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At the Frontiers of Cycling:

Policy Innovations in the Netherlands, Denmark, and Germany

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Editorial

This is a special-issue WTPP monograph on cycling – particularly on international variations in cycling activity. We have covered many aspects of cycling in this journal over the past 12 years and will continue to do so. The objective here is to make sure that the intelligence virus infects enough of our senior decision-takers, politicians and bureaucrats to produce a radical transformation of cycling so that in the majority of urban areas of the world we can deliver one third or more of all trips by bike. The same point applies to walking trips and to so-called "active-travel" in general. It is clear to us that many of our much publicised transport policy objectives including climate change, health and social inclusion will not be achieved until we produce seriously high levels of active travel.

The article by John Pucher and Ralph Buehler is well timed. It coincides with a strengthening view on every continent that we just have to get on with serious greenhouse gas reductions and significant reductions in auto-dependency. Not doing so is no longer an option. The urgency of climate change mitigation (i.e. reducing greenhouse gases) was made clear at the Bali conference in December 2007 and in the welcome adoption of Kyoto targets by the new Australian government on 3rd December 2007. What is also clear is that transport must now step forward and play a full proportionate role in reducing greenhouse gas emissions. If this means reducing emissions on a 1990 base by 30% by 2020 and 60% by 2050 then so be it. This can be done and the only thing working against success is the business-as-usual mindset and perverse ideas about regeneration and the economy.

Cycling is crucial to achieving climate change objectives and can also help to sort out the so-called obesity epidemic. It can transform our urban wasteland and traffic sewers into healthy, liveable, pleasant and quiet communities that value people and places and do not buy into the idea that thousands of vehicles rushing around an urban highway represents progress or civilisation.

There are, of course, many problems to be overcome and these are well illustrated by the progress of the Lancaster Cycling Demonstration Town Project (CDT) in the north of England (see Note 1).

The Lancaster CDT has a target to double cycling levels and has pursued an ambitious policy containing the following elements:

- New cycling infrastructure both on road and off road
- Projects to encourage cycle use on the part of school children and cycling infrastructure at schools
- Projects to use workplace travel plans to encourage cycle use for the journey to work

More detail can be found on http://www.celebratingcycling.org/

The Lancaster CDT is currently not making much impact on cycling levels in the city (see Note 2). This is disappointing and frustrating though is not related to the amount of local effort and enthusiasm devoted to the project.

This level of effort is very high but the CDT project is forced to work within a conventional transport and traffic ideology that is stuck in a car-centred 1960s world view and is not prepared to adapt in a way that would boost cycling.

This is best illustrated by the brief given to transport consultants, Mayer Brown, when they were asked to study the city centre one-way system and ways of encouraging cycling in a very cycling-unfriendly context of a one way system and its barrier effects. The brief states:

Aims of Study

ES.3 The aim of the study is to provide an evidence based cycle strategy to enable appropriate investment in cycle facilities and encourage cycle use to, and through the city centre. This will support the Cycle Demonstration Towns project up to 2008, and provide a strategy for future investment beyond this date.

ES.4 The strategy must provide a fast, safe and comfortable cycle network, whilst not impacting on the traffic capacity within Lancaster city centre's main one way (gyratory) system. In addition, the implementation of the cycle strategy should not adversely affect the operation of other modes of transport within the city centre.

Source: Lancaster City Centre Cycle Strategy. Draft Final Report by Mayer Brown transport consultants (http://www.celebratingcycling.org/images/downloads/EXECUTIVE%20SUMMARY.pdf)

The brief excludes any proposal or set of proposals that would prioritise the bicycle or take up highway capacity with dedicated contra-flow cycle links across the city centre. It reinforces the dominance of "real" traffic (the car) and says that nothing must be done for the bike that might reduce or dilute this dominance. This eliminates any possibility of re-engineering the city centre and the one way system into a cycle-friendly environment.

More worryingly, the brief reveals a fundamental misunderstanding of sustainable transport generally and cycling in particular. The point is that we must adopt policies that *do* impact on other traffic because the objective is to transfer trips and choices from the car to the bike. Reducing car use by reallocating highway space to the bike through a segregated contra-flow cycle route will "adversely affect the operation of other modes"; that is the whole point of the exercise. This "adverse" impact is, of course, a highly beneficial and positive impact that will shift trips away from the car, reduce congestion, reduce pollution, help us to achieve air quality objectives in Lancaster's (failing) Air Quality Management Area and improve health.

The brief to Mayer Brown is one of the strongest statements in favour of the status quo we have ever seen and the status quo is seriously anti-cycling.

Key issue identified by cyclists and the cyclist's organisation, Dynamo, remain unresolved:

- The closure by a locked gate from Lancaster railway station to a high quality cycle path
- A decision by the CDT steering committee to adopt a 20mph general, system-wide speed limit on all residential roads to create safe and secure conditions for cyclists
- A contra-flow cycle route across the city centre to connect

residential areas with the railway station

The gate to the railway station was locked shut by the privatised railway operator, Virgin trains, on security grounds after an incident at Glasgow airport raised fears about terrorism attacks. The locked gate has cut-off direct cycle access to a high quality bike path designed to give access to the railway station. In spite of 6 months of effort to get the gate re-opened and a request to Sustrans to ask that organisation to intervene the gate remains locked shut. This sends a powerful anti-cycling message not only to the population of Lancaster, but to cyclists arriving in Lancaster by train.

The 20mph speed limit proposal was supported 100% by the CDT steering Committee and by Dynamo and by a committee of councillors known as "Lancashire Locals-Lancaster". The decision on 30th January 2007 is recorded on:
http://www3.lancashire.gov.uk/council/meetings/displayFile.asp?FTYPE=M&FILEID=20207
Lancashire County Council (the responsible transport authority) has refused to implement this decision.
The contra-flow link across Lancaster city centre was rejected by the consultants and by Lancashire County Council. The County council is pursuing other less direct and less useful routes.

The Lancaster CDT project has had to work within a media supported climate of anti-cycling rhetoric. A small group of local councillors have mounted a vigorous campaign against cyclists riding their bikes on pedestrian pavements even though the frequency of these incidents is small and nothing is done to deal fairly with system-wide traffic offences that are far more dangerous:

- Red-light running
- Vehicles mounting pedestrian pavements and using bus lay-bys to avoid traffic calming
- Vehicles parked on pedestrian pavements forcing pedestrians to walk in the road because the pavement is totally blocked
- Vehicles using pedestrianised areas as "rat-runs" and free parking
- Vehicles parking in cycle lanes
- Speeding
- Vehicle turning right into minor roads across a flow of pedestrians and not "giving way"

There has been a sustained attack in the press on cycling and on those who support higher cycling levels e.g.
"Suicide cyclist is back"

http://www.thelancasterandmorecambecitizen.co.uk/search/display.var.1534625.0.suicide_cyclist_is_back.php
http://www.thelancasterandmorecambecitizen.co.uk/search/display.var.1847581.0.an_unbelievable_response.php
http://www.thelancasterandmorecambecitizen.co.uk/search/display.var.1847577.0.nine_out_of_10_have_no_lights.php

It is highly likely that efforts to encourage higher levels of cycling have been rendered less effective than they might otherwise have been because the negative media comment on cycling and cyclist. This is compounded by the lack of public leadership and media support for cycling by senior politicians.
The silence on cycling and its many positive connotations has been

compounded by the silence of local businesses, the two universities in Lancaster, the local hospitals and National Health Service and the police. All responsible public bodies without exception have maintained "radio silence" and a complete indifference to the positive roles that key public and community based organisations can have in changing image, perceptions and culture. The only strong message getting through to the citizens of Lancaster is that cyclists are anti-social and a nuisance.

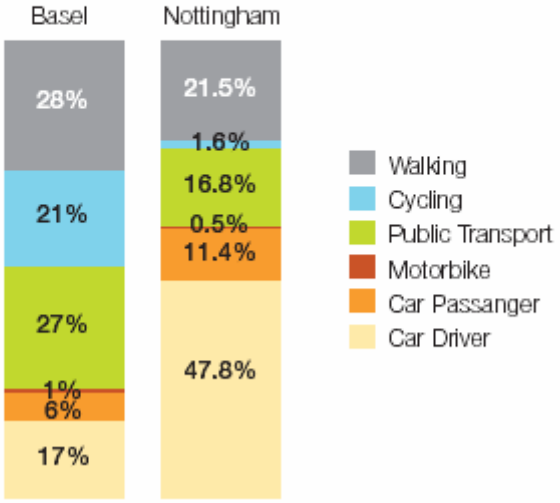
What next?

John Pucher and Ralph Buehler show very clearly what can be done to increase cycling levels. Whilst we are not in a position to comment on all CDT projects in England we can say that in Lancaster we will not achieve a doubling in cycling levels because of the lack of leadership by key local figures, the lack of commitment and vision by the transport authority and the failure to deliver well documented interventions that boost cycling (extra road space, cross-city centre routes, lower speed limits). All of these things have been requested by cyclists but the transport authority (Lancashire County Council) persists in its efforts to maintain the dominance of motorised transport and to avoid re-engineering urban to create cycle and pedestrian friendly environments. This is a major lost opportunity and one that will inevitably be used as evidence that even if you spend £3 million to improve cycling it does not work.

So back to John Pucher and Ralph Buehler. In their brilliant exposition of what does work and what works well they show that cycling can be celebrated and can succeed. They set out very clearly the details of what has to be done to improve cycling and there are no excuses left in the store cupboard of excuses about why cycling "is not working". In addition we have the experience of London where there has been an 80% increase in cycling since 2003 and we have the reality of Basel in Switzerland on which to finish:

Mode travel choice in Basel, Switzerland and Nottingham, UK

% trips per person (Socialdata)



Source: Sustrans http://www.sustrans.org.uk/webfiles/Publications/Sustrans_theNetwork_issue06_web.pdf, page 9

Basel has 21% of all trips by bicycle and Nottingham (UK) 1.6%. At the risk of promoting trans-national travel, I would invite anyone to compare the quality and ambience of Nottingham with Basel. Why are key decision makers so blind and unreceptive to the quantifiable benefits of confident promotion of cycling and walking as a key driver of town and city engineering? Lancaster can either go in the direction of Basel or the direction of Nottingham. Unless mindsets change and decision-takers wake up, the decision has

already been made and we have rejected the Basel model. We will all be considerably poorer, more vulnerable, unhealthier and more unhappy as a result.

John Whitelegg
Editor
World Transport Policy and Practice

Sustainable Transport Adviser to the Lancaster Cycling Demonstration Town Project Steering Committee

Note 1

The UK government has funded a national scheme to increase cycling levels. The project is administered by Cycling England

http://www.cyclingengland.co.uk/demotowns.php

The project has provided £17 million to improve cycling.

