaces can be treated on paths by traditional road salt, gritting or alternatively by a saline solution.

Traditional salt is highly detrimental to the path environment since for technical reasons the salt dosage on cycle paths needs to be far higher than on traffic lanes.

Gritting too has environmental costs, in addition to increasing the risk of puncture and skidding. Furthermore, gritting is not particularly effective as a de-icing measure. Grit must be continuously removed from sewers, and the grit that remains on roads and paths needs to be deposited at specially controlled waste dumps due to its mixture with hazardous materials. There is a special deposit charge in Denmark. Furthermore, grit is a scarcer resource than gravel.

A saline solution consisting of 22% sodium chloride reduces salt consumption by 80% when



Snow removal is crucial to bicycle traffic volume.

it is applied correctly, compared to traditional salt consumption. Applying the saline solution costs approximately the same as using traditional salt, but only 2/3 of what it costs to apply grit. Saline solutions, however, have proved less effective for heavy snow fall and thick layers of ice. Good meteorological data makes it possible to use salt as a preventive measure prior to heavy snowfall and frost.

De-icing treatments are only effective if snow is removed first. In Denmark the same vehicle can usually easily handle snow removal and de-icing. Heavy tractors are necessary to ensure high service levels in all snow situations by quickly and efficiently removing snow from circulation areas. Normally, snow may be piled in an embankment on the kerb between the cycle track, pavement and carriageway, but when cycle tracks and lanes are very narrow, snow should be removed and carted away. This is so costly that it should only be done when absolutely necessary, which is



The road sweeping vehicle does not necessarily sweep around bollards.

another reason for never compromising on cycle track width.

CLEANING

There should be a high service standard for cycle path cleaning as well. Paths should be swept systematically according to the maintenance hierarchy, from twice a month to once every two months.

In addition extra sweeping is necessary during leaf fall. An emergency corps should be available for the acute removal of dangerous objects and broken glass. This applies especially to Saturday and Sunday mornings in urban streets where night life results in broken glass strewn over paths and roads.

When cleaning can't be performed by standard tractors, and special, extra narrow vehicles are needed instead, the minimum passage of such vehicles is 1.6 m.

FROM CONSTRUCTION TO OPERATION

Operation personnel should be an integral part of any construction project to provide them with adequate knowledge of the project's aim and to incorporate their experience into the project

scheme. In addition, the operations department should always inspect construction before the contractor delivers the end product.

Examples of the most common issues after delivery are incorrectly aligned gullies, drainage construction that fails to work, and subsidence. The operations department should ensure that the contractor addresses such issues during the period for supplementary performance.

Costly operational elements

When sett paving, paving stones, etc. are installed for aesthetic reasons, it should be noted that such surfaces are more difficult and more costly to maintain and clean than asphalt surfaces. In addition, uneven surfaces are often criticized by cyclists.

Blue cycle crossings are also more expensive to maintain, since the price is approx. twice as high as standard thermoplastic. Painted marking costs approx. $\frac{3}{4}$ of the price of thermoplastic, but its service life is only 1/10 of the service life of thermoplastic. In addition, aggregate materials in thermoplastic prevent it from being slippery.

The Danish road standards state that cycle tracks may be signed by cycle track signposts or marked by a thermoplastic cycle symbol. Cycle symbols are the most cost effective unless there are other reasons to choose signposting. In urban areas cycle tracks are usually not signposted.

POOR MAINTENANCE AND OPERATION RESULT IN CYCLIST ACCIDENTS

Low quality operation, including poor winter maintenance, increases cyclist risk of traffic accidents. A number of accidents are related to operation quality. It is not always possible to establish the real cause of an accident. Accidents are usually due to a combination of factors that are difficult to keep apart. Solo accidents are generally caused by fewer factors than accidents where several parties are involved.

The Accident Analysis Group at Odense University has made a study of solo cycling accidents. It is interesting to note that only 2% of solo accidents are registered by the police compared to 26% of multiple accidents. In approx. 70% of the studied solo accidents there were no flaws and deficiencies on the road surface, which might have caused the accident. In 10-15% of the accidents loose objects (branches, pebbles, etc.) were a contributing factor, while 3-4% were caused by a pothole. Factors such as incline, road work, gullies and railway tracks were of minor importance.



Large puddles make it necessary for cyclists to engage in dangerous dodging manoeuvres.

There are many indications that accidents can be prevented by more frequent sweeping of roads and paths and faster patching of potholes on paths and along the road. Roads with poor surface quality constitute a particular risk for solo accidents among cyclists. Finally, snow removal is important as it eliminates any risk for cyclists, but primarily to increase cycling volumes during the winter.

De-icing should be performed before the road becomes icy. When cycle tracks are wet and the temperature is touching zero cyclists risk falling since "black ice" forms suddenly, making it difficult for cyclists to judge whether the surface is slippery. A slippery surface warning system is an invaluable instrument, helping the administration avoid such situations.

ROAD REPAIR

It is often consciously or unconsciously assumed that road users can tackle road construction sites on their own. It's a good idea to give cyclists special consideration during road construction since they're more vulnerable to rough surfaces and diversions than motorists. Clear marking and barriers can prevent bicycle accidents. Occasionally it may be necessary to manage motor traffic in the interests of cyclist safety, comfort and passability. 2-3% of bicycle solo accidents are caused by road construction.

The road authority can introduce stricter requirements for utility construction sites and



asphalt works on cyclist circulation areas, and above all improve inspection and control. It is in the road authority's interests that the condition of the reinstated circulation area is at least as good as before excavation.

GENERAL REMARKS ON ROAD REPAIRS

Road construction sites are often highly inconvenient and risky for road users. Cyclists demand smooth surfaces and road construction is particularly inconvenient for them. Cyclist safety, passability and comfort should always be taken into account regardless of whether the contractor is the road authority, the underground cable owner or others, and regardless of whether the road authority performs the work itself or hires an independent contractor.

Road construction is often of short duration and will not necessarily have a negative impact on the cycling experience. However, there are a number of measures that can be taken to meet cyclist needs. In some cases road users are not be allowed to enter the work area; in such cases the best alternative route should be indicated.

When cyclists are directed onto the carriageway, there should be a "Cyclists on road" sign. Many excavations direct cyclists into the pedestrian area rather than the carriageway. Depending on the amount of space available and the number of pedestrians, it may be a safer solution to place cyclists with pedestrians.

Cyclists shouldn't have to ride over high kerbs or dismount at road construction. High kerbs and dismounting are only acceptable as an exception, and only for road construction of under a day's duration and outside peak hours.

CITIZEN INFORMATION

Citizens do not always receive notification of excavation in advance since there are so many projects. Notification of excavation is only required when passage will be obstructed or prevented, or when road users may anticipate significant delays.

Notice of excavation is typically given in a local newspaper, a door-to-door distributed weekly, or as a news item on the local radio station. Large construction signboards can also be used to inform citizens of the road construction and its duration. It's also a good idea to present the benefits, for example when a new wearing surface is being laid on a cycle track.

SIGNAGE AND MARKING

Signage and road marking of a road construction

site should be easily understandable. It may be necessary to issue a warning at an appropriate distance, partly to heighten cyclist vigilance and partly to give cyclists time to choose another route.

It is often difficult for cyclists to adjust their speed in relation to road construction since there is rarely preliminary warning of sharp bends and high kerbs. It should be clearly signed when cyclists need to reduce speed at a road construction site. Occasionally temporary, clearly painted road markings on the track or carriageway are the best means of directing cyclists.

Incorrect or unnecessarily restrictive signage may occur when excavation takes place at short notice. A typical example is a "No entry" sign when a "No motor vehicles" sign would do. Cycling prohibitions should be avoided whenever this is technically possible without jeopardizing safety.

It can be necessary to divert cyclists when construction takes up the full width of the road. It is crucial that cyclists should be informed of the diversion in good time and that they know it's in force. Diversions are more inconvenient for cyclists than for motorists. The longer the construction lasts, the greater the inconvenience.

There are examples of incorrect placement of temporary traffic signs. Traffic signs are typically mounted on a low post on a rubber base, and typically placed on the edge of the road or on the cycle track. Cyclists can't pass underneath the low height of the post and the sign including the safety margin takes up 1 meter of the cycling area. This is particularly problematic in bad weather when cyclists are typically looking downwards. A standard bike light is not sufficient to light up the sign in the dark.

BARRIER MATERIALS

It is essential that construction site barriers are made of correct materials, especially when it's a question of a deep excavation that may constitute a cyclist risk. It should not be possible for a cyclist to fall over or under the barrier. In addition, cyclists should not be squeezed against the barrier by other traffic.

A lateral cycle track barrier can be established by a bar, a wire fence, etc. and should be marked with at least two marker lights unless the barrier is sufficiently illuminated, which is rarely the case.

The advantage of a full height wire fence compared to a bar barrier is that it prevents

the cyclist from falling into the excavation. Regardless of the type of barrier used it should be continually inspected since at worst a defect may be fatal to the cyclist.

MARKER LIGHTS

Normally marker lights are only required when containers, etc. are placed on the carriageway. Since bike lights can rarely light up the road and cycle path safely, marker lights should be considered for dark areas and dangerous excavations.

There should be 2 m max. between lights at lateral cycle track barriers, and 10 m. max at longitudinal barriers.