Lancaster is one of 6 Cycling Demonstration Town projects (CDT) and has £3 million to spend on cycling initiatives over a 3 year time period

http://www.cyclingengland.co.uk/dt_lancaster.php

http://www.cyclingengland.co.uk/documents/lancaster.ppt#263,13,Contact Us

Note 2

Cycling monitoring is fraught with difficulties but current monitoring data on cycling in Lancaster and Morecambe shows a disappointingly poor performance. In a monitoring report from Sustrans in July 2007 (the national cycling organisation co-ordinating monitoring) the following percentage increases in cycling were recorded:

Darlington +56.8%
Derby +10.8%
Exeter +20.9%
Lancaster +2.4%

Abstracts & Keywords

At the Frontiers of Cycling: Policy Innovations in the Netherlands, Denmark, and Germany

John Pucher and Ralph Buehler

This article presents six detailed case studies of cycling in the Netherlands (Amsterdam and Groningen), Denmark (Copenhagen and Odense), and Germany (Berlin and Muenster). Except for Berlin, they represent the very best in coordinated policies and programs to make cycling safe, convenient, and attractive. Not only are cycling levels extraordinarily high in these cities, but virtually everyone cycles: women as well as men, the old and the young, the rich and the poor. Moreover, they cycle for a wide range of daily, practical trips purposes and not mainly for recreation. Berlin is a special case. It does not even approach the five other cities in their cycling orientation. Nevertheless, its recent measures to encourage cycling have achieved an impressive bike share of trips for such a large city, higher than any other European city of that size. Thus, all six of the bicycling case study cities examined in this article truly are at the frontiers of cycling. They have many lessons to offer other cities in the Western World about the best ways to encourage more cycling.

Keywords: Bicycle, Bike city, Transportation Policy, Subsidiarity

At the Frontiers of Cycling:

Policy Innovations in the Netherlands, Denmark, and Germany

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Introduction

Cities in the Netherlands, Denmark, and Germany have cycling levels that are among the highest in the world. Over the past three decades, they have succeeded in raising the total number of bike trips while decreasing the number of cyclist fatalities and injuries. The cycling successes of these cities may provide valuable lessons for cities in other countries of Europe, North America, and Australia precisely because they are similar in so many other ways. They are all democratic, capitalist, affluent societies with nearly universal car ownership. The experiences of the Netherlands, Denmark, and Germany show that cycling can thrive even when people have the freedom to make their own travel choices and can easily afford motorized transport. The success of cycling does not depend on poverty, dictatorial regimes, or the lack of transport options to force people onto bikes. It does, however, depend crucially on a wide range of supportive government policies to make cycling convenient and safe.

This article provides detailed case studies of cycling in six cities: two in the Netherlands (Amsterdam and Groningen), two in Denmark (Copenhagen and Odense), and two in Germany (Berlin and Muenster). The largest city in each country is also the capital. The smaller city is of intermediate size, but in every case, it is the most bicycling oriented city in the country, with the highest bike share of trips. By examining cycling in cities of different sizes, we show that cycling can be a practical, safe, and convenient way to get around cities of virtually any size.

The focus in each case study is on the wide range of integrated, mutually supporting policies and programs that are used to promote cycling. To some extent, the cycling successes of the six cities rely on more and better implementation of the same sorts of traditional policies that many other European cities use. In addition, however, the case study cities examined here have been particularly innovative, introducing new approaches to encouraging cycling and making it safer.

In most countries throughout the world, cycling policies and programs are considered primarily, if not exclusively, a local Government Issue, with only limited state and central government involvement. That is certainly true in Denmark. In the Netherlands and Germany, state and central governments provide financial support for cycling facilities and assist with planning and research activities. In every country, however, the ultimate success or failure of cycling rests with local governments. They are responsible for implementing the key transport and land use policies that establish the necessary supportive environment for cycling to thrive.

For example, city and county governments in the Netherlands, Germany, and Denmark have been planning, constructing, and funding bicycling facilities for many decades, at least since the 1970s, but much earlier in some cities. Municipalities make the specific plans that reflect the particular conditions and needs of the local context. Cycling training, safety, and promotional programs are usually carried out at the local level as well, even if they are mandated and funded by higher levels. Thus, this article focuses on the local government policies and programs that are so crucial to the success of cycling.

Before presenting the six case studies, we provide a brief overview of cycling in the Netherlands, Denmark, and Germany. The success of cycling in the six case study cities is exceptional from an international perspective but not so unusual in their own countries.

National Overviews of Cycling

As shown in Figure 1, there are enormous differences in levels of cycling among the countries of Western Europe, North America, and Australia. Netherlands tops them all with 27% of all trips by bike. Denmark comes in second with a bike share of 18%. Germany is roughly tied with Finland and Sweden at 10%. Our three case study countries are far ahead of most other European countries and much farther ahead of the USA and Australia, where cycling accounts for about one percent of trips.

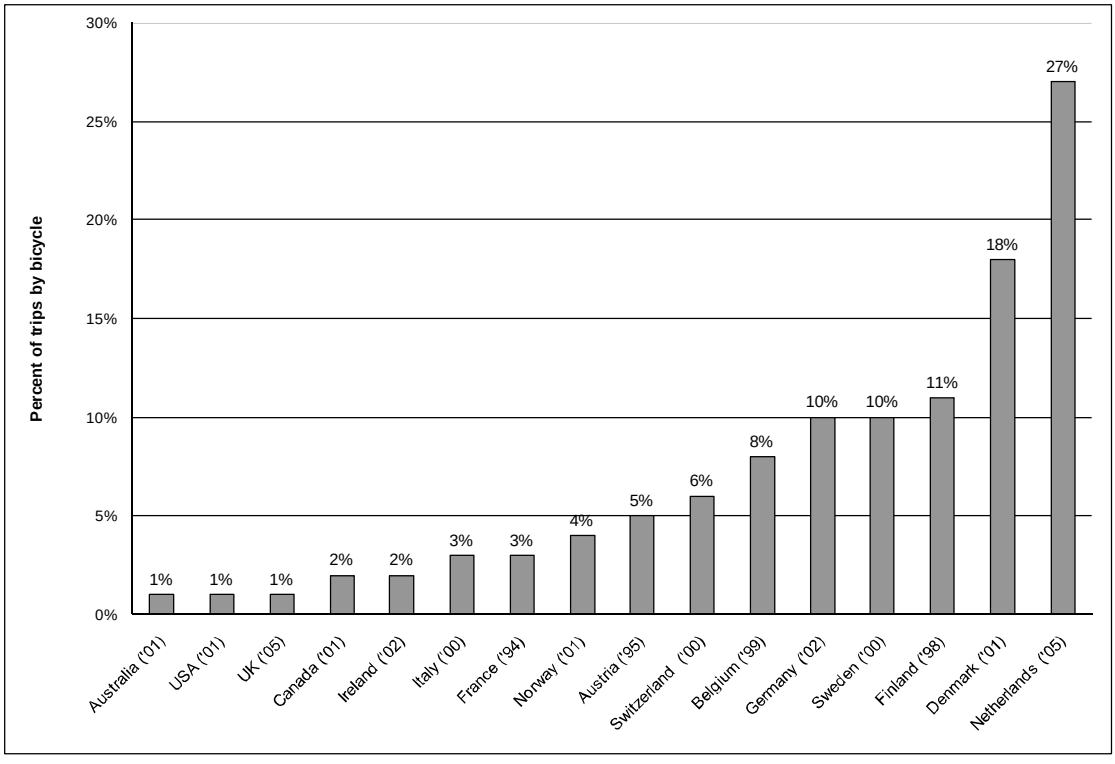

Figure 1: Bicycle share of trips in Europe, North America (Percent of total trips by bicycle)
Source: European Conference of the Ministers of Transport (2004); European Union (2003); U.S. Department of Transportation (2003); Netherlands Ministry of Transport (2006), German Federal Ministry of Transport (2003); Department of Transport (2005)

Most cycling in the Netherlands, Denmark, and Germany is for practical, utilitarian purposes. Travel to work or school accounts for 32% of bike trips in the Netherlands, 35% in Denmark, and 25% in Germany. Shopping trips account for 22% of bike trips in the Netherlands, 25% in Denmark, and 20% in Germany (German Federal Ministry of Transport, 2003; Danish Ministry of Transport, 2007; Dutch Ministry of Transport, 2006). Only about a fourth of bike trips in these three countries are for purely recreational purposes, compared to three three-fourths of bike trips in the USA (U.S. Department of Transportation, 2003).

Dutch, Danish, and German cyclists comprise virtually all segments of society. For example, women are just about as likely to cycle as men. Women make 45% of all bike trips in Denmark, 49% in Germany, and 55% in the Netherlands (German Federal Ministry of Transport, 2003; Danish Ministry of Transport, 2007; Statistics Netherlands, 2005). Another dimension of cycling's universality in the Netherlands, Denmark, and Germany is the representation of all age groups. Children and adolescents have the highest rates of cycling in almost every country. As shown in Figure 2, however, cycling levels in the Netherlands, Denmark, and Germany remain high even among the elderly. Finally, rates of cycling are similar among different income classes in these three countries, with the number of bike trips per day falling only slightly with increasing income (German Federal Ministry of Transport, 2003; Statistics Netherlands, 2005; Dutch Bicycling Council, 2006). In short, cycling in the Netherlands, Denmark, and Germany is for women as well as men, all age groups, all income classes, and all trip purposes.

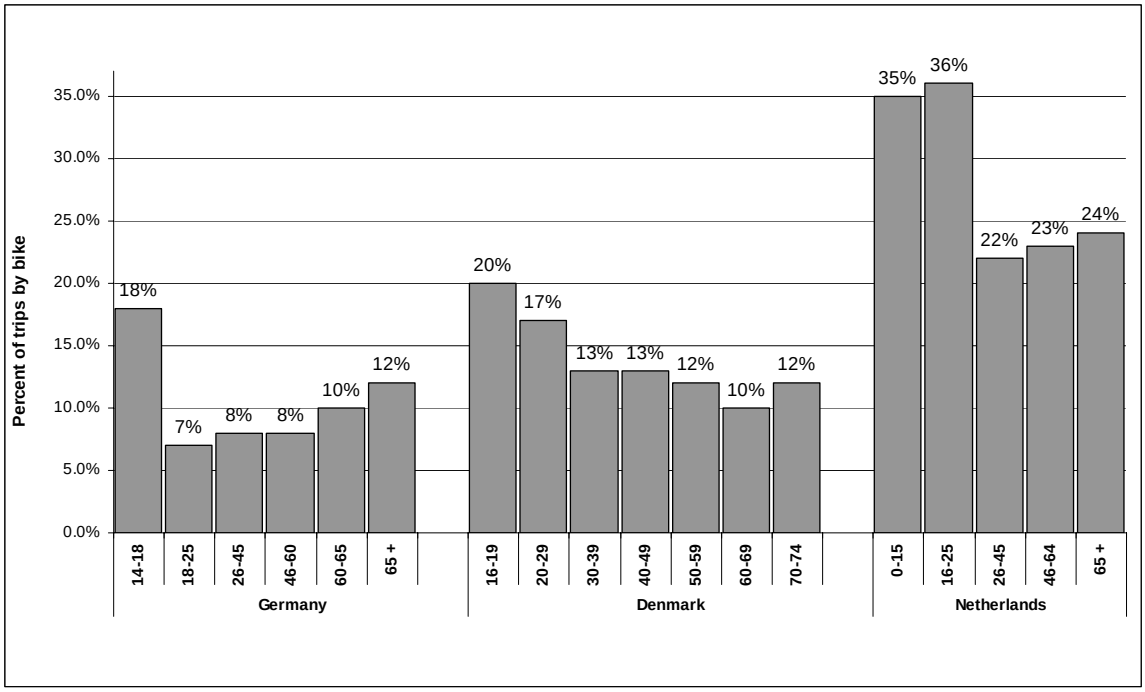

Figure 2: Bicycling share of trips by age groups in the Netherlands, Denmark and Germany (2000 – 2002)

Source: German Federal Ministry of Transport (2003); Danish Ministry of Transport (2007); Statistics Netherlands (2005)

One important reason for the universality of cycling in these three countries is the relative safety of cycling compared to other countries. As shown in Figure 3, the Netherlands has the lowest cyclist fatality rate. Averaged over the years 2002 to 2005, the number of bicyclist fatalities per 100 million km cycled was 1.1 in the Netherlands, 1.5 in Denmark and 1.7 in Germany, compared to 3.6 in the UK and 5.8 in the USA. Thus, cycling is over three times as safe in the Netherlands as in the UK and more than five times as safe as in the USA. That might explain why the Dutch do not perceive cycling as a dangerous way to get around. Cycling in Germany and Denmark is not quite as safe as in the Netherlands, but still 3-4 times safer than in the USA and twice as safe as in the UK. The relative safety of cycling in the Netherlands, Denmark, and Germany helps explain the higher levels of cycling there, especially among women, children, and the elderly. Those groups are probably the most vulnerable and the most sensitive to traffic dangers (Garrard et al, 2007).

While safety surely encourages cycling, there is strong evidence that more cycling facilitates safer cycling. The phenomenon of 'safety in numbers' has been consistently found to hold over time and across cities and countries. Fatality rates per trip and per km are much lower for countries and cities with high bicycling shares of total travel, and fatality rates fall for any given country or city as cycling levels rise (Jacobsen, 2003).

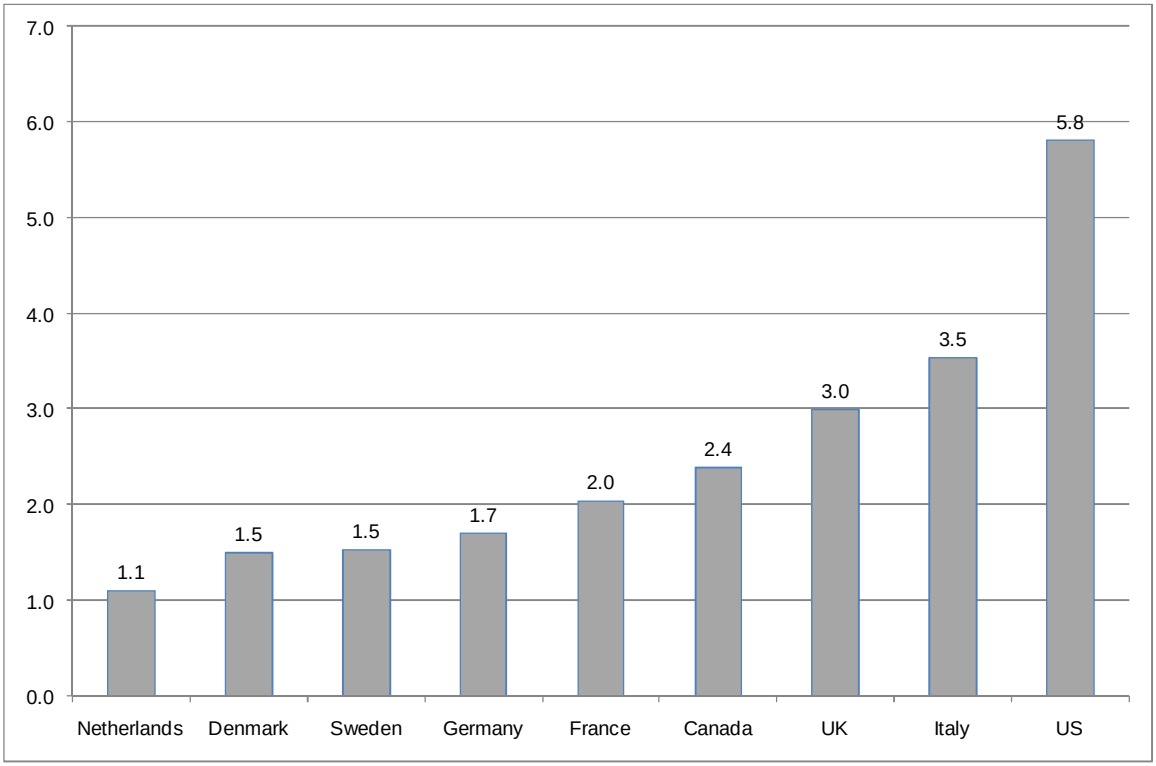

Figure 3: Bicycling fatality rate in European countries, Canada and the US (2002)
Source: Organisation for Economic Cooperation and Development (2005); European Union (2003) and U.S. Department of Transportation (2003 and 2007)

The much safer cycling in the Netherlands, Denmark, and Germany is definitely *not* due to widespread use of safety helmets. On the contrary, in the Netherlands, with the safest cycling of any country, less than one percent of adult cyclists wear helmets, and even among children, only 3-5% wear helmets (Dutch Bicycling Council, 2006; Netherlands Ministry of Transport, 2006). The Dutch cycling experts and planners interviewed for this paper adamantly oppose laws to require the use of helmets, claiming that helmets discourage cycling by making it less convenient, less comfortable, and less fashionable. They also mention the possibility that helmets make cycling more dangerous by giving cyclists a false sense of safety and thus encouraging riskier riding behaviour. At the same time, helmets might reduce the consideration motorists give cyclists, since they might seem less vulnerable if wearing helmets (Walker, 2007).

German and Danish cycling planners seem far more supportive of increased helmet use, especially among children. There have been extensive promotional campaigns in these two countries to encourage more helmet use, but there are no laws requiring helmet use, not even for young children. In 2002, 33% of German children aged 6-10 years wore helmets while cycling, compared to only 9% of adolescents aged 11-16, and only 2% of Germans aged 17 or older. In 2006, 66% of Danish school children aged 6-10 wore helmets, compared to 12% among school children 11 years or older, and less than 5% among adults (Andersen, 2005; Boehme, 2005; City of Muenster, 2004; Danish Ministry of Transport, 2000; German Federal Ministry of Transport, 2002).

We now turn to the six detailed city case studies of cycling, grouped by country: first the Netherlands, then Denmark, and finally Germany.

Case Studies of Cycling in the Netherlands

More than any other country in the Western World, the Netherlands is famous for its high levels of cycling. Almost every Dutch city is served by extensive cycling facilities, and the widespread presence of cyclists is an integral part of the urban landscape, central to the very image of Dutch cities. We have chosen two cities to examine in detail: Amsterdam and Groningen. Amsterdam is the largest Dutch city and is famous throughout the world for its bike-oriented culture. Groningen, in the far north of the Netherlands, is far less well known, but it has the highest bike share of travel of any Dutch city.

Amsterdam

(Information on cycling in Amsterdam was collected directly from Dutch transport planners and cycling experts. The main bicycling planner for Amsterdam, Ria Hilshorst, provided extensive information, corrections, and valuable feedback on this case study of cycling in Amsterdam. Information was also collected from the following published sources: City of Amsterdam (2003a; 2003b; 2007); Dutch Bicycling Council (2006); Osberg et al. (1998); and Langenberg (2000).

Bikes have shaped the image of Amsterdam to such an extent that, for many people throughout the world, Amsterdam is almost synonymous with cycling. In 2005, cycling accounted for 37% of all vehicle trips - a bike mode share unheard of in other European cities of comparable size (City of Amsterdam, 2007).

Typical cycling scene in central Amsterdam: Note that women predominate and that no one is wearing a helmet
Source: John Pucher

This bike path in Amsterdam swerves to the right several meters to increase cyclist safety when crossing the intersection. The increased distance between the main road and the bike path crossing gives motorists and cyclists more time to see each other and thus avoid collisions. Moreover, the traffic island with the two bollards forces a sharp turning radius, requiring cars to slow down.
Source: Lewis Dijkstra

With a population of 743,000, Amsterdam is the largest city in the Netherlands. The greater Amsterdam region has 1.5 million inhabitants and is situated at the northern end of the Randstad, the Netherlands' largest urban agglomeration.

Amsterdam's city administration estimates that there were 600,000 bikes in Amsterdam in 2006, about 0.75 bikes per inhabitant (City of Amsterdam, 2007). Amsterdam's topography and spatial development patterns are ideal for cycling. The city is mostly flat and Odensely built-up. Mixed use neighbourhoods keep trip distances relatively short. Furthermore, many small bike bridges and bike short cuts make it easy to navigate the city centre by bike. By comparison, car use is difficult in the central city. There are few car parking spaces, and many cul-de-sacs and one way streets hinder car travel.

Given high bike ownership levels, restrictive policies on car use, compact and mixed-use development patterns, it is no wonder that in 2003 fifty percent of Amsterdam's inhabitants made daily use of their bikes (City of Amsterdam, 2003a). Over 85% of Amsterdam's residents rode their bike at least once a week in 2003. Bicycling is almost universal in Amsterdam. The rich and the poor, men and women, children and the elderly, all use the bicycle for a minimum of 20% of their trips (City of Amsterdam, 2003b). Two noteworthy variations in bike usage exist, however. First, the affluent cycle more than the poor in Amsterdam.

Higher car ownership levels in affluent households lead one to expect more car use in this income group compared to poorer households. Bike planners in Amsterdam speculate that lower income groups see the car as an important status symbol, while they view the bicycle as a "poor man's" vehicle. Consequently, they prefer to drive instead of cycle. Bike planners argue that richer households find the bicycle to be a fast, healthy and convenient means of transportation without a stigma attached to it.

The placement of the bike path behind the bus stop avoids conflicts between cyclists and passengers getting on and off of buses in Amsterdam.
Source: Lewis Dijkstra

Secondly, recent immigrants and their children also cycle less than the average resident of Amsterdam (Dutch Bicycling Council, 2006). Amsterdam's bike planners found that cycling is often not part of the original culture of immigrants. Therefore cycling is not their transport mode of choice in the Netherlands either. The city council tries to promote bike use through special programs for immigrants and their children.

Travel trends

Similar to Copenhagen, Amsterdam has a long tradition of cycling. In 1955, up to 75% of all trips in Amsterdam were made by bicycle. From 1955 to 1970 the cycling mode share had declined to only 25% of all trips (Dutch Bicycling Council, 2006; Langenberg, 2000). Declining levels of cycling were accompanied by increasing suburbanization and growing car ownership and use. However, most other European cities of comparable size would be proud of a bike mode share of 25%.