COVER PLATES AND THE LIKE

Excavations are covered with plates, etc. in order to facilitate traffic flow. These are usually thick iron plates with a high metal edge. Rounded edges should be used whenever possible in the interests of bicycle tires and spokes. It is difficult for the cyclist to judge whether the edge is uncomfortable and whether he needs to "jump", stand up, or reduce speed. When an excavation is of longer duration asphalt ramps should be installed on all plates with a high edge.

When there are cables and pipes running across the road a board is often placed on each side, frequently with a height difference of several centimeters. Cyclists find this very annoying and it may cause falls.



SPEED REDUCTION

Motorists trying to overtake cyclists on sections with narrow traffic lanes in mixed traffic pose a significant threat to cyclist safety. Narrow spaces combined with the risk of falling into an excavation may make it necessary to reduce traffic speeds in the interests of the working environment and road safety.

Speeds can be reduced by signing a slower speed limit. In exceptional cases it may be necessary to install temporary physical traffic calming measures, such as removable, screwed on speed humps made of loose asphalt or rubber. In a few cases it might be worthwhile considering reducing cycling speed. In that case a cyclist speed hump, etc. can be installed.

ACCIDENT RISK

As a general rule construction work cannot be considered a major cause of solo cycling accidents. This is due to the fact that road construction is not particularly widespread so that when cyclists encounter it they increase their vigilance.

The Accident Analysis Group at Odense University Hospital has made a study of cyclist solo accidents. More than 70% of the injured cyclists were involved in solo accidents. 2.4% of the cyclists interviewed in a solo accident survey stated that there was road construction on the road. 1.8% of the cyclists cited barrier materials as the cause of the accidents. 2.7% of collisions with solid objects were caused by a cyclist hitting a barrier. There were more adults than children and young people involved in solo road construction accidents.

The exact relation between road construction and cyclist accident risk has not been studied. Still, there is every reason to believe that considerate design of road construction may prevent some bicycle accidents.

Potholes are a threat to cyclists.

PLACING CYCLISTS

The following is a brief introduction to the placement of cyclists at fixed construction sites.

ROAD CONSTRUCTION ON ROADS WITH CYCLE TRACKS

- If there are 1.2 m minimum of cycle track outside the work area, cyclists should remain on the track.
- If the pavement outside the work area is wider than 3 m, a temporary cycle track should be installed on the pavement by a longitudinal barrier.
- If the pavement outside the work area is 2-3 m wide, placing cyclists on the pavement with or without a longitudinal barrier should be considered.
- If cyclists are not placed on the pavement, a 1.2 m minimum wide cycle track should be established on the carriageway by a longitudinal barrier.
- If a temporary cycle track on the carriageway is undesirable, traffic calming of motor traffic should be considered.
- Establish good cyclist diversion routes or good asphalt ramps on the carriageway.

ROAD CONSTRUCTION ON ROADS WITH MIXED TRAFFIC, KERB LANES OR CYCLE LANES

- Consider establishing a 1.2 m wide minimum temporary cycle track on the carriageway by a longitudinal barrier.
- If the pavement is more than 2 m wide, a temporary cycle track on the pavement with or without a longitudinal barrier should be considered.
- Consider motor traffic calming.
- Establish a good diversion route for cyclists.





PUBLIC BIKES AND COMMUTER BIKES

Danish cyclists do most of their biking on their own bicycles, and in Denmark this will continue to be the case. Many cities abroad, however, have kick-started significant bicycle traffic growth by making bicycles available to the public. The situation in Denmark is quite different since most people already own one or more bicycles. However, there is a potential in offering bicycles in different contexts. There are four concepts: public bikes, commuter bikes, station bikes, and company bikes.

The following examples illustrate Danish experience in this field. The chapter also provides examples of public bike systems from abroad, which are quite different from Danish solutions.



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PUBLIC BIKES

Public bikes in Denmark are normally located throughout the city centre and are either freely available to everyone or only to registered users. The original systems (which were primarily Danish) were free with a refundable coin deposit. More recent systems cost money based on an hourly rate. The bicycles must be returned to a public bike stand whereas the German Call-A-Bike system allows the bikes to be dropped off anywhere. Since bicycles are often vandalized Danish public bikes are very robust and thus not very comfortable. On the other hand once the user has returned the bike to the stand he needn't worry about it anymore.

More than 100 cities abroad have city bikes. There is a growing trend to install new public bike systems as a supplement to collective transport concentrated around major railway stations. In some cities public bikes may only be used within a certain area.

A large number of cities abroad are introducing public bikes in order to kick-start bicycle traffic growth within a short period of time. New York is an example where there are plans to introduce 10,000 public bikes in central urban neighbourhoods in 2012.

Danish experience with public bikes

Danish public bikes are typically funded by external support and partially funded by advertisements on the bike frames and in advertising displays. In several areas operation and maintenance have been linked to job training. Copenhagen started out in 1995 followed by Aarhus, Aalborg, Frederikshavn, Assens and Odense. Aarhus introduced public bikes in 2005. 93% of citizens have either never used a public bike or have used them less than once a week. 2% have used a public bike at least once a week. The Aarhus system is similar to Copenhagen except that some Aarhus public bikes have 3 gears.

The Copenhagen and Frederiksberg authorities are planning to introduce a new public bike system with DSB (Danish State Railways) and Movia (local bus service provider) as potential partners.

Danish public bikes are fairly similar and often lack a bike basket or luggage carrier. Very few Danish public bikes have bike lights and no public bikes are lockable. Danish public bikes are too unreliable for commuters, partly because they're only available during the summer months. Experience from cities such as Copenhagen that have a high cycling modal split indicates



Commuter public bikes in Odense.

that public bikes don't always promote the city's image; a bad, worn out public bike system can impair the city's cycle image. Aalborg is an example of a well-functioning public bike system.

Odense public bikes

Odense introduced a system of 120 public bikes in 2010. The design resembles other Danish public bikes, but the bicycles have 3 gears, bike lights and baskets. Bike use is paid for by mobile access thereby eliminating the need for dispensing machines on the street.

The public bikes are placed in 9 locations and cost DKK 20/h. Public bikes may be returned at any stand. Public bikes were rented 288 times during the first 5 months. Out of 9 locations, 61% of the rentals took place at 2 locations: the central station and the town hall.

Vélib public bikes in Paris.



Paris

In Paris there are a total of 23,000 public bikes. The system is largely based on experience from a pilot project for JCDecaux in Lyon. The system has put both cities on the map as extremely progressive cycle cities, a status they didn't formerly have.

There are typically 300 meters between the Vélib public bike stations.

In order to use the Vélib public bikes in Paris the user has to be at least 14 years old and have an access card. The card can be purchased at any bike station by following instructions on the screen. Payment is exclusively by credit card. Tourists can buy a one day card or a 7 day card to the public bikes, but may not keep the same bike for an entire day or week.

The first half hour is free. The same bike may

be taken again after a minute, and is free for another half hour. After one half hour the bike costs €1, after 3 half hour periods €2, and the following half hour periods cost €4. The idea is that the progressive rates will encourage users to return public bikes quickly and rent them again later in the day. A one-day card costs €1 euro and a 7 date card costs €5.

JCDecaux has 400 employees in charge of operating the Paris system. Their primary task is to maintain the public bikes and transfer public bikes between stations. www.velib.paris.fr

Berlin

Call-A-Bike is run by Deutsche Bahn in 6 German cities, including Berlin. The user has to sign up with Deutsche Bahn with a credit card number in order to use a Call- a- Bike bicycle in Berlin. The user calls in when a bike has been found. The system has no stations, stands, dispenser machines or other fixed locations.

Personal data is linked to a mobile phone and the system can immediately see whether the caller is an approved user. The user is given a code to unlock the bike and the bike can be returned anywhere. The public bike merely has to be fastened to a solid object on the street, preferably on a major thoroughfare. When the bike is locked, the user calls in the confirmation code.

The initial charge is €5. Bike rental costs 8 cents a minute and €9 for the entire day. The system switches automatically to the day rate after €9. www.callabike.de

London

OY Bike is a London bike provider. Before using the bike the user has to sign up and whenever a bicycle is rented the user calls and receives a PIN code to unlock the bike. There are detailed instructions at all public bike stations explaining what to do.

Registration costs £10. The first half hour is free. After that it costs £2 for the first 31-60 minutes, £4 for 61-120 minutes, £6 for 121-180 minutes. For periods longer than 3 hours the user automatically pays for a 24 hour rental, which costs £8. The price structure does not encourage rapid return of the bicycle. www.oybike.com

Stockholm

A special pass is needed to use the public bikes. The pass is available as a 3 day pass or a season pass. Bike stands open at 6 a.m. and the bicycles have to be back in a stand by 9 p.m. Cycle journeys may take up to 3 hours after which the bicycle has to be returned to the stand. However,



In Germany, Call-A-Bike bicycles are parked at random all over the city.



Public bikes in Stockholm are functional.

it is allowed to take a new bicycle from the stand at once.

The 3 day pass costs SEK 125, the season pass is valid from 1 April – 31 October, and costs SEK 200. www.stockholmcitybikes.se

Effects of public bikes abroad

Cities such as Lyon, Paris and Barcelona have managed to boost bicycle traffic significantly by introducing public bikes, primarily because hardly anyone used a bicycle before.

In Lyon the introduction of public bikes in 2005 doubled bicycle traffic in 2 years. 16% of public bike users would have taken the bus if public bikes hadn't existed. On the other hand public bikes function as a feeder link to buses so the total impact on buses is estimated to be neutral.