Since the late 1960s and early 1970s, bicycle advocates and environmentalists have promoted bicycle use in the city. Their main concerns were air and noise pollution, traffic congestion, and unsafe traffic conditions caused by automobile use in the city. At the time, there were two competing solutions to Amsterdam's traffic problems: adapting the development patterns and city structure to the automobile or limiting car access to the city centre and promoting walking, cycling, and public transportation. The city council chose to promote alternative modes of transport over widening roads and building car parking garages in the city centre.

Finally in 1978, a newly elected city council focused on bicycling as an integral tool for solving the city's transport problems. Since the early 1970s bicycle use has been increasing. It reached 31% of all vehicle trips in the mid 1980s, and was at 37% of all vehicle trips in 2005 (City of Amsterdam, 2007). Over the same period of time, the mode share for public transport declined, however (27% in 1985, 22% in 2005). The percentage of trips made by car remained almost unchanged from 1985 to 2005 (42%

in 1985, 41% in 2005) (Dutch Bicycling Council, 2006; City of Amsterdam, 2007). This indicates that increased levels of cycling were most likely in expense of lower levels of transit use and walking. Bicycling in Amsterdam is used for all trip purposes: for 34% of work trips, 33% of shopping trips and 27% of leisure trips in 2003.

In 2000, over half (55%) of all vehicle trips in the historic city centre were by bike. Cordon counts at important intersections in the city centre support this number. They also reveal an increase of up to 20% in the number of bike trips from 1986 to 2000 (City of Amsterdam, 2003b).

As in most other cities, bicycling levels decline with distance to the city centre. In 2000, 40% of trips were made by bike in inner ring city districts; and 21% of all trips were by bike in more suburban districts built after World War II. From 1986 to 2000 bicycling levels decreased by around 10% in these outlying areas.

Overall policy goals

Non-motorized modes of transport are at the centre of Amsterdam's transport policy. Even though the city's main transport policy goal is to increase accessibility by all modes, concerns about quality of life and air pollution give the bicycle a special role in transportation planning. In 2006, the main area of concern for cyclists were bicycle theft, shortage of safe bike parking facilities, traffic safety, and relatively long waiting times at signalized intersections.

Following its bicycle policy plan "Choosing for Cyclist: 2007-2010", the city has started to try to address these problems by increasing bike parking facilities, combating bicycle theft, improving and promoting traffic safety, completing and improving the bike network and getting young people to bike more (City of Amsterdam, 2007). From 2007 to 2010, about €40 million of city funds will be spent on bicycling projects, not including additional measures to increase traffic safety. Together with matching funds from other levels of government the total amount of funding for bicycling will increase to €70 million over 4 years. This comes to about €13 per inhabitant per year, which is comparable with other Dutch cycling cities. About €12 million are set aside to improve bike parking facilities and guarded bicycle garages. Furthermore, traffic calmed areas (with a speed limit of 30km/h) are to be expanded. Amsterdam will invest €500,000 for bike education, public relations campaigns and other activities designed to increase bicycling among young people and other groups of society that tend to cycle less often (City of Amsterdam, 2007). The city also wants to replace on-road bike lanes with separate bike paths.

The city is making efforts to integrate bike and transport planning across all city districts and across many departments of the city administration. For example, efforts are being made to integrate transport and spatial development plans. The main responsibility for carrying out bicycle projects lies with the city districts. This results in slight differences in implementation of bike projects and bike infrastructure among the different areas of the city. The traffic and transport infrastructure department (DIVV) tries to coordinate and harmonize all bicycling efforts city wide.

Bike traffic signal in Amsterdam that shows cyclists the number of seconds till they get a green light
Source: Peter Berkeley

Amsterdam recently launched a comprehensive program to combat bike theft. In 2006, about 50,000 bikes were stolen in Amsterdam (almost 10% of all bikes!). That might seem like a lot, but it is in fact a 37.5% decrease compared to 2001 and can be considered a first success in combating bike theft. Amsterdam's bike policy postulates the goal to further reduce bike theft to 6% of all bikes by 2010 (City of Amsterdam, 2007).

To help to achieve this goal, the city has a comprehensive approach consisting of official bike registration, collaboration with bike stores, and strict police checks for bike ownership will. Amsterdam has invested €5 million since 2002 and plans to invest €4 million over the next 4 years into bike registration and police checks (City of Amsterdam, 2007). For example, the city actively promotes engraving unique codes into the bike frame. Engraving is free and engraved bikes are registered with the police. Based on this unique registration code, stolen bikes can be returned to their owner and police can detect stolen bikes during bike checks. The city even has a special webpage especially for this program and other bike theft issues (http://www.fietsendiefstal.nl/english/index.html).

Amsterdam's bicycle stores have adopted a new policy, not to repair, buy or resell any bike that could potentially be stolen. Additionally, Amsterdam police are stepping up checks of bikes on the road. In 2006, over 70,000 cyclists were checked for ownership status and potential bike theft.

Safety

As in most of our case study cities traffic safety increased for cyclists over the last few decades. In 2005, there were 40% fewer severe cyclist injuries and deaths from traffic accidents than during the mid 1980s. Even though progress has been made, between 6 and 7 cyclists are still killed in traffic accidents in Amsterdam every year. As already described in the case study about Groningen, bicycle safety is important in the Netherlands. It does not revolve around bicycle helmets, however. In the Netherlands, bicycle helmets are seen as unattractive and therefore potentially discouraging cycling. Additionally, bike planners argue that bike helmets might lead cyclists to behave more dangerously, as they feel less vulnerable. Finally, bike planners point out that car drivers use less care when interacting with cyclists wearing helmets.

Dutch traffic laws protect young cyclists and put the responsibility for an accident on the car driver. The only exception is when cyclists deliberately and flagrantly disobey traffic laws. Similar to Germany, Dutch traffic laws postulate that car drivers have to take

special care when encountering children and the elderly.

Police officer in Amsterdam ticking a cyclist for disobeying traffic regulations
Source: Peter Berkeley

Provision of cycling facilities

In 2007, the city of Amsterdam had a total of 450km of bike paths and lanes. In contrast to cities like Copenhagen, where bike paths and lanes have a long history, most paths and lanes in Amsterdam have been built since the early 1980s. In 2007, the city's bike infrastructure was made up of 200km of separate bike paths throughout the city and 200km of bike lanes along 30 km/h traffic calmed neighbourhood streets. There were 50km of bike paths along roads with speed limits of 50 km/h. In addition, Amsterdam had about 775 km of traffic calmed streets in 2000. Over the coming years, the city plans to expand the main bicycle network by about 40 – 50 km of paths and lanes and to add another 175 km of traffic calmed streets.

Most of the proposed investments for bicycling discussed above will go towards cycling infrastructure. The majority of funds (€24 million) will be used for three crucial bridges and tunnels connecting the main bike network ('Hoofdnet Fiets'). Building separate bicycle paths to connect the bike network will cost an additional € 18 million. Funding for bike infrastructure comes from district, city and regional budgets (City of Amsterdam, 2007).

Restrictions on cars

The city of Amsterdam has greatly restricted car access to the city centre. Many streets are one way for cars, and others are solely reserved for pedestrians and cyclists, and are completely off-limits for automobiles. Since the 1970s the city has reduced the amount of car parking in the city centre. Additionally, fees for the remaining car parking spaces were substantially increased since the 1970s (Langenberg, 2000; Dutch Bicycling Council, 2006). In 1992, citizens voted to continue to decrease car parking in the city centre. This has proven to be an effective transportation demand management tool. When parking is sparse and costly, it discourages car trips to the city. Furthermore, as in most Dutch cities, many residential areas are traffic calmed at a low speed for cars (30 km/h areas).

Bike Parking and Coordination with public transport

Amsterdam has large bike parking facilities at its train stations. During peak hours on workdays, up to 10,000 bikes were parked at Amsterdam Central Station in 2006. Unfortunately, the number of unguarded bike parking facilities has declined sharply in recent years due to massive reconstruction around the Central Station. The reconstruction is proposed to last until 2012. The city is trying to accommodate bike parking needs with a temporary three story bike parking garage. Demand for parking outnumbers the available 2,500 parking spots, however. City planners estimate that

about 4,000 bikes are parked in this parking garage. This is accomplished by double parking bikes in parking spots originally designed for single bikes. Even though this parking garage is overcrowded, it is still not enough to accommodate all bicycles.

As a result bikes are parked all around the train station. The City of Amsterdam installed an additional 1,000 bicycle racks around the station and provided another 1,500 bike parking places on an old ferry -anchored on an adjacent river- until construction of the train station is completed. After reconstruction is complete in 2012, there will be 10,000 bike parking spaces in sheltered facilities at the train station.

Amsterdam has pioneered an innovative integration of automobile and bike use. This program is called “Park and Bike” and allows motorists to park their cars at the fringe of the city and to complete their trip to the city centre on bike (Dutch Bicycling Council, 2006). The main reason for implementing this program was the lack of car parking in the downtown area and a shortage of transit access to all parts of the city. The bike rental fee is included in the price of the car parking ticket. In 2006, Amsterdam had 80 of these rental bikes at two locations (Olympic Stadium and Sloterdijk station). During summers the city reports that 60% of all rental bikes are in use every day. The program is not working at a profit, thus municipal governments in the region cover excess costs not met by parking fees.

Bicycling promotion

Similar to Germany, Dutch school children go through bicycle training in school. This further familiarizes children with bicycling and teaches necessary traffic rules and behaviour. Bicycles are made available to schools by the city government for free so that children who do not own a bicycle can learn at school how to cycle safely in Amsterdam. In the Netherlands many children experience bicycling early in life; they learn to cycle when they are 3-4 years old. Many infants make their first bike ride on the backseat or in special bike trailers with their parents. Children of immigrants often do not have these early experiences of bicycling, as cycling is not part of the culture of their country of origin. Indeed, the city reports that children of recent immigrant cycle less than the average child in Amsterdam. Therefore, the city plans to make special efforts to target children of recent immigrants through bicycling promotion and to make bicycling as appealing and as irresistible as possible to them.

Groningen

(*Information on cycling in Groningen was collected directly from Dutch transport planners and cycling experts. The main bicycling planner for Groningen, Cor van der Klaauw provided extensive information as well as corrections and improvements to this case study of Groningen. Information was also collected from the following published sources: City of Groningen (2007); Dutch Bicycling Council (2006); and van der Klaauw (2006))*

As the most bicycling oriented city in Europe’s most bicycling oriented country, Groningen is very special indeed. Similar to Muenster and Odense, the bicycling policies, programs, and facilities in Groningen have become a model for other cities to follow.