In Paris public bikes are used 4 times a day during the winter. In Barcelona experience with the Clear Channel bicycle system indicates that each public bike is used 12 times a day. Such figures are irrelevant in a Danish context, however, since bicycle ownership is so high.

Redefining Danish public bikes to reach new target groups and at the same time raise the standard of the entire system is an exciting future challenge.

Station bikes in Fredericia are used to encourage motorists to combine cycling and rail travel instead of using their car.

COMMUTER BIKES

Commuter bikes are aimed at journeys between home and work place/educational institution. They may display a commercial logo and the project is often sponsored by the employer. These are typically high quality bicycles. Folding bikes can be used, the smallest versions of which can be taken on the train and bus as hand luggage, which doesn't require a special ticket.

Aarhus Bike Busters

The city of Aarhus ran a pilot project from May 1995 to May 1996 offering free bicycles and bus passes to 175 daily Aarhus commuters. Their motivation was boosted with small gifts, information and health checkups.

Prior to the project's initiation, in April 1995, 78% of the participants' travel activities were by car and 11% by bicycle. In March 1996 the car market share was 31% and the bicycle market share was up to 35%. In September 1996 56% of the participants' journeys was by bicycle and only 43% by car, i.e. 5 times as many bicycle journeys as before the project.

The conclusion was that it is possible to significantly change people's daily transport habits, but it requires a great deal of concentrated effort; it is easier to encourage motorists to use their bicycles than take the bus.

STATION BIKES

Station bikes are located at railway stations and target the last portion of the journey from train to workplace or educational institution. The area within cycling distance is 8 times greater than the area within walking distance. It takes more or less the same amount of time to cycle or take the bus, but many people prefer the freedom of only having to worry about train schedules. Nationally, 20% of passengers cycle from home to station while only 5% cycle from the station to their final destination (workplace or educational institution); a huge potential lies in encouraging people to cycle to and from the station.

Aalborg commuter bikes

In 1999 NT Nordjyllands Trafikselskab (Northern Jutland's regional bus service) established a commuter bike/station bike rental system in Aalborg for DKK 100 per month. 11-22 bikes were rented each month and each bike



was ridden 3-4 km each way. The project demonstrated that the combination bicycle/public transport is a feasible alternative to commuting by passenger car. At the time a rental system could be established with an initial investment in the bicycle's purchase price and a running grant for operating costs of approx. DKK 900/bicycle/year including administration and marketing, and renovation of the bicycle stock every 4 years. After administration and marketing costs were deducted, operation of the rental system could break even with a grant for operating costs of approx. DKK 350 per bike per year at a rental charge of DKK 100 per bike per month.

Odense station bikes

In 2010 Odense introduced a station bike system consisting of 80 bikes. The design resembles other Danish public bikes but the bikes have 7 gears, bike lights and baskets. A wire lock makes it possible to lock the bicycle during use. Rental is paid via mobile access eliminating the need for dispensing machines on the street.

Station bike stands are located at the central station and three local stations. The bicycles cost DKK 1000 per year and may be booked on line from 1 week – 3 months. The bicycles have to be returned to the same stand so the user gets the same bicycle every day.

Fredericia station bikes

Fredericia is a railway junction with many incoming commuters. In 2011 Fredericia and DSB (Danish State Railways) wished to study

the potential of train/bicycle integration in Danish market towns with railway stations. The target group was people who commuted to their workplace in Fredericia by car from other communities. Participants were offered a 3 month loan of a carbon unisex bicycle, lockable bicycle parking facilities, a helmet and a free commuter pass for the train.

136 people volunteered and 30 were chosen for each period.

COMPANY BIKES

Company bikes are aimed at journeys during working hours. This typically involves staff who have not cycled to work, but who find it more practicable to use a bicycle for work related journeys. Many workplaces have a number of bikes available for the common use of the staff. However, there are often difficulties booking the bicycles or maintaining them properly. If employers are made more aware of the cost and health benefits, this may encourage them to improve the offer. Some bicycle shops are starting to offer on-site bicycle maintenance at workplaces.

The Aalborg ABC project

The ABC project (stands for work, home, cycle) made 35 bicycles available to 9 companies from May to November, 1996; afterwards the bicycles would be donated to the company free of charge if the company had cycled at least 300 km. Bicycle use was registered in a log. The bicycles could be used to and from work and on





The launch of the Odense company bike project generated a great deal of positive media coverage



work related journeys. At the completion of the testing period the bicycles had cycled 21,669 km and 2,940 journeys, the equivalent of 619 km per bicycle, and 84 journeys per bicycle over a 6 month period. Even though most of the round trip journeys were less than 6 km the total average was 7.4 km. Bicycles were used instead of other transport modes, primarily buses and passenger cars, in 86% of the 21,669 cycled kilometers.

58% of the cycled kilometers and 43 of the 84

journeys were home-workplace journeys with an average journey length of 9.8 km.

Odense company bikes

In 2002 Odense provided 29 work places with 67 company bikes. The agreement was that if the company could cycle at least 500 km over a 6 month period the price of the bicycle was DKK 1,500, otherwise it would cost DKK 4,000. 5 bicycles cycled 4,645 km each, the equivalent of 30 km a day. All 67 bicycles cycled 817 km each, the equivalent of 5 km a day.

21% already had a company bike. Everyone was satisfied with the quality of the bicycles. 37% also used the bicycle in their spare time, and 37% used the bicycle every single day.

Nykredit company bikes

Nykredit acquired 20 white company bikes for its Copenhagen staff; 12 unisex bikes, 4 men's bikes and 4 ladies' bikes were freely available to the staff for meetings and errands about town. The bicycles were popular and had to be booked in advance. It was also possible to borrow a helmet. In June 2008 the company bikes cycled a total of 200 km a week.

PRINCIPLES

Experience shows that the target group should be defined first:

- Tourists
- Citizens
- Commuters

The project's timeline should be established too:

- The summer months or all year round
- Always, or as an introductory period for new cyclists

Bicycles can be returned:

- Anywhere
- To a number of bike stations
- 2 places
- 1 place

Funding is a crucial issue. Here are some options:

- Advertising space on bicycles
- Advertising through other platforms
- User charges
- Grants from the local authority and the collective transport operator

The aim of many projects is not merely to benefit the individual cyclist using the offer, but also to promote cycling as a transport mode in a broader perspective. However, bicycles and systems that are not user friendly may have the opposite effect. In any case it is always a good idea to calculate the cost of each new bicycle journey.



CYCLE TOURISM

Denmark is flat as a pancake; the country has a highly developed network of cycling routes and cycle tracks. In other words, Denmark is an obvious destination for cycle tourists. However, cycle tourism in Denmark is almost non-existent from the commercial point of view and compared to our neighbours. If Denmark wishes to be recognized as a cycle tourist country, we have to develop products that are credible to the industry and attractive to tourists.

The potential is enormous and there is every reason to believe that the field will experience explosive growth in the coming years. All the prerequisites are in place: a growing interest in green tourism, environmental and climate considerations plus a growing interest in health issues and activity holidays, all factors that contribute to telling a stronger story of Denmark as a cycle friendly country.



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The flat Danish landscape provides excellent opportunities for cycle tourism.

CURRENT STATUS

Neither Danish nor international cycle tourists choose Denmark as a destination for a cycling holiday despite the fact Denmark is extremely well suited for cycling and has a long and extensive cycling tradition.

In the years 2004-2008 cycle tourism in Denmark dropped from a DKK 3.6 billion turnover in 2004 to DKK 3 billion in 2008, an annual drop of approx. 4%. During the same period cycle tourism in Germany and Switzerland enjoyed an annual increase of almost 10%.

Let's take a look at the situation in Germany and Switzerland.

In Germany the total turnover generated by cycle related tourism is over € 9 billion, the equivalent of almost total tourist turnover in Denmark. In Germany the average daily consumption per one-day cyclist is € 16 while a long distance cyclist spends € 64.60. One-day cyclists are responsible for 63% of total cycle related turnover.

German calculations show that 7 out of 8 cycle tourists are one-day cyclists. This means that the quantitative potential lies primarily among tourists who take a cycling day trip during their holiday, whereas only 1 out of 8 are actual cycle tourists, i.e. cyclists who cycle long distances and who go on holiday in order to cycle. The estimates for Denmark indicate a similar distribution.

Another interesting point is that one-day cycling was not a specific focus area in Germany; the focus was on developing long distance routes

aimed at long distance tourists. In spite of this, one-day tours are the predominant segment. Cycle tourism in Germany is more or less on a level with camping tourism, i.e. 10% of total tourism. For purposes of comparison the Danish figure is 4%.

VisitDenmark estimates that tourist turnover will amount to DKK 85 billion by 2017. If cycle tourism is given high priority in Denmark it is realistic to assume that cycle tourism could constitute 10% of tourist turnover, which is more than twice as much as today.

German experience provides the basis for assuming that it is possible to create a turnover of at least DKK 3 billion. This is ¼ of VisitDenmark's total growth goal of DKK 12 billion by 2017.

Switzerland has experienced similar growth rates but from a lower starting point. Switzerland has successfully built up a completely continuous cycle tourism product via the Schweizmobil site by massive investments in infrastructure and web facilities, which is why Switzerland has experienced explosive growth in cycle tourism.

The Swiss example shows that when tourists feel invited and welcomed before they decide on their holiday destination they arrive in droves. By presenting the cycle tourist with a visible and integrated gateway to what the country offers, a pre-packaged product and an integrated, central booking system the mountainous country of Switzerland leaves Denmark in its dust.

A cycle journey doesn't necessarily require a lot of equipment.





Denmark has many asphalt secondary roads, which are excellent cycle routes.

CONCEPT

Every 3 years VisitDenmark asks a large number of tourists what made them travel to Denmark. 30% of them state that being able to cycle is a primary factor. Unfortunately this is not put into practice when the tourist is actually here; access to good cycling experiences is too difficult.

The Danish concept of cycle tourism needs to be rethought. The following section contains a number of ideas and recommendations that should be implemented in order to create the necessary basis for developing economically sustainable cycle tourism. A number of these projects have already been initiated.

Denmark was a pioneer cycle country at the time the national cycle routes were established; the mere existence of the national routes put Denmark in the lead. Suddenly it was possible to cycle on a long, continuous route that was signposted, communicated by mapping materials, and which the cycle tourist knew had a certain standard. Being a cycle tourist was suddenly made easier and the label "national route" gave the concept a certain promotional value.

The value turned out to be limited, however. Other countries took up the idea, and developed it in terms of essential parameters such as activity themes, full service cycling holiday offers, and visibility, clarity, and easy access to all information during the planning phase.

The cycle routes in themselves are not enough to attract tourists to the country. They can of course still be used promotionally to attract long distance cyclists who go on holiday in order to ride several hundred kilometers on a Danish cycle route, but the real potential lies in one-day tourists.

The aim of most tourists is not merely to cycle; they want to experience the Danish outdoors, Danish culture and history. The challenge is to communicate the elements of Danish life style and cultural history that could be interesting to outsiders while at the same time developing offers that are best experienced by bicycle. A cycle tour is an experience in itself. However, if Denmark wishes to attain a higher level of tourist volume and turnover, we have to market more than the mere route. We need to remove the focus from the route to the destination and to develop theme based activity clusters linked to and arising from the Danish outdoors, Danish culture and history.

The effect of the national cycle routes has not been measured. Experience shows, however, that the routes in themselves do not generate traffic; good facilities and interesting activities are what attract tourists. Marketing should aim at giving tourists the necessary information on their options. Close collaboration is essential between operators, providers, local authorities and others to provide easy access to such activities.

The next four sections discuss the following development perspectives:

1. Activity options should be further developed and communicated as destinations.
2. Organisational coherence should be developed between the cycling holiday's different constituent elements and the different types of service provider.
3. The concept should be marketed with a focus on attracting new groups of cycle tourists in order to generate critical mass, which can serve as an incentive for further investments and initiatives.
4. The cycle tourist should be guaranteed a minimum standard for the quality of the offered product, including the infrastructure.

DEVELOPING DESTINATIONS

If Denmark is to compete on the European level there are two prerequisites that need to be in place. First, a product has to be created that can be marketed and that the tourist industry feels is exciting to market. Second, the product should make the potential guest feel that an activity is being offered that cannot be experienced elsewhere.

The following is recommended:

- Develop theme based activity clusters and destinations.
- Further develop signage.
- Maximize user friendliness.

Thematization

The existing Danish cycle routes can in principle be further developed into theme based activity clusters and destinations in two ways:

- 1) If a cycle route already has a story, the story should be told. The primary examples are the coastal routes and Hærvejen, the historic trading and military path running through Jutland, which because of their location and context can either constitute the story itself or be a major part of the story.
- 2) If the cycle route runs through areas that refer to major historical figures and events beyond the local level, the stories should be collected and communicated on a regional basis. Theme based detours can be added to the existing route creating a coherent theme throughout the established route so the guest can take a circular route and return to the main route. This makes it possible for interested tourists to visit medieval churches, gourmet restaurants and small island communities, or choose unique outdoor experiences in collaboration with the national parks, for example. The concept is based on the existing national routes, but the marketing focus should be on destinations and associated activities.

Examples of uniquely Danish themes that are sure to strike a responsive chord in visitors from abroad are the manor houses and castles visited by Hans Christian Andersen, the castles and monuments of Kongernes Danmark, and the Viking ships. These themes can be developed into a battering ram for general growth in cycle tourism in Denmark.

Signage

Denmark is privileged in having a national, a regional and a local cycle route network characterized by consistent, uniform signage. When the signage was introduced it served

as an inspiration abroad because it was easily recognizable and logical. The signs are easily readable and discreet in the landscape. The challenge is that several numbering systems overlap, particularly among the regional routes, and that the numbers assigned to regional or local routes seem to be fairly arbitrary.

When designing routes and signage, it's a moot question whether the most user friendly routes are the most linear. In Holland, for example, the route network consists of very short routes that always end at a junction where there are several options. Each section has a number and it's up to the user to combine the individual elements into a continuous route. The user chooses his own starting point A and termination point B.

Signage is crucial, particularly for the inexperienced user. Another crucial factor is the allocation of funding to maintain and develop existing routes. The routes are a product that can be used to promote Denmark as a bike friendly country; furthermore they knit the country together. In addition there should be a focus on local routes.

Keep in mind that what knits cycle routes together are activities and not municipal boundaries, and that traveling by bicycle should always be made easy and attractive.

The use of GPS and smart phones will gradually reduce the demand for physical signage in the landscape. There are now 3 categories of users: those who are completely dependent on signage to find their way, those that always bring a map, and those who prefer a digital solution. Gradually as routes become more user friendly and the cyclist target group younger, it is likely that the new digital instruments will become increasingly popular.

Two pieces of simple advice on signage make it easy to be a guest:

- Make sure the signage is in working order when and where the guest needs it (maintenance).
- Build up new routes around theme based experience clusters using the existing route network as a starting point.

User friendliness

In Denmark products are usually developed by an individual enterprise in a chain collaboration or within a geographically demarcated area, such as a municipality. This is partly due to the fact that development is funded by the enterprise or the municipality.



There is a huge potential in one-day cycle tourism.

The problem is that cycle tourists often visit several different enterprises, don't limit themselves to enterprises within a specific chain collaboration, and cross municipal boundaries. This means that tourists need to use several different booking systems, that rules for whether bicycles are allowed at accommodation vary, that map materials look different, and that on

the whole tourists find it very difficult to form an overall picture in advance.

One solution to this challenge is the quality label scheme, Active Denmark, which defines a standard for what a guest may expect and follows it up by official inspection to ensure the standard is upheld.

Children are old enough to bike at an early age.



The German Bett&Bike system is a huge success. The price of joining is low and visibility is high. It's a simple concept which Denmark would do well to copy.

Another option is to create a cohesive product and marketing concept such as www.haervej.dk. The guest should be informed of the activity options along the route, which should be presented as an integrated whole, cf. the discussion of theme based activities above. Cohesiveness can be created for example by offering cycling guests activity based reductions, by establishing central booking systems, and by coordinating luggage transport and bike rental.

A central luggage transport booking system inspired by the Swiss model is worth considering in order to generate critical mass, which is necessary to attract the interest of professional providers.

The local authorities should bear in mind that not only does tourist development generate new workplaces and revenues; it also provides an infrastructure for the use of the local population.

Even though municipal boundaries are not interesting to tourists, municipalities have an active, central role to play in the development process, both in terms of construction and infrastructure and in relation to creating collaborative relationships and motivation for new initiatives.

Infrastructure:

- Construction and above all maintenance of routes and signage
- Construction of bicycle parking facilities and cycle space in woods and towns
- Inter-municipal collaboration to create longer routes

Motivation:

- Support destination and activity development
- Support new operators
- Support local tourist organisations in their product development and marketing efforts.

Another excellent option is a bike rental collaboration between the tourist office and the local bicycle shops. In Odsherred for example the tourist office and the bicycle shop have an agreement by which the tourist office is in charge of administration while the bicycle shop is in charge of bicycle service. This is an excellent business for both parties.

ORGANISATIONAL FRAMEWORK

It is not easy to market a product whose ownership is distributed across 98 municipalities all of which have different priorities. The aim should be to develop the product to a level that is interesting to private investors in the industry. Proposed initiatives must respect the existing administrative structure and division of responsibilities.

In Denmark a liaison committee for tourist road signage already exists (Sambejdsudvalg vedrørende Turistvejvisning). An obvious option is to expand the committee's authority so that committee consultation is required for all modifications of the national cycle routes. Another obvious step is to anchor all signage projects in the committee.

It is a problem that municipalities have highly varying knowledge of the rules regulating cycle routes. It might be a good idea to give the Danish Road Directorate the role of initiator and coordinator based on the Norwegian model (pådriver). This would mean that the Danish Road Directorate is in command of the situation and can monitor the individual municipality's maintenance and development initiatives.

The first step toward further product development can be taken by establishing a cycle industry partnership in which all relevant stakeholders participate. The advisory group that was established in connection with the new digital communications platform (Gateway til cykeloplevelser i Danmark, see Box 5) would be an excellent starting point for the partnership. The group includes the Danish Road Directorate, HORESTA, VisitDenmark, the regional tourist development companies, the Danish Nature Agency, the Danish Outdoor Council, and the quality label scheme Active Denmark.

Other potential stakeholders include Foreningen Danske Destinationer, Danish Regions, LGDK (Local Government Denmark), the Danish Ministry for the Environment, DN (Danish Society for Nature Conservation), the Danish Cancer Society, and Ældre Sagen.



Many people still prefer to map out their cycle tour on a printed map.

The second step is to create a framework and conditions that make it attractive for professional tour operators to develop a wide range of cycling holiday products. There is a great need for tour operators. At the time of writing there are fewer than 5 Danish players in the field and the number of foreign operators that arrange tours in Denmark is also limited.