Typical scene in Groningen, with the entire family cycling together, and without helmets, not even for the young child. Source: Peter Berkeley

Groningen has 181,000 inhabitants, including about 46,000 university students (City of Groningen, 2007). It is the seventh largest city in the Netherlands, located in the far north of the country. As in other Dutch cities, its flat terrain facilitates cycling. Over many decades Groningen has consistently implemented sustainable land use and transport policies. Together with the provision of extensive cycling infrastructure, the city's compact land use and car-restrictive measures have encouraged the continued growth of cycling as a means of daily travel.

Groningen has remained quite compact in spite of its gradually increasing population. In 2005, 78% of its residents and 90% of its jobs were located within a 3-km radius of the city centre (Dutch Bicycling Council, 2006). That compactness generates trips are short enough to be made by bike, and that is perhaps the most important factor in explaining the extraordinarily high bike share of travel.

The compactness of Groningen is not an accident but resulted from strict land use plans that limited the type of sprawled, low-density development that would have greatly increased trip distances and required more car use. In fact, there was considerable planned decentralization in the 1970s to accommodate increase population and commercial development. Since 1980, however, there has been very little additional expansion, and the focus over the past 25 years has been on maintaining Groningen's compact, bike-friendly spatial pattern (Dutch Bicycling Council, 2006; van der Klaauw 2006).

Travel trends

Groningen has the highest bike share of local trips of any large Dutch city, remaining steady at slightly less than 40% for the past two decades. For local trips within Groningen, the bike share of trips is 59%, also the highest in the Netherlands. In 2002, the Dutch Cyclists Union designated Groningen as "Cycling City of the Year." Thus, Groningen is comparable to Odense, Denmark and Muenster, Germany. Each city has its country's highest bike shares of travel, and each city has been awarded the designation of best cycling city. Although the bike share of trips in Groningen has remained steady since 1980, the total number of bike trips has increased along with population and overall travel demand.

As for the Netherlands as a whole, there is no significant difference between men and women in their levels of cycling. Indeed, national statistics show that women make more bike trips than men. The highest rates of cycling are among the age groups 12-19 and then again among those over 45. There is a fall in cycling levels among those 20-45 years old, possibly because they are in the middle of their careers and rushed for time (Dutch Bicycling Council, 2006).

Overall policy goals

The main goal of transport policy in Groningen is the preservation of cycling as a feasible, safe, and convenient means of local travel, thus providing a sustainable alternative to the private car. To achieve that goal, the city has consistently pursued self-reinforcing policies of compact land use, car-restrictive measures, and high-quality cycling infrastructure.

Safety

There has been substantial improvement in cycling safety in Groningen over the past ten years, with the number of bicyclist injuries falling from 202 in 1997 to 101 in 2005, thus halving total cyclist injuries, although the total number of bike trips has surely increased (van der Klaauw, 2006).

Almost no one in Groningen wears a safety helmet when cycling - neither adults nor children. Moreover, there is no public program to encourage cyclists to wear helmets. There is a widespread belief in the Netherlands that wearing a helmet is neither necessary nor appropriate. Both at the national and local levels, Dutch cycling planners have opposed efforts to encourage let alone require helmet use. They assert that helmets discourage cycling by making it less convenient and less comfortable. Whatever safety benefits helmets might offer, they are far offset by the reduced cycling they would cause. One bike planner suggested that helmets might make cyclists seem less vulnerable in the eyes of motorists, who might then drive with less care and consideration toward cyclists. Cyclists themselves might also cycle more dangerously and take more risks if they are wearing a helmet.

Groningen's strategy for improving cycling safety relies mainly on the provision of extensive bike lanes and bike paths, priority traffic signals for cyclists, traffic calming of residential neighbourhoods, and sharp restrictions on car traffic in the city centre. In this respect, Groningen has undertaken the same measures as Muenster and Odense.

There is also a concerted program in Groningen to reduce bike theft, which has been a major problem. Groningen's first guarded bike parking facility was opened in 1982. Thanks to its success, the number of such guarded bike parking facilities increased to 20 by 1995 and to 30 by 2006. Guarded bike parking facilities for the general public charge a daily fee of €0.90 or an annual subscription fee of €25 for regular users. In addition, there were 15 schools in Groningen in 2006 with guarded bike parking for a fee of €22.50 per year. The parking fees charged for guarded bike parking fully cover the costs of hiring the necessary staff for surveillance (Dutch Bicycling Council, 2006; van der Klaauw, 2006).

Provision of cycling facilities

Perhaps the most impressive aspect of Groningen's cycling policy is the vast expansion of cycling facilities. The city has more than doubled the extent of its separate bike lanes and paths since 1980, reaching 220 km in 2006. Clearly, that has greatly facilitated cycling, making it safer as well as more convenient. By 2006, all outlying residential areas had been connected with

separate cycling facilities leading directly to the city centre. To enhance its cycling network, Groningen has constructed many special infrastructure facilities such as cyclist bridges and underpasses to further separate cyclist traffic flows from motor vehicles.

The City of Groningen invested €23 million in cycling facilities between 1989 and 2000 and another € 9.5 million between 2000 and 2006, or a total of almost €33 million in the past 17 years. For the years 2006 to 2010, it is projected that at least €11 million will be spent expanding and improving cycling facilities in Groningen. That would be a total of €44 million over 21 years or about €2 million per year (Dutch Bicycling Council; van der Klaauw, 2006).

Just as in Muenster, Groningen has installed many short cuts for cyclists to increase the directness of bike trips, cut trip distances, and thus increase the overall speed and convenience of bike travel compared to car travel. At the same time, the city introduced many artificial dead ends, traffic-calmed areas, and car-free zones that make car travel more circuitous, less convenient, and more time consuming that bike travel.

Intersection treatments and traffic priority for cyclists

At some key intersections, Groningen has introduced four-way green traffic lights for cyclists, permitting faster and safer crossing of the intersections for cyclists, especially when making left turns. Generally, the city has tried to remove traffic lights to avoid interruptions in bike trips at intersections. For example, bicycling routes have been planned so that it is now possible to cycle from several outlying residential areas directly to the city centre without having to stop at even one traffic signal, greatly speeding up bike travel between outlying residential areas and work, shopping, and the university in the centre.

Traffic signal enabling four-way all-green crossing for cyclists in Groningen, avoiding all possible conflicts with turning cars
Source: Peter Berkeley

There are separate traffic signals for cyclists, and cyclists usually get advance green lights. At especially busy intersections, cyclists get two green light phases during each cycle of the traffic signal. Cyclists are also allowed to make right turns at intersections when the traffic signal is red, while car drivers cannot. At many intersections, cyclists proceed to the front of the intersection and wait in an area ahead of all the cars, which must stop further behind at another stop line. Cyclists also get an advance green light, which speeds them through the intersection and provides greater visibility and safety. In addition, cyclists are permitted to make right or left turns at many intersections where they are - prohibited for cars. That gives cyclists greater flexibility in the routing of their travel.

Cyclists and pedestrians have absolute priority in the city centre - in the use of public spaces and roadways, direction and routes of travel, and traffic signals. On many one-way streets cyclists are permitted to travel in both directions, while motorists can only drive in one direction.

Restrictions on cars

Much of Groningen's city centre is off limits to cars. It is not possible for cars to pass through the city centre from one end to the other. That forces such traffic to take circumferential routes and mitigates the problems of congestion, noise, air pollution, and traffic danger in the city centre. Through motor vehicle traffic is diverted to ring roads outside the city centre (Dutch Bicycling Council, 2006; van der Klaauw, 2006).

Just as in Muenster, almost all residential neighbourhoods in Groningen are traffic calmed so that speed limits are reduced to 30km/hr or less. In addition, there are many woonerfs (home zones) with speeds limited to 7km per hour and cars forced to share roads with pedestrians, cyclists, and playing children.

The reduction of car parking spaces within the city centre has also discouraged car use there. New car parks have been built near the edge of the city centre, with motorists encouraged to park their cars there and then to walk, bike, or take a bus to the centre. Motorists are directed either to the nearest car park just outside the centre or to more outlying car parks that permit free parking of cars and provide direct bus service via the CityBus shuttles between the park and ride lots and the city centre.

Coordination with public transport

The main form of multi-modal coordination is the provision of very extensive bike parking at train stations and some key bus stops. Virtually all bus and train services converge radially on the city centre, either at the main train station or the main city square (Grote Markt). As noted in the next section, there is extensive bike parking of various sorts at those locations.

Suburban rail services permit bikes on their trains, and both the Amsterdam and Rotterdam metros permit bikes on board the trains. There are no bike racks on buses, but some of the longer-distance regional buses permit bikes to be taken on-board on certain off-peak days, such as the weekends and holidays. By comparison, none of the regular city buses permit bikes on board and they do not have bike racks.

Bike Parking

There are 36 bike parking facilities in the centre of Groningen, including 7 which are guarded to prevent bike theft. At the central train station, there are three different bike parking facilities: a guarded parking facility with 1,700 bike parking places, an unguarded parking lot with space for 4,150 bikes, and a bicycle parking deck with 900 bike parking spaces. Groningen's most innovative parking policy is the provision of extensive guarded parking to reduce bike theft, as discussed earlier (Dutch Bicycling Council, 2006; van der Klaauw, 2006).

New bike parking facility directly next to the main train station in Groningen, with this major bike path leading right through it.
Source: Peter Berkeley

Bicycling promotion

There are no special programs in Groningen to promote cycling, in sharp contrast to Muenster and especially Odenese, with its incredible range of cycling promotion campaigns. Cycling is so common and natural in the Netherlands - especially in Groningen, with the highest rate of cycling of any Dutch city - that there does not seem to be a need to implement special promotional programs. Nevertheless, there are some movements in this direction, partly to counter the increasing problem of obesity among the Dutch. The main way that Groningen promotes cycling is not through any special marketing gimmicks but rather by providing superb cycling facilities and restrictions on car travel.

Case Studies of Cycling in Denmark

In the Western World, Denmark is second only to the Netherlands in its overall levels of cycling. Somewhat similar to the Netherlands, cycling in Denmark benefits from a mostly flat topography and moderate climate. But it also benefits from a wide range of transport and land use policies that have increasingly supported cycling and restricted car use over the past few decades. We first examine Copenhagen, the capital and largest city of Denmark. Somewhat similar to Amsterdam, cycling has become a key aspect of Copenhagen's image throughout the world. And that enables it to benefit from a considerable amount of cycling tourism on top of all the other benefits of cycling. The second Danish case study is Odense, which is hardly known outside of Europe. It has an even higher bike of trips than Copenhagen and has been designated the official National Bicycling City of Denmark. Odense has truly been at the forefront of cycling policies and programs, having implemented perhaps the most innovative pro-bike measures of any city in the world.

Copenhagen

Information on cycling in Copenhagen was collected directly from Danish transportation planners and cycling experts. The main

bicycling planner for Copenhagen, Niels Jensen, provided extensive information, corrections, and improvements to this case study of cycling in Copenhagen. Information was also collected from the following published sources: Cervero (2001); City of Copenhagen (2002; 2004; 2006; 2007a; 2007b); Fonden Bycycklen (2007); and Dutch Bicycling Council (2006).