Danish operators are needed because of the way the package is packaged, marketed and sold. A large part of a Danish tour operator's tour sales take place in collaboration with operators in different countries (Ruby rejser for example.)

When a tourist buys a tour from Ruby's catalogue an operator at the destination is usually the subcontractor. In other words if tours to Denmark are to be included in the major established chain's catalogues there need to be subcontractors in Denmark who can carry out the tours in practice.

The individual destination can make it easier to attract tour operators, primarily by helping them design tours and enter into dialogue with hotels, etc. but also by developing appropriate information materials.

Many Danish municipalities have successfully turned cycle tourism into a significant source of tourist revenue. At the time of writing Bornholm is the number one cycle tourist destination thanks to the conversion of disused railway tracks into cycle tracks, a solid supply of accommodation, and a focus on cycle track construction. One out of 10 tourists to Bornholm is a cycle tourist.

Viborg has recently established a number of super cycle routes which not only enable commuters to bike from neighbouring towns into Viborg but also allows cycle tourists to spend the night in one area and bike out to new landscapes and new activities every day. This creates a win-win-win situation for accommodation providers in Viborg, tourist destinations in the surrounding area, and local bicycle commuters.

Vordingborg has converted the preserved ferry Ida into a museum ship and bike ferry thereby making the infrastructure even more cohesive. A regional and inter-municipal collaboration has been established to develop the Danish continuation of the popular German "monk route" thereby establishing links across municipal and national boundaries. Communicating information about the route is a focus area. Finally a cycle route map was produced covering all of Møn and opening up new opportunities for experiencing the area.

MARKETING

The information a tourist needs is not easily accessible today. Information on cycling options in Denmark is distributed over different platforms and even if the tourist is successful in finding all the information no coherent picture emerges. The cycle tourist needs to be particularly experienced and resourceful to plan a cycling holiday in Denmark. The difficulty involved in accessing information and the lack of overview precludes new target groups.

The situation is aggravated by the fact that very little existing material is communicated digitally. A potential tourist from abroad planning a bicycle tour in Denmark can find very little information on the internet despite the fact that studies show that 2/3 of tourist information seeking is online.

Switzerland has been successful in creating a completely cohesive product via the Schweizmobil site. Massive investments were made in



Good cycling infrastructure increases road safety and provides an enjoyable experience.

infrastructure and website facilities, which is why cycle tourism in Switzerland experienced almost explosive growth.

In Denmark we have a product which is considered attractive abroad. As mentioned above the Danish cycling infrastructure is excellent and there are many accommodation and activity options. The crucial challenge is that the product is not visible to the world at large and it is difficult for tourists to plan their holiday. A simple comparison between Denmark and competing cycle holiday destinations shows that product visibility is a critical success factor. The Danish Cyclists' Federation has therefore taken the initiative to implement a digital communications platform to function as an intelligent planning tool for the cycle tourist and render activity options visible.

The Gateway platform provides a link between cycle tourism and all types of provider. Local authorities and destinations can put all relevant information on their website and it will be rendered directly visible to potential customers. New destinations, local routes and events, new service options, etc. can be added continuously. Another benefit is that local authorities and destinations may freely print out maps and other materials from the gateway and use the material to market local options.

Target groups

The term "cycle tourist" often conjures up the image of a professionally equipped lonely rider. VisitDenmark has focused on the so-called "hard core" segment and the national cycle route network was largely developed for long distance cycling. The definition in itself, i.e. that a national cycle route needs to be at least 200 km long, indicates this.

The problem is that the major potential doesn't lie in the hard core segment, but in shorter tours. Furthermore the classification into hard core or soft core is far from adequate. In the first place demand from people of different nationalities varies, in the second place there are divisions around families with children and adult couples, and finally tourists have a number of other holiday wishes than cycling, such as experiencing history, eating well, spending time with their families, etc.

In this context it is recommended to focus on Danish target groups and the areas with maximum potential for these target groups.

This means focusing on:

- Tourists who are interested in shorter tours.
- Adult couples and families with children.
- Tourists interested in culture and gastronomy.

Product development should focus on developing options for shorter tours and a variety of activities along the routes.

Marketing should switch focus from long routes and equipment demanding tourism to lifestyle. It



should also be taken into account that individual destinations and enterprises are attractive to different target groups; this should be included in the overall marketing framework.

QUALITY CONTROL

The quality and attractiveness of the national cycle routes is very uneven. The route's design and the activities provided vary greatly as does the maintenance standard. The product being offered is uneven and opaque. This results in the following:

- Lack of interest in marketing the routes.
- Users have a bad or mixed experience.
- Lack of standards for route maintenance.

In order to break the vicious circle a set of criteria should be developed which have to be met before a route may be termed national. This applies to physical quality as well as the quality of the service facilities offered in the area and along the route.

Appropriate senders of such criteria are users (the Danish Cyclists' Federation), commercial interests (HORESTA, Destinations, the regional tourist development companies and VisitDenmark), and "owners" (Danish Nature Agency, LGDK, and the Danish Road Directorate).

The criteria should address the following issues as a minimum:

- Quality assured surface that is suitable for cycling
- Reliable signage (maps, signposts, etc.)
- Critical mass of activities
- Critical mass of accommodation and restaurants
- Security and safety
- Facilities for getting to and from the route (bus, train, parking)

Cycle routes do not have to be uniform. A route may offer large variations in terrain, level of difficulty, surface, etc. However, there should be a minimum standard and it is crucial that the information the tourist is given about the route before embarking is reliable. Safety is absolutely essential and non-negotiable. Heavily trafficked road sections are not suitable for family cycling with children. National cycle routes must never include such sections.

A quality labeling scheme for cyclist friendly accommodation and other facilities already exists. It is essential that the standard is further developed and maintained. If a cycle tourist repeatedly experiences non-existent



Families with children are a major target group.

cycling facilities at supposedly cycling friendly accommodation, the system loses its value.

Maintaining on-going quality control is costly; users should be actively involved so as not to drain public funds. Homepages and websites already exist where cyclists can report potholes on the cycle track directly to the local technical administration. Such systems should be further

developed both on the sender and receiver level. On-site reporting systems should be developed. They should be built up selectively and include a system that makes it easy for the receiver to understand the report's importance and the action required.

Road safety is crucial, especially when cycling with children.





It should constantly be born in mind that, finally, the routes exist in order to give users a great experience. The likelihood of developing an attractive route network is significantly increased by opening up for user input, allowing users to create new experiences and submit proposals for modifying the routes and improving services.

SUMMARY

Exploiting the inherent potential of cycle tourism will create economic growth and employment even in the peripheral areas. The following prerequisites must be met:

1. Activities and destinations should be marketed rather than cycle routes.
2. The experience should be as seamless as possible for the cycle tourist, from the planning stage to the field.
3. Physical facilities should be maintained and developed, and coordinated across municipal boundaries. The routes should be reliable in terms of cycling comfort, signage and safety.
4. Users should be actively involved in maintenance and development.
5. Public and private services should be developed and coordinated so they support each other. Municipalities play a central role in such collaboration.

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CHAPTER 3 COLLABORATIONS AND NETWORKS

Sources

- 3.1 Dansk Cyklist Forbund og Cycling Embassy of Denmark.

CHAPTER 4 COST-BENEFIT AND TRAFFIC MODELS

Sources

- 4.1 COWI (2008): Samfundsøkonomiske analyser af cykeltiltag - metode og cases.
- 4.2 DTU Transport og COWI (2010): Transportøkonomiske enhedspriser til brug for samfundsøkonomiske analyser.
- 4.3 Johan de Hartog J, Boogaard H, Nijland H, Hoek G.: Do the health benefits of cycling outweigh the risks? Environ Health Perspect. 2010 Aug;118(8):1109-16. Epub 2010 Jun 11.
- 4.4 SQW (2007): Valuing the Benefits of Cycling -Executive Summary.
- 4.5 Kevin Mayne, CTC The UK Cyclist's Organisation (2010): The proces of evaluating English Cycling cities - præsentation på National cykelkonference 2010.
- 4.6 Tetraplan (2009): Opgradering af cykelruten langs Vestvolden - med fokus på at tiltrække flere pendlere.

CHAPTER 6 HEALTH AND CYCLING

Sources

- 6.1 Statens Institut for Folkesundhed, Sundheds- og sygelighedsundersøgelserne 1987-2005.
- 6.2 Sundhedsstyrelsen (2011): Den nationale sundhedsprofil 2010 – Hvordan har du det?
- 6.3 Det økologiske råd (2005) Cykling, motion, miljø og sundhed.
- 6.4 Sundhedsstyrelsen, Center for Forebyggelse (2003): FYSISK AKTIVITET – håndbog om forebyggelse og behandling del 1 og del 2.
- 6.5 Andersen L.B, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med (2000);160:11.:1621-1628.
- 6.6 Cooper, Andersen, Wedderkopp, Page, Froberg. Physical activity level of children who walk, cycle or are driven to school. Accepted 2004, Am J Prev Med.
- 6.7 House of Commons Health Committee: Obesity, 2004, oprindeligt lavet af Sustrans (Sustainable Transport Charity). Kilder: andel overvægtige: International Obesity task force (2002). Andel cyklende børn: Department for Transport (1996).
- 6.8 Motions- og Ernæringsrådet (2007): Fysisk inaktivitet - konsekvenser og sammenhænge.
- 6.9 Odense Kommune, Evaluering af Odense – Danmarks Nationale Cykelby.
- 6.10 Troelsen, Jens (2004): Syddansk Universitet Mobil på cykel.
- 6.11 Berlingske Tidende, Jakob Stig Jørgensen 2. november 2010.

CHAPTER 5 - CAMPAIGNS AND MARKETING

Sources

- 5.1 Kommunikationsplan.
- 5.2 Transport Studies Group (1998) INPHORMM, England.
- 5.3 Eval_Odense.
- 5.4 Contact sheet Randers.
- 5.5 Kenneth Hartley Blanchard and Spencer Johnson: "The one minute manager"



CHAPTER 7 URBAN PLANNING AND BICYCLE PLANNING

Sources

- 7.1 Miljøministeriet (2010): Landsplanredegørelse 2010
- 7.2 Naturstyrelsen, Miljøministeriet (2011) Planloven
- 7.3 Rietveld, Piet, V. Daniel (2004): Determinants of bicycle use: do municipal policies matter? Transportation Research Part A no. 38 p. 531–550
- 7.4 Linda Christensen og Thomas C. Jensen, (2008): Korte ture i bil DTU Transport
- 7.5 Hartoft-Nielsen, Peter (2001): Arbejdspladslokalisering og transportadfærd
- 7.6 Miljøministeriet (2007): Fingerplan 2007
- 7.7 Jan W Hansen og Roseels Tegnesteue (2009)
- 7.8 By & Havn og Københavns Kommune (2009): Nordhavnen Urban Strategy
- 7.9 Fietsberad (juni 2011): Specialist's news
- 7.10 Retail Institute Scandinavia (2011)
- 7.11 Miljøministeriet (2007): Planloven i praksis
- 7.12 Celis, Pablo og Bølling-Ladegaard, Erik (2007): Cykelparkeringshåndbog
- 7.13 Helsingør Kommune, Aarhus Kommune, Aalborg Kommune, Odense Kommune, Københavns Kommune, Fredericia Kommune, Randers Kommune; Kommunale cykelhandlingsplaner m.v. (2008-2011)
- 7.14 Bypad.org (2011)
- 7.15 European smart cities; Pleon Publico Salzburg m.fl. www.smart-cities.eu. (2011)
- 7.16 Vejdirektoratet (2011): Aftale om HyperCard, busser, cykler, trafikikkerhed, støjbe-kæmpelse mv.
- 7.17 Jensen, Søren Underlien og Nielsen, Michael Aakjer (1996): Bystrukturens betydning for cykeltrafikken, konferencerapport fra Trafik-dage på Aalborg Universitet '99.

CHAPTER 8 PLANNING THE CYCLING INFRASTRUCTURE

Sources

- 8.1 Cykelregnskaber for nordiske cykelbyer, bl.a. Frederikshavn, Silkeborg og Viborg. www.nordiskecykelbyer.dk.
- 8.2 Cykelregnskab 2009. 8000 fordele ved at cykle. Aarhus Kommune. 2009. www.aarhuscykelby.dk.
- 8.3 Cykelregnskaber for 2008 og 2010. København cyklernes by. Københavns Kommune 2009 og 2011. www.kk.dk/cyklernesby.
- 8.4 Niels Jensen. Udvikling og implementering af målemetode for cyklister rejsehastighed. Konferenceindlæg Trafikdage 2004. www.trafikdage.dk.
- 8.5 Cykelsuperstipjektets hjemmeside. www.cykelsuperstier.dk.
- 8.6 Planlægning for cyklister, hverdag og fritid. Miljøministeriet. 1985.
- 8.7 8-80cities hjemmeside. www.8-80cities.org.
- 8.8 Nicolas Mercat. Modelling of bicycle journeys, using energy rather than journey time or distance. Proceedings Velo-City 99. Graz & Maribor.
- 8.9 Krister Spolander (1999): Staden, bilen, farten. Malmö.
- 8.10 Shared space. Eksempelsamling. Vejdirektoratet. www.vejsektoren.dk.
- 8.11 Linda Christensen og Thomas C. Jensen (2008): Korte ture i bil – Kan bilisterne ændre adfærd til gang og cykling. . DTU Transport. www.transport.dtu.dk.
- 8.12 Inga löjligen bilresor (Malmö kampagne). www.ingalöjligenbilresor.nu
- 8.13 Odense cykelby. www.odense.dk.
- 8.14 European Cyclists' Federation Road Safety Charter: Halving injury and fatality rates for cyclists by 2020. ECF 2010. www.ecf.com. Tal fra figuren: Safety in numbers (i ECF's rapport) bearbejdet til brug i Idékataloget.
- 8.15 Søren Underlien Jensen (1998): DUMAS - Safety of Pedestrians and Two-wheelers. Note 51. Vejdirektoratet.
- 8.16 Movia - www.moviatrafik.dk: Pedaler i bussen.
- 8.17 Danmarks Radio - www.dr.dk (2010): Book plads til cyklen. P4 Bornholm.
- 8.18 Niels Jensen (2002): Cykelpolitik 2002-12. . Københavns Kommune. www.kk.dk/cyklernesby.
- 8.19 Københavns Kommune (2007): Miljømetropolen. Vores vision CPH 2015. www.kk.dk/cyklernesby.
- 8.20 Københavns Kommune (2010): Fra god til verdens bedste. Københavns cykelstrategi 2011-2025. www.kk.dk/cyklernesby.
- 8.21 Frederikshavn Kommune (2011): Flere cykler. Opfølgning på byrådets cykelpolitik (forslag) .
- 8.22 Nordiske cykelbyer. www.nordiskecykelbyer.dk.
- 8.23 Friluftsrådet (2011): Stier – inspiration til planlægning og forvaltning. www.friluftsradet.dk (se politik og derefter planlægning).
- 8.24 Trafiksnering i en bydel med trafikadskillelse (Albertslund Syd). I Planlægning for cyklister, hverdag og fritid. Miljøministeriet. 1985 (ref. 8.6).
- 8.25 Cykelstrategi. Albertslund Kommune. 2009. www.albertslund.dk
- 8.26 Flere cykler på sikker vej i staten. Transport- og Energiministeriet 2007. www.trm.dk/publikationer/2007
- 8.27 Aftale mellem regeringen (Venstre og Konservative og Socialdemokraterne, Dansk Folkeparti, Det Radikale Venstre og Liberal Alliance): En grøn transportpolitik. 29. januar 2009. www.trm.dk/publikationer
- 8.28 Cykelpuljen 2011. www.vejsektoren.dk.
- 8.29 Vejregleportal: http://vejregler.lovportaler.dk/. Også henvisning til trykte hæfter. "Hæfte 0"/"Håndbog"/"Stikordsregister" for en given vejregel (se nedenfor) giver overblik.
- 8.30 Byernes trafikarealer. "Hæfte 0" giver overblik. http://vejregler.lovportaler.dk/
- 8.31 Planlægning af veje og stier i åbent land. "Hæfte 0" giver overblik. http://vejregler.lovportaler.dk/
- 8.32 Vejvisning på cykel-, vandre- og rideruter. "Håndbog". http://vejregler.lovportaler.dk/
- 8.33 Fauna og menneskepassager. "Håndbog". http://vejregler.lovportaler.dk/
- 8.34 Niels Jensen: Sikkerhed og tryghed på cykelstier i København. Københavns Kommune. Cykelviden nr. 13 (feb. 2007). http://issuu.com/cykelviden/
- 8.35 Trafiksikkerhed for cyklister. Indsatsplan for sikker cykeltrafik 2007-2012. www.kk.dk. Følg By og trafik, Byens Trafik, Trafiksikkerhed. Heri links til Trafitec-undersøgelser for Københavns Kommune (se også 8.36).
- 8.36 Sikkerhed og tryghed ved cykelstier og cykelbaner i København. 4 Trafitec-undersøgelser (Søren Underlien Jensen) for Københavns Kommune: Effekter af cykelstier og cykelbaner (2006). Cyklister oplevede tryghed og tilfredshed (2006). Effekter af overkørsler og blå cykelfelter (2006). Smalle cykelbaner ved lyskryds (2010). www.trafitec.dk.
- 8.37 Bekendtgørelse om cyklers indretning og udstyr. nr. 316 af 20-5-1999. www.retsinfo.dk.
- 8.38 Bekendtgørelse nr. 783 af 6-7-2006 om vejaf-mærkning. Ny udgave i høring medio 2011. http://vejregler.lovportaler.dk/
- 8.39 Håndbog for trafikikkerhedsrevision og -revision. 1.dec. 2009. http://vejregler.lovportaler.dk/
- 8.40 Fodgængeres og cyklister oplevede serviceniveau på vejstrækninger (tilsvarende for kryds er under udarbejdelse i 2011). http://vejregler.lovportaler.dk/
- 8.41 Det visuelle miljø. Hæfte 10 (1992). Byernes trafikarealer. http://vejregler.lovportaler.dk/