With about half a million inhabitants in the city and 1.7 million inhabitants in its metropolitan area, Copenhagen is Denmark's largest city as well as its capital (City of Copenhagen, 2007a). Of Europe's major cities, only Amsterdam is more bicycling oriented than Copenhagen. With its long history of cycling and high share of trips by bike, the city actively markets itself as the "city of cyclists." Since spring 2007, the city has set itself the goal to become "the best city in the world for cycling" (City of Copenhagen, 2007b).

Children ride up front on this bike in Copenhagen, a design that was developed in Denmark and is called the 'Christiania" bike.
Source: Peter Berkeley

Brightly colored blue bike lane crossings at intersection in Copenhagen to highlight presence of cyclists to motorists
Source: Peter Berkeley

The extensive bicycling network and the central role of cycling facilities in all traffic planning highlight the importance of bicycling in the city's transport policies. Indeed, a third of Copenhagen's road transport budget is earmarked for cycling facilities and programs.

Land use and development policies have also facilitated cycling. As noted by Cervero (2001), Copenhagen's suburban expansion has been concentrated along radial train corridors that focus on the city centre. The relatively high residential densities and mixed land uses ensure a high percentage of trips that are short enough to cover by bike.

In contrast to most other case study cities, there are no bicycle streets in Copenhagen, and traffic calming is not very extensive. Currently, some residential areas have 30km/h speed limits and a very limited number of streets have car speed limits of 15km/h. However, the city has plans to reduce the general speed limit for cars from 50km/h to 40km/h in large parts of the city.

Travel trends

Cycling has almost continuously increased in and around Copenhagen in recent decades. Cordon counts indicate that the number of bike trips grew by about 70% from 1970 to 2006, with especially rapid growth in the areas beyond the city centre. A 2005 travel survey found that 20% of all trips in Copenhagen were by bike. An even higher 36% of work trips were by bike (City of Copenhagen, 2006).

Cycling rates are high for all groups: men and women, all age groups, all professions, and all income levels. Similar to Amsterdam, cycling is viewed as a perfectly normal way to get around the city, and cyclists are a permanent part of the scene on virtually every street. Interestingly, bike use in recent years has risen most among older age groups. For example, the percentage of Copenhagen residents over age 40 who cycle regularly increased from 25% in 1998 to 38% in 2005 (City of Copenhagen, 2006).

Entire family cycling together on this bike path in Copenhagen. Note that the child is wearing a helmet but not the parents. Source: Peter Berkeley

Overall policy goals

The goals of its cycling policy were first clearly stated in Copenhagen's 2002-2012 Cycling Policy Plan and then slightly revised in 2007 (City of Copenhagen, 2007b). The city aims to increase the bike share of work trips to 50% by 2012 (for jobs located within the city), and to reduce the number of cyclist injuries by 50%. Moreover, the city has a specific goal of raising the percentage of cyclists who *feel* safe from the current 57% to 80%. The Policy Plan also sets the goals of increasing cycling speeds by improving the cycle pathway system and by giving cyclists more priority at intersections. As of spring 2007, the city plans to double funding for bicycling (City of Copenhagen, 2007b).

Safety

Although cycling levels in Copenhagen are high, they would be much higher if safety were improved - as well as the *perceived* safety of cycling. Indeed, a recent survey revealed that the majority of those who do not cycle feel that cycling is unsafe. Even among regular cyclists, only 53% feel safe, according to the 2006 Bicycle Account survey (City of Copenhagen, 2006). That is in spite

of impressive improvements in actual cycling safety. From 1995 to 2006, the number of cyclist fatalities and serious injuries fell by 60%, although the total number of kilometres cycled rose by 44% over the same period (City of Copenhagen, 2006).

In the past, Copenhagen's main approach to increasing safety was the extension and improvement of the system of bikeways along roads and in parks. Although those efforts continue, the city's focus now is on improving safety at intersections, since that is where most serious crashes occur. Increasingly, the city is installing advance stop lines for cyclists, priority traffic signals, and bright blue marking of bike lanes crossing roads.

Similar to Dutch cities, cyclists in Copenhagen rarely wear helmets. In sharp contrast to Odense, there does not appear to be any public campaign to promote helmet use. As in the Netherlands, bike planners in Copenhagen reject laws requiring helmet use since they would probably discourage cycling by making it less convenient and less fashionable.

Provision of cycling facilities

Even as far back as 1934, Copenhagen had 130 km of bike paths, but they have been extended considerably since then (Dutch Bicycling Council, 2006). In 2004, there were 345 km of separate bike paths and 14 km of bike lanes, with plans to invest €16 million to build an additional 50 km of bike paths by 2015 (City of Copenhagen, 2004 and 2007b). In addition, the city has begun construction of a series of 21 new bike routes—designated as green bicycle routes. They will have a total length of over 110 km and cost €70 million. By routing them through parks, along waterfronts, and in other green spaces, the planners are minimising roadway crossings, thus maximizing safety, comfort, and speed (City of Copenhagen, 2007b).

Copenhagen bike planners have a strong preference for separate paths over on-street lanes on major roads. Although some bike lanes are being built, they are viewed as cheap, temporary measures - less safe than separate paths. Most lanes will eventually be replaced by fully separated paths. Generally, bike paths in the city are on both sides of the street, situated between the roadway and the sidewalk. The bike path is separated from motor vehicles by a curb and elevated by 7-12 cm above the level of the street. Most bike paths are 2.2 meters wide, but on especially busy commuter routes, they are widened to 3 meters. At intersections and other road crossings, bike paths turn into bike lanes and are often painted a bright, highly visible blue to alert motorists to the presence of cyclists crossing the road.

Green wave for cyclists on this major street in Copenhagen, synchronized at 20km/hr. Note the specially protected path, with a curb separating the path from the lanes for motor vehicles.
Source: Niels Jensen, City of Copenhagen

While the bicycling facilities in Copenhagen are extensive, about a fifth of current cyclists report in the bi-annual survey that they are dissatisfied with them overall (City of Copenhagen, 2004 and 2006). Over half of current cyclists complain about poor maintenance. As in many cities, motor vehicles sometimes stop or park illegally on cycle tracks, endangering cyclists and slowing them down. Another problem is the congestion of several key bike paths during rush hours, with over 2,300 cyclists per hour. Congestion is limited to only 3 to 4km of the bike networks, but bike planners and cyclists still consider it a problem.

In response to these problems, the city is planning to expand the network of bike paths, widen paths to 3 meters on the most congested routes, ticket motor vehicles obstructing paths, and improve maintenance. Furthermore, similar to Odense, the city synchronizes its traffic lights on certain roads to give cyclist consecutive green lights (a so-called green wave). First results show that this measure speeds up bike trips by an average of 10%. Overall, Copenhagen planners report considerable progress with these recently implemented measures.

Intersection treatments and traffic priority for cyclists

As already noted, the transport planners in Copenhagen are now making intersection improvements the main focus of their efforts to make cycling faster, more convenient, and safer. Many key intersections already provide advance stop lines, traffic signal priority, and special blue lane markings for cyclists. In the

coming years, the city plans to redesign more intersections in this way to be more bicycling friendly.

Coordination with public transport

Although city planners recognize the importance of integrating cycling with public transport, 42% of Copenhagen's cyclists rated the situation in 2006 as unsatisfactory (City of Copenhagen, 2006). Consequently, improvements in bike and ride facilities are a major goal of city cycling policies.

Bikes are now allowed on all suburban trains as well as the metro. All suburban trains and most regional trains have special compartments for bike parking. Bike parking around train stations, however, is not nearly sufficient to meet demands. Many of the existing facilities are crowded, outdated, inconvenient, unguarded, and primitive in comparison to the state-of-the-art facilities in Muenster and Groningen. Likewise, Amsterdam has vastly superior bike parking facilities at its rail stations. Fortunately, the city plans to improve bike parking at train stations in the coming years, but it has a long way to go.

Bike parking

Similar to the unsatisfactory state of bike-public transport coordination, bike parking in general is both insufficient and of poor quality in Copenhagen (City of Copenhagen, 2006). In the city's bi-annual survey, cyclists regularly rate the lack of good bike parking as the worst aspect of cycling conditions (rating only 3 on a scale of 1 to 10).

The total number of bike parking places is over 20,000, but that is not nearly sufficient. Thus, the city's goal is to vastly improve both the quantity and quality of bike parking facilities in the coming years. Over 400 new bike parking places were built for the city centre from 2000 to 2002.

Copenhagen could learn a lot from Odense, which has been pioneering a range of advances in bike parking, both overall and especially at train stations.

Bicycling promotion

There are two innovative policies that Copenhagen has implemented to promote cycling: the free bike rental program and the annual survey of bicyclists. The City Bikes program places over 2,000 free city bikes at over 110 locations in the city centre (Fonden Bycycklen, 2007). Only a small deposit is required to retrieve the bike from its parking location, and it can be left any many different locations, depending on the route taken. The City Bikes programme certainly is a good idea in principle, making bikes easily available on short-term basis. Unfortunately, the programme has been hampered by the inevitable problems of vandalism and theft, as well as insufficient maintenance of the bikes. Technological improvements to the City Bikes in 1996 mitigated these problems somewhat, but one often finds abandoned, broken, vandalized City Bikes throughout the city. Overall, however, the City Bike program appears to be a success.

Another innovative program in Copenhagen is the Bicycle Account, a bi-annual survey of cyclists (City of Copenhagen, 2004 and 2006). Every two years cyclists themselves evaluate the actual performance of the bicycling system in the city, and provide suggestions for its improvement. They are asked, for example, about their degree of satisfaction with the extent and width of bike paths, road and path maintenance, bike parking, coordination with public transport, and safety. Because it is a bi-annual survey, it permits cycling planners to track progress over time.

In addition to monitoring cyclist satisfaction with the current system, the Bicycle Account

also provides information on cycling levels, trip purpose, and cyclist characteristics, thus supplementing the information from cordon counts of cyclists and other travel surveys.

Odense

Information on cycling in Odense was collected directly from its former bicycling planner, Troels Andersen, and from the following published sources: City of Odense (2007); Andersen, T. (2005); and Dutch Bicycling Council (2006).

Odense was designated as Denmark's official National Bicycling City in 1999. It has the highest bike mode share of any Danish city, with cycling accounting for about a quarter of all trips. That is not much higher than the overall Danish average of 18%, but it is impressive nevertheless.

Separate cycling facilities in Odense attract men and women, young and old
Source: Troels Andersen

Odense is the third largest city in Denmark, with 185,000 inhabitants. That includes about 40,000 university students, who are among the most frequent cyclists. Odense is located at the centre of the island Fyn about 140 km southwest of Copenhagen. Its flat topography and moderate climate facilitate cycling.

Travel trends

From 1984 to 2002, the total number of bike trips in Odense grew substantially - by about 80%, based on regular, manual cordon counts on 21 key cycling routes (Dutch Bicycling Council, 2006). The increasing number of bike trips is due mainly to considerable growth in overall travel demand, of which cycling has captured a slightly higher percentage share. Although travel surveys are only available for the shorter time period from 1994 to 2002, they indicate that the bike share of trips rose only slightly - from 22.5% to 24.6%, but with fluctuations from year to year. Thanks to the extraordinary package of federally supported pro-bike programs implemented between

1999 and 2002, there was an impressive 20% increase in total bike trips over that short 3-year period.

Odense developed a unique trip counting device in 2002 that supplanted manual counts. Cycling volumes are now automatically measured as cyclists pass each of 25 permanent counting stations. That permits frequent monitoring of cycling travel demand, greatly facilitating bike planning (Andersen, 2005).

Overall policy goals

The main objective of transport policy in Odense has been to increase cycling levels while reducing cycling injuries. As noted above, the city has achieved those dual objectives over the past 20 years. The recent focus of the city's policies has been on modernising, improving, and better maintaining its existing cycling facilities, which are already quite extensive (Dutch Bicycling Council, 2006; Andersen, 2005).

The city has also carried out a massive, multi-faceted marketing campaign aimed at all groups. Thus, another aspect of Odense's cycling policy is to get everyone cycling more, including men and women, all age groups, and all professions. The emphasis has been on everyday cycling for practical purposes, but there are also programs to encourage recreational cycling (Andersen, 2005).

Safety

While Odense has undertaken many measures to improve cycling safety, bicycling injuries remain a top concern. From 1999 to 2004, total cyclist injuries fell from 80 to 57, indicating considerable success. Unfortunately, the number of serious injuries fell only slightly (from 36 to 33), and the number of fatalities actually rose (from 1 to 3). Since the number of bike trips increased over the same period by about 20% over the same period, however, the decrease in both total and serious cyclist injuries would translate into a more significant fall in the overall cycling injury rate per trip (Dutch Bicycling Council, 2006; Andersen, 2005). The correlation between rising cycling levels and falling injury rates in Odense is consistent with the theory of "safety in numbers," which suggests that more cycling leads to greater cycling safety, as documented for a range of countries and cities by Jacobsen (2003). Of course, greater cycling safety also encourages more cycling, so the causation is surely in both directions.

Innovative bike trip counter in Odense, displaying real-time information on daily cycling volumes on this route.
Source: Troels Andersen, City of Odense

As one of several approaches to improving cycling safety, Odense has been strongly promoting bike helmets. During an experimental period, the city provided 50%

discounts on helmet purchases and widely advertised the safety advantages of helmet use in various media campaigns. These efforts were quite successful. From 1999 to 2005, the rate of helmet use rose from 1.5% to 10.4% for adults and from 50% to 89% for children. The rate of helmet use among adults is still very low but higher than in most German and Dutch cities (Dutch Bicycling Council, 2006; Andersen, 2005).

As in many German and Dutch cities, children in Odense receive training in safe cycling as part of their school curriculum. That is crucial, since 43% of children reach school by bike. Recently, Odense introduced the world's first interactive cycling trainer for children to help them improve their cycling skills in traffic (www.b-game.dk/demo.php). It is in the form of an internet video game, but with actual scenes of cycling throughout Odense. The user plays the role of a cyclist who must respond to a wide range of traffic situations.

The city also has encouraged more use of lights on bikes at night by offering cyclists free lights. They operate without batteries from electricity generated by magnets attached to the wheels, which automatically produce the needed current from the act of pedalling the bike. A pilot study including 4,000 cyclists resulted in a 32% fall in cyclist accidents.

Green wave for cyclists in Odense, with bright green lights flashing on bollards just to the right of the lane to indicate correct cycling speed to achieve all green lights at intersections
Source: Troels Andersen, City of Odense

Provision of cycling facilities

Already since the mid 1980s, Odense has had over 500km of bike lanes and paths, so it has long had a very extensive cycling network. The National Cycling City program from 1999 to 2002 extended the network by only another 400m with one new bike lane (Dutch Bicycling Council, 2006; Andersen, 2005).

Nevertheless, there were numerous minor infrastructure improvements: modifications to bike lane and path crossings at 20 intersections, installation of 5 new right hand turn lanes and 5 mini-roundabouts, and bright blue painting of cyclist crossings at intersections.

In addition, many intersections were equipped with advance bicyclist waiting positions (ahead of motorists), and combined with advance green traffic signals for cyclists. Finally, signage of all cycling routes was improved throughout the network.

Not only does Odense provide extensive and high quality cycling facilities, but it undertakes truly extraordinary measures to ensure proper maintenance. It employs a group of 4 free-lance trouble-shooting cyclists who regularly cover the entire

network and report any defects or maintenance problems, receiving €3.30 for every confirmed repair problem that needs to be fixed. Even more impressive is the use of a special vehicle with laser technology to inspect the fundamental structure underlying every bike lane and path in order to detect possible surface problems before they even occur. Finally, bike lanes and paths are promptly cleared of ice and snow with a special vehicle that sprays a salt solution onto the riding surface. That facilitates winter cycling (Andersen, 2005).

Restrictions on cars

There are no direct routes for cars to pass through Odense's city centre from one side to the other. In effect, that restricts traffic to vehicles with destinations in the city centre instead of just passing through. That results in less traffic overall as well as less noise, air pollution, and traffic danger. There are also a number of car-free pedestrian streets that have been modified with 3.5m two-way cycle paths through the middle to permit accommodate cyclists.

As in many Danish, Dutch, and German cities, parking in the city centre is quite limited and expensive, which discourages car use in general and obviously provides an additional incentive to bike or walk.

Coordination with public transport

Bike parking at the main train station in Odense is probably the most important form of multi-modal coordination of cycling with public transport. In addition to 400 regular bike racks just behind Odense's Central Station, there is also a state-of-the-art bike parking facility immediately below the station, with 300 bike racks that provide especially high level of security, with video surveillance cameras, as well as piped-in music and conveniences such as toilets, drinking fountains, luggage boxes, and a bike shop for repairs and rentals. There are also 800 free parking stands at the second Cycle Centre next to Central Station (Dutch Bicycling Council, 2006; Andersen, 2005).

Simple but convenient bike parking at bus stop in Odense
Source: Troels Andersen, City of Odense

Bike Parking

There was already extensive bike parking in Odense prior to 1999, but the National Cycle City program greatly increased the number and quality of bike parking facilities. The city added 400 sheltered bike parking stands near the main shopping area, where there is also a state-of-the-art automatic bike parking facility for 20 bicycles, in the form of a carrousel.

As already noted, the Central Train Station added 400 bike racks in back of the station as well as 300 bike parking spaces in a special bike parking garage beneath the station, featuring video camera surveillance and attendants for greater security, as well as special lighting, music, luggage boxes, and bike repairs and rentals (Dutch Bicycling Council, 2006; Andersen, 2005).

Convenient bike air pumps throughout central city of Odense
Source: Peter Berkeley

Bicycling promotion in Odense

However innovative the infrastructure improvements have been in Odense in recent years, the wide range of cycling marketing programs have certainly attracted the most attention. Of the six case study cities in this article, Odense has unquestionably been the most imaginative and enthusiastic in promoting cycling among all age groups. The most notable efforts include (Dutch Bicycling Council, 2006; Andersen, 2005):

- The "Cycling Duckie" program for very young children, which offers gifts, candy, balloons, and entertainment
- A range of cycling competitions for somewhat older schoolchildren

- Improved lighting and security of bike parking facilities, especially important for women concerned about their personal safety

- The “Get Rid of the Sack” program targeted at overweight middle-aged men with pot bellies, with cycling viewed a good form of exercise to lose weight

- Extensive bike touring programs for seniors

- A fleet of 67 bicycles for 29 companies who let their employees use these bikes during the day for short business trips

- Ten special bike tire air pumping stations all over the city

- Free test bike trailers to haul kids behind bikes

- Subsidised bike lights and bike helmets to encourage safety

- Distribution of free candy and fruit to cyclists

- Innovative, interesting-looking cycle trip counters that regularly measure cycling volumes and publicise rising levels of cycling

- Digital display signs along bike routes that measure the speeds of passing cyclists

- Bicycling website with extensive information for cyclists on bicycling routes, activities, special programs, health benefits of cycling, bike and bikes and bike accessories http://www.cykelby.dk/eng/index.asp

- Over 800 articles on bicycling in local newspapers and magazines; frequent advertising on radio and TV; and free lectures on cycling

- Annual Bike Day in June, featuring bike exhibits, lotteries, cycling competitions, etc.

- Cycling Ambassador Programme: 86 cycling ambassadors serve as role models of safe cycling and help with cycling promotion in neighbourhoods throughout the city, distributing newsletters and information about cycling events.

As interesting and innovative as these cycling promotion efforts have been, cyclists themselves appear to be more impressed by actual improvements in cycling conditions. As part of the National Cycling City program, cyclists were surveyed in 2002 to determine their preferred strategies for improving cycling. Somewhat surprisingly, most cyclists did not even mention the many highly creative marketing programs in Odense.

Instead, the survey respondents praised infrastructure improvements and traffic priority. Above all, cyclists strongly endorsed priority traffic signals for cyclists at intersections and synchronised green wave lights adjusted to cyclist speeds; improved and better maintained surfaces of the existing cycle paths and lanes; and expanded and improved bike parking facilities. Thus, while marketing is a key part of an overall cycling policy, it seems clear that improvements in actual cycling conditions are far more important.

Summary: Cycling in Odense

Although Odense was designated the official National Cycling City of Denmark from 1999 to 2002, it does not stand out as much from other Danish cities as does Muenster from other German cities. Danish cycling levels are almost twice as high as in Germany overall (18% vs. 10%), and Muenster's bike share of trips is higher than Odense's (35% vs. 25%).

Nevertheless, there can be no question that cycling is an important part of Odense's character and gives it a special ambience that makes Odense a special place. Similar to Muenster, Odense has been vigorously and enthusiastically building on that reputation by implementing the most innovative and diverse cycling promotion programs of any city examined for this article.

Case Studies of Cycling in Germany

Germany is especially interesting for this examination of cycling policies precisely because the country does not have a long tradition of cycling, certainly nothing even approaching the bicycling culture of the Netherlands. Moreover, Germany has a much higher level of car ownership and use than the Netherlands and Denmark, indeed one of the highest rates of car ownership in the world. Germany is home to some of the world's most important car manufacturers (Volkswagen, Daimler-Benz, Audi, Porsche, BMW), which together represent a very strong lobby for highways and cars. And for individual Germans, there is a love affair with the car that is at least as passionate as that in the USA. Thus, it is surprising indeed that German cities have undertaken so many policies to promote cycling.

Of the two German case study cities, Muenster seems almost identical in many ways to its Dutch neighbours just an hour or two to the west. And its bike share of trips is roughly the same as well. By comparison, Berlin is probably more typical of German cities. Although it has vastly expanded its cycling facilities in recent years and achieved a 10% bike share of trips, Berlin does not come close to the dominance of cycling in Amsterdam and Copenhagen.