CHAPTER 9 DESIGNING THE CYCLING INFRASTRUCTURE

Sources

- 9.1 Engel, Ulla og Iversen, Lis (1979): Cyklisters kriterier for rutevalg, Rådet for trafikikkerhedsforskning, Danmark.
- 9.2 Landis, Bruce W.; Vattikuti, Venkat R. og Brannick, Michael T. (1996): Real-Time Human Perceptions – Toward a Bicycle Level of Service, Transportation Research Record 1578, USA.
- 9.3 Greibe, Poul og Hemdorff, Stig (1998): Uheldsmode for bygader – Del 2: Model for strækninger, Notat 59, Vejdirektoratet, Danmark.
- 9.4 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.5 Vejdirektoratet (1992): Cykelstier i Frederiksborg Amt - En brugerundersøgelse, Danmark.
- 9.6 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.7 Elvik, Rune; Mysen, Anne Borger og Vaa, Truls (1997): Trafikikkerhetshåndbok, Transportøkonomisk institutt, Norge.
- 9.8 Davies, D.G.; Ryley, T.J.; Rayler, S.B. og Halliday, M.E. (1997): Cyclists at road narrowings, Report 241, Transport Research Laboratory, England.
- 9.9 Vejdirektoratet (1985): Trafiksanering af store bygader – nogle eksempler, Danmark.
- 9.10 Taylor, David (1996): The Feet First Report, England.
- 9.11 Taylor, David C. og Mackie, Archie M. (1996): Review of traffic calming schemes in 20 mph zones, Report 215, Transport Research Laboratory, England.
- 9.12 Søren Underlien Jensen – Trafitec: Sikkerhedseffekter af trafiksanering og signalregulering i København Teknik og Miljø, januar 2009.
- 9.13 Coates, Nigel (1999): The safety benefits of cycle lanes, Proceedings of Velo-City '99, Østir/Slovenien.
- 9.14 Nielsen, Erling Dan, Andersen, Karina Vestergaard og Lei, Karen Marie (1996): Trafikikkerhedseffekten af cykelbaner i byområder, Rapport 50, Vejdirektoratet, Danmark.
- 9.15 Smith, Robert L. og Walsh, Thomas (1988): Safety Impacts of Bicycle Lanes, Transportation Research Record 1168, USA.
- 9.16 Trafitec (2006): Effekter af cykelstier og cykelbaner.
- 9.17 Ágústsson, Lárus og Lei, Karen Marie (1994): Trafikikkerhedseffekten af cykelbaner på strækninger mellem kryds i byområder, Notat 12, Vejdirektoratet, Danmark.
- 9.18 Nielsen, Erling Dan, Andersen, Karina Vestergaard og Lei, Karen Marie (1996): Trafikikkerhedseffekten af cykelbaner i byområder, Rapport 50, Vejdirektoratet, Danmark.
- 9.19 Nielsen, Erling Dan, Andersen, Karina Vestergaard og Lei, Karen Marie (1996): Trafikikkerhedseffekten af cykelbaner i byområder, Rapport 50, Vejdirektoratet, Danmark.
- 9.20 Søren Underlien Jensen, Trafitec (2006): Effekter af cykelstier og cykelbaner.
- 9.21 Landis, Bruce W.; Vattikuti, Venkat R. og Brannick, Michael T. (1996): Real-Time Human Perceptions – Toward a Bicycle Level of Service, Transportation Research Record 1578, USA.
- 9.22 CROW (1993): Sign up for the bike, Record 10, Holland.
- 9.23 CROW (1998): Recommendations for traffic provisions in built-up areas, Record 15, Holland.
- 9.24 Giæver, Terje; Øvstedal, Liv og Lindland, Terje (1998): Utforming av sykkelanlegg - intervju og atferdsundersøkelser, Rapport STF22 A97615, SINTEF, Norge.
- 9.25 Herrstedt, Lene; Nielsen, Michael Aakjer; Ágústsson, Lárus; Krogsgaard, Karen Marie Lei; Jørgensen, Else og Jørgensen, N.O. (1994): Cyklisters sikkerhed i byer, Rapport 10, Vejdirektoratet, Danmark.
- 9.26 Rosbach, Ole (1984): Kantlinier forbedrer både bilisters og cyklisters sikkerhed, Dansk Vejtidskrift nr. 10, Danmark.
- 9.27 Vejdirektoratet (1992): Cykelstier i Frederiksborg Amt - En brugerundersøgelse, Danmark.
- 9.28 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.29 CROW (1998): Recommendations for traffic provisions in built-up areas, Record 15, Holland.
- 9.30 Risegaard, Peter (1995): Ny type kantbaner afprøvet i nordjyske byer, Dansk Vejtidskrift nr. 11, Danmark.
- 9.31 Ludvigsen, Henrik S. (1982): Cykel- og knallertuheld på veje med kantbaner, Dansk Vejtidskrift nr. 6, Danmark.
- 9.32 Rosbach, Ole (1984): Kantlinier forbedrer både bilisters og cyklisters sikkerhed, Dansk Vejtidskrift nr. 10, Danmark.
- 9.33 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.34 Jørgensen, Else (1978): Cykelstier på landet, Vejdirektoratet, Danmark.
- 9.35 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.36 Alrutz, Dankmar; Fechtel, Hans W. og Krause, Juliane (1989): Unfall- und Sicherheitsforschung Strassenverkehr – Dokumentation zur Sicherung des Fahrradverkehrs, Heft 74, Bundesanstalt für Strassenwesen, Tyskland.
- 9.37 Trafitec (2006): Effekter af cykelstier og cykelbaner.
- 9.38 Nielsen, Michael Aakjer; Olsen, Mette og Lund, Belinda la Cour (2000): Cyklisthastigheder i byområder, Notat 62, Vejdirektoratet, Danmark.
- 9.39 Søren Underlien Jensen, Trafitec (2006): Fodgængeres og cyklisters oplevede serviceniveau på vejstrækninger.
- 9.40 Page, Matthew; Siu, Yim Ling; Tight, Miles og Wardman, Mark (1999): Cycling and urban travel choice, Proceedings of Velo-city '99, Østir/Slovenien.
- 9.41 Vejdirektoratet (1999): Trafikindeks, Danmark.
- 9.42 Møller, Jes og Larsen, Flemming (1983): Cykel- og knallertulykker i landområder - Dokumentationsrapport, Vejdirektoratet, Danmark.
- 9.43 Vejdirektoratet (1992): Cykelstier i Frederiksborg Amt - En brugerundersøgelse, Danmark.
- 9.44 Lahrmann, Harry (1992): Cykelbaner med asfaltvulst, Aalborg Universitet, Danmark.
- 9.45 Herrstedt, Lene; Nielsen, Michael Aakjer; Ágústsson, Lárus; Krogsgaard, Karen Marie Lei; Jørgensen, Else og Jørgensen, N.O. (1994): Cyklisters sikkerhed i byer, Rapport 10, Vejdirektoratet, Danmark.
- 9.46 Engel, Ulla og Thomsen, Lars Krogsgård (1985): Cyklist ved busstoppesteder, Dansk Vejtidskrift nr. 7/8, Danmark.
- 9.47 Engel, Ulla og Thomsen, Lars Krogsgård (1986): Rumlestriber på cykelstier, Dansk Vejtidskrift nr. 2, Danmark.
- 9.48 Københavns Kommune (1999): Frederikssundsvej – Evaluering af spørgeskemaundersøgelse, Udkast, Danmark.
- 9.49 Ministeriet for offentlige arbejder (1984): Cirkulære om etablering af dobbelttrettede cykelstier langs vej, Cirkulære nr. 567-00-04, Danmark.
- 9.50 Vejdirektoratet – Vejreguludvalget (1987): Vejregler for opsætning af vej- og broautoværn, Danmark.
- 9.51 Vejdirektoratet (2000): Vejsektorens Informations-System (VIS), Danmark.
- 9.52 Herrstedt, Lene (1979): Sikkerhed for cyklist og knallertkørere på hovedfærdselsårer i Københavnsområdet, Notat 5, Rådet for Trafikikkerhedsforskning, Danmark.
- 9.53 Søren Underlien Jensen, Trafitec (2006): Effekter af overkørsler og blå cykelfelter.
- 9.54 Nielsen, Michael Aakjer (1994): Nye afmærkninger på cykelstier ved ikke signalregulerede T-kryds – Effektundersøgelse, Notat 8, Vejdirektoratet, Danmark.
- 9.55 Lund, Belinda la Cour (1999): Cyklisters sikkerhed i kryds – Forslag til nye design af vigepligtsregulerede T-kryds, upubliceret materiale, Vejdirektoratet, Danmark.
- 9.56 Herrstedt, Lene (1979): Sikkerhed for cyklist og knallertkørere på hovedfærdselsårer i Københavnsområdet, Notat 5, Rådet for Trafikikkerhedsforskning, Danmark.
- 9.57 Søren Underlien Jensen, Trafitec (2006): Fodgængeres og cyklisters oplevede serviceniveau på vejstrækninger.
- 9.58 Vejdirektoratet – Vejreguludvalget (1991-93): Byernes trafikarealer – Hæfte 1-10, Danmark.
- 9.59 Lahrmann, Harry og Leleur, Steen (1994): Vejtrafik – Trafikteknik & Trafikplanlægning, Polyteknisk Forlag, Danmark.
- 9.60 Søren Underlien Jensen, Trafitec (2009): Safety Effects of Intersection Signalization: a Before-After Study
- 9.61 Vejdirektoratet – Vejreguludvalget (1984): Vejregler for signalanlæg, Danmark.
- 9.62 Søren Underlien Jensen, Trafitec (2006): Effekten af cykelstier og cykelbaner.
- 9.63 Behrendorff, Inge og Hansen, Lars Klit (1994): Sidespejle på lastbiler - brug og effekt af nærzone og vidvinkelspejle, Rådet for Trafikikkerhedsforskning, Danmark.
- 9.64 Herrstedt, Lene; Nielsen, Michael Aakjer; Ágústsson, Lárus; Krogsgaard, Karen Marie Lei; Jørgensen, Else og Jørgensen, N.O. (1994): Cyklisters sikkerhed i byer, Rapport 10, Vejdirektoratet, Danmark.
- 9.65 Behrendorff, Inge og Hansen, Lars Klit (1994): Sidespejle på lastbiler - brug og effekt af nærzone og vidvinkelspejle, Rådet for Trafikikkerhedsforskning, Danmark.
- 9.66 Nielsen, Michael Aakjer (1995): Cyklisters sikkerhed i byen, Dansk Vejtidskrift nr. 8, Danmark.



CHAPTER 9 DESIGNING THE CYCLING INFRASTRUCTURE

- 9.67 Jensen, Søren Underlien og Nielsen, Michael Aakjer (1996): Cykelfelter - Sikkerhedsmæssig effekt i signalregulerede kryds, Rapport 51, Vejdirektoratet, Danmark.
- 9.68 Trafitec (2006): Effekter af overkørsler og blå cykelfelter.
- 9.69 Trafitec (2009): Cykelommer - Spørgeundersøgelse om tryk, tilfredshed, mv.
- 9.70 Vejdirektoratet - Vejreguludvalget (1991-93): Byernes trafikarealer - Hæfte 1-10, Danmark.
- 9.71 Brude, Ulf og Larsson, Jörgen (1996): The safety of cyclists at roundabouts, VTI meddelande 810A, Sverige.
- 9.72 CROW (1993): Rontondes, Publikatie 79, Holland.
- 9.73 CROW (1998): Eenhein in rotondes, Publikatie 126, Holland.
- 9.74 Fietsersbond enfb (1999): Fietsvriendelijke rotondes, Holland.
- 9.75 Haller, Wolfgang; Lange, Johannes; Dankmar, Alrutz og Stellmacher-Hein, Jörg (1999): Verkehrssicherheit von Fussgängern und Radfahrern an kleinen Kreisverkehrsplätzen, Strassenverkehrstechnik 10/99, pp. 496-502, Tyskland.
- 9.76 Hülsen, H. (1993): Unfälle mit radfahrern in Bayern, Beratungstelle für Schadenverhütung, Mitteilung 33, Tyskland.
- 9.77 Vejdirektoratet (1992): Cykelstier i Frederiksborg Amt - En brugerundersøgelse, Danmark.

CHAPTER 10 BICYCLE PARKING

Sources

- 10.1 Dansk Cyklistforbund (2007): Cykelparkeringshåndbog.
- 10.2 Trafikstyrelsen (2009): Bedre samspil mellem cyklen og den kollektive trafik.

CHAPTER 11 ROAD SIGNAGE AND MAPS, CYCLE ROUTE PLANNERS, AND ITS

Sources

- 11.1 Vejvisning på cykel-, vandre- og rideruter. "Håndbog". <http://vejregler.lovportaler.dk/>. Bekendtgørelse nr. 841 om vejvisning på cykel-, ride- og vandruter af 8-9-2009. www.retsinfo.dk.
- 11.2. Europæiske cykelruter. www.EuroVelo.com.
- 11.3 Grøn cykelruteskiltning i København. Bilag til møde i Teknik- og Miljøudvalget 9-4-2008. www.kk.dk. Søg under Politik.
- 11.4 Cykelruteskiltning i Aarhus. Personlig meddelelse fra Pablo Celis, Aarhus Kommune 2011.
- 11.5 Midtby cykelskiltning i Aarhus. Personlig meddelelse fra Pablo Celis, Aarhus Kommune 2011.
- 11.6 Odense cykelkort. Odense Kommune. www.odense.dk.
- 11.7 Kom frit frem. Cykelkort over København 2011. Pop-up kortet er en del af kampagnen God cykelkarma. www.kk.dk/cyklernesby.
- 11.8 Cyklistforbundets landsdækkende serie af guidebøger med tilhørende kort i 1:100.000. www.dcf.dk.
- 11.9 Vejdirektoratets digitale kort over nationale cykelruter på nettet. www.trafikken.dk.
- 11.10 Guidebøger Cycline/Esterbauer forlag. www.esterbauer.com. Udsolgte udgaver ses ikke på forlagets hjemmeside, men kan lånes i danske folkebiblioteker.
- 11.11 Kommunale cykelkort. Jens Erik Larsen. Konferencindlæg 2010. www.vejforum.dk.
- 11.12 Cykelrutekort. Gribskov kommune. 2009.
- 11.13 Cykelkort København/Cycling Map Copenhagen. 2. udgave 2010. Også PDF på nettet. www.kk.dk/cyklernesby.
- 11.14 Albertslunds cykelplaner til mobiltelefon. www.albertslund.dk/cykelruteplaner.
- 11.15 Aalborg cykelplaner på nettet. Udarbejdet af Krak/Eniro for kommunen. www.trafikken.dk/Nordjylland.
- 11.16 Fredericia cykelplaner på nettet. Udarbejdet af Kofoed & Co for kommunen. www.fredericiacykelguide.dk.
- 11.17 Fællesoffentligt Geografisk Administrationsgrundlag. www.fotdanmark.dk.
- 11.18 Det digitale vejnet. Pilotprojekt for 7 kommuner. 2011. www.digitalt-vejnet.dk.
- 11.19 Öresund som cykelregion, delprojekt Info n Bike. Forarbejder (upubliceret) til cykelruteplaner. 2011. www.oresundsomcykelregion.nu.
- 11.20 Forarbejder til cykelplaner (Cykelsekretariatet, Københavns Kommune, upubliceret). Desuden bilag til møde i Teknik og Miljøudvalget 26-9-2011. www.kk.dk. Søg under Politik.
- 11.21 Rejseplanen. www.rejseplanen.dk.
- 11.22 Cykelsuperstipjektets hjemmeside. www.cykel-superstier.dk.
- 11.23 Cyclistic. www.cyclistic.dk.
- 11.24 Cyclecopenhagen. www.cyclecopenhagen.dk.
- 11.25 Resejämföraren. www.kartor.lund.se/resejamforaren.
- 11.26 Cyclejourneyplanner. www.cyclejourneyplanner.tfl.gov.uk.
- 11.27 Journeyplanner. www.transportdirect.info.
- 11.28 Naviki. www.naviki.org.
- 11.29 Evalueret af Odense - Danmarks Nationale Cykelby. Odense Kommune 2004. www.trafitec.dk.
- 11.30 Nicolai Ryding Høgh. Grøn bølge for cyklister i København. Konferencindlæg. www.vejforum.dk/vejforum2007.

- 11.31 Michael Bloksgaard, Anders Kreutzfeld og Karen Marie Lei. Trafik & Veje nr. 3 (2011): Forsøg med variable tavler, lyssøm og stibump. www.trafikogveje.dk.
- 11.32 ITS idékonkurrence. Københavns Kommune. 2009. www.kk.dk/ITS.
- 11.33 Supercykelstier i København. Projektudviklingsplan. Udarbejdet af Rambøll By og Trafik for Københavns Kommune. Center for Trafik, Teknik- og Miljøforvaltningen. Københavns Kommune. 2009.
- 11.34 Marianne Weinreich (Veksø A/S) og Morten Riisgaard-Dam (Aros Kommunikation). Newsletter 3, 29-6-2011: GPS-teknologi makes cycling fun! Cycling Embassy of Denmark. www.cyclingembassy.dk/2011.
- 11.35 Marianne Weinreich (Veksø A/S). 3-1-2011: Showing cyclists that they count. Cycling Embassy of Denmark. www.cyclingembassy.dk.
- 11.36 Copenhagen wheel. www.senseable.mit.edu/Copenhagenwheel/.

CHAPTER 12 MAINTENANCE AND ROAD CONSTRUCTION

Sources

- 12.1 Mercat, Nicolas (1999): Modelling of bicycle journeys: Using energy expended rather than journey time or distance, Proceedings of Velo-City '99, Østrig/Slovenien.
- 12.2 Mikkelsen, Leif og Prah, Knud Bjørn (1999): Vintertjeneste med saltlage på cykelstier, Dansk Vejtidskrift nr. 10, Danmark.
- 12.3 Larsen, Lars Binderup (1991): Eneuheld på cykel, UlykkesAnalyseGruppen, Odense Sygehus, Danmark.
- 12.4 Vejdirektoratet - Vejreguludvalget (1987): Vejregler for afmærkning af vejarbejder, Danmark.
- 12.5 Davies, D.G.; Ryley, T.J.; Coe, G.A. og Guthrie, N.L. (1998): Cyclist safety at road works, Report
- 12.6 Larsen, Lars Binderup (1991): Eneuheld på cykel, UlykkesAnalyseGruppen, Odense Sygehus, Danmark.

CHAPTER 13 PUBLIC BIKES AND COMMUTER BIKES

Sources

None

PHOTO CREDITS

Albertslund Kommune
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Frederiksberg Kommune
Lars Bahl
Linda Hansen
Malmö Stad
Søren Hytting
Middelfart Kommune
Odense Kommune

Rambøll Danmark A/S
Dansk Cyklist Forbund
Sweco Infrastruktura AB
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MANIFESTO
Cycling Embassy of Denmark
COWI A/S
Kræftens Bekæmpelse
Vejle Kommune

CHAPTER 14 CYCLE TOURISM

Sources

14.1 Dansk Cyklist Forbund