Berlin

Information on cycling in Berlin was collected directly from German transportation planners and cycling experts. The main bicycling planner for Berlin, Roland Jannermann, provided extensive information as well as corrections and improvements to this case study of Berlin. Information was also collected from the following published sources: City of Berlin (2003; 2004; 2005; 2007a; 2007b); and German Railways (2007).

Berlin is the largest of our 6 case study cities and is situated in eastern Germany, about 70 miles from the Polish border. It has about 3.4 million inhabitants and is completely surrounded by the rural State of Brandenburg. The larger Berlin Region contains about 4.5 million inhabitants, including the City of Berlin and adjacent counties in the State of Brandenburg (City of Berlin, 2003).

From 1961 to 1989 Berlin was divided into two distinct parts, with different political systems of government that left their imprint on Berlin's transport systems. The western part was controlled by the allied forces (the USA, UK, and France). The eastern part was the capital of the German Democratic Republic (GDR). Differences in the former transport systems can still be seen today between East and West Berlin. The eastern part of the city lacks bike paths and lanes. Cycling is also impaired in the east by many bumpy cobblestone streets and roads bisected by tram tracks (City of Berlin, 2003 and 2007a).

In contrast to the other five case study cities presented in this paper, Berlin is not a typical bicycling city. The city is very spread out. Moreover, the winters are long and cold. Finally, after World War II West Berlin accommodated the automobile by demolishing its tramway system and building limited access highways in the city centre. East Berlin accommodated the automobile by building large arterial boulevards and had the highest rates of car ownership and use in all of East Germany. Today road supply in Berlin is so abundant that traffic congestion is rarely a problem. Indeed, the average speed of a car trip in the city is higher than the average speed of a transit trip.

Upon reunification of the city in 1990, the bike mode share was 6% in West Berlin and only 3% in the Eastern part. Especially since 2000, the city has tried to promote bicycling for a wide range of trip purposes. Today's share of all trips made by bike is 10%, which can be considered high given the cold winters, the automobile oriented transport policies implemented in the past, and the population size of the city (City of Berlin, 2003 and 2007a).

The main driving forces for promoting bicycling in Berlin were environmental pollution and air quality considerations, but also the city's worsening financial crises. Promoting bicycling and expanding cycling infrastructure is relatively cheap compared to building roads or rail transport infrastructure.

Even though Berlin is spread out, it is flat and has a bike friendly spatial development structure. City life is organized around many vibrant neighbourhoods (Kieze) with a good mix of land uses, which keeps trip distances short. A recent travel survey found that 45% of all trips in Berlin are shorter than 3 kilometres, a distance easily covered by bike. Current efforts are geared toward increasing biking for everyday utilitarian purposes, such as shopping (City of Berlin, 2003 and 2007a).

Travel trends

Similar to most other Western European cities, bike use in Berlin dropped after WWII. From 1951 to 1972 kilometres cycled per inhabitant declined by nearly 90%. During that period, the city was rebuilt from war damages in a way to accommodate the car through highways and wide boulevards. Moreover, disposable income and automobile ownership skyrocketed. Since 1972 kilometres of bike use have increased, but in 2004 cycling levels were still less than half of the 1951 level (City of Berlin, 2003 and 2007a).

Between 1992 and 1998 the share of all trips made by bicycle increased from 7% to 10%. Unfortunately, the travel survey of 1998 was the last comprehensive city wide survey. A new survey is planned but has been deemed too expensive for the city to afford. In personal interviews transportation planners reported that bicycle counts at certain roads and intersections confirm a 10% or even slightly higher bike share since 1998. The only recent data that exist for the whole city is the German National Travel Survey (MiD) 2002. That survey reports a bike share of 7% of all trips in Berlin, with a margin of error of 3%. Berlin's bike planners point out that the sample for this survey was very small, and that a 10% bike mode share is still within the margin of error (City of Berlin, 2003 and 2007a).

Most residential neighbourhoods in Berlin are traffic calmed in this way, providing ideal conditions for cycling. Indeed, 72% of all streets are traffic calmed, with speed limits of 30km/hr or less. Cyclists and pedestrians have as much right to use these streets as motorists.
Source: Peter Berkeley

Overall policy goals

The city of Berlin wants to increase the mode share of bicycling to 15% of all trips by 2015. The city's bicycling strategy states that bicycling should become as convenient and safe as possible. One of the means to realize this goal is to make every city street bike friendly, either by building bike paths and lanes or by traffic calming residential areas (City of Berlin, 2003 and 2007b).

Increased funding for bicycling facilities will help accomplish this goal. Until 2000, the city government only funded cycling infrastructure in connection with new road construction projects. This made it nearly impossible to upgrade existing roads to accommodate the needs of bicycle traffic. In 2000, the city established a dedicated annual funding source for bicycling infrastructure by introducing a special bicycling budget of €1.5 million per year. In 2006 the bike budget increased to €2.5 million per year and is expected to increase even further to €3 million in 2008. Additionally, the federal government now makes funds available for cycling infrastructure, such as separate bike paths alongside federal highways. In the years 2008 and 2009, an additional program for upgrading substandard cycling paths will commence at a budget of €1 million per year. Berlin's bike planners estimate that roughly 5-8 million Euros per year will be spent on cycling in 2008 and 2009.

According to the "Cycling Strategy" of 2004 the city intends to increase the budget for bicycling to more than €15 million annually by 2015. Due to the current financial crisis of the city, these plans are subject to annual availability of city government funds, however. The funds would be used to close gaps in the existing bike network, to integrate cycling with public transport, increase bike parking, improve signage for cyclists, improve and expand training for children, upgrade surfaces of roads and bike paths, and to promote bike tourism in Berlin and its hinterlands. With financial assistance from the federal government, the city administration intends to invest €80 million in cycling projects between 2004 and 2010. (City of Berlin, 2003 and 2007a).

Safety

Between 1998 and 2004 the number of cyclists killed in traffic declined by 30%. Severe cyclist injuries dropped by 22% and the number of minor cyclist injuries fell by about 8%. Police reports show that cyclists are only involved in 5% of all traffic accidents in the city, less than the bike mode share of

10% would lead to expect (City of Berlin, 2003, 2004, and 2007a).

In Germany, children younger than 8 years old have to ride their bike on the sidewalk or completely separate bike paths. Children of this age are not considered to be alert enough to cycle on the road, not even in separate bike lanes. In general, cyclists older than 8 years of age can choose to ride on the road or on bike paths and lanes. At certain especially dangerous intersections and streets, all cyclists are required to use the bike path or lane. These sections are marked by a blue round traffic sign for cyclists. Cyclists have to conform to these signs and all other traffic signals throughout the city. In fact, Berlin police are planning to enforce current traffic regulations for cyclists and drivers more strictly (City of Berlin, 2003, 2004 and 2007a). Overall, the city wants to promote responsible driving and bike riding and to improve the co-existence of cyclists and automobile traffic. The city will supplement this awareness and enforcement campaign by building improved facilities for cyclists. These improvements will include more advanced green lights for cyclists at traffic lights, advanced stop lines for cyclists at intersections, better marking of bike paths and lanes at intersections, and enhanced signage and connectivity of

As in most German cities, school children have to take part in cycling training and pass a test with real police between 3rd and 4th grade. During this training police officers first supervise cycling lessons for children on closed training grounds with miniature roads and traffic signals. Once the children have mastered the traffic signs on the training course the police take them for a ride on real city streets and bike lanes and paths. Unfortunately, this second step is sometimes omitted due to lack of staff. During the courses, children learn about bicyclists' responsibilities on the road and some essentials about bike safety, such as wearing a helmet or cycling with lights when it is dark.

Provision of cycling facilities

In 2004, Berlin had 620km separate bike paths, 60km of on-road bike lanes, 70km of shared bus lanes, 100km of joint pedestrian/cyclist sidewalks, 50km of bike lanes on sidewalks, and 190km of off-road bikeways through parks and forests. In addition, there were 3,800km of traffic calmed neighbourhoods (City of Berlin, 2003 and 2007a).

Special bicycling test course for children in Berlin Source: Ralph Buehler

These mostly residential areas do not have any special bike facilities. Instead, bikes and cars share these roads, which have a maximum speed of 30km/h or even less on special "Spielstrassen" (home zones), where speed limits can be as low as 7 km/h.

Overall 72% of all city streets are traffic calmed. Unfortunately, some of these traffic calmed areas, especially in the eastern part of the city, have cobble stone road surfaces and still have to be made more bike friendly.

Separate facilities for bikes are only deemed necessary at roads with a speed limit of 50km/h or more and with automobile traffic volume of at least 10,000 cars per day. Overall, more than half of all heavily trafficked roads in Berlin have bike facilities (750km out of 1450km). Together with the off-road paths and bike friendly traffic calmed areas the city is easily and safely accessible by bicycle. For the future the city is planning on building and sign posting 12 radial bicycling routes that connect the city's neighbourhoods to its centre. Additionally, 8 tangential bike routes are planned to link the 12 radial bike routes and to connect the neighbourhoods to each other (City of Berlin, 2007b).

Restrictions on cars

In contrast to many other German cities Berlin does not have a car-free downtown area. Some smaller car-free areas exist in certain neighbourhoods (e.g. downtown Spandau or the Nikolaiviertel), but they are by far less extensive than in other German cities, such as Muenster.

While the city does not have extensive car-free zones, it has implemented restricted parking areas in many parts of the city through so-called parking management systems (Parkraumbewirtschaftung). In these areas long term parking is provided for residents only. In contrast, shoppers or visitors have to pay and can only park for a limited amount of time. Overall, however, Berlin's effort to limit car use are very modest compared to our other case study cities.

The latest city wide travel survey found that the mode share of car use was only 38% in 1998. This is well below other German cities. Car ownership rates are also low in Berlin. After an initial increase in car ownership rates after reunification, the level of car ownership has been roughly stable since 1994 at only about 330 cars per capita (compared to about 560 for Germany as a whole). Clearly, low levels of car ownership and less access to cars increase the potential for cycling, walking and transit use (City of Berlin, 2003).

Bike Parking and Coordination with public transport

In 2004, there were 22,600 bike & ride parking spots at regional and commuter rail (S-Bahn) as well as at subway stations (U-Bahn). The S-Bahn and regional transit providers plan to increase bike parking at transit stops. From 2004 to 2005 the S-Bahn already built 2,000 additional bike parking spots. The regional transit provider BVG plans to increase bike parking by 7,000 places by the year 2010 (City of Berlin, 2007a and 2007b). Unlike Muenster, Groningen or Amsterdam, however, Berlin does not have special bike parking garages at its large train stations. Bike parking, of course exists at train stations, but is mainly limited to bike racks, some of which are sheltered from the rain. Bicycles are allowed 24 hours a day on trams (streetcars) as well as on regional and commuter trains in Berlin. There is a modest additional charge for season ticket holders who want to transport their bike frequently on public transport (€ 8 per month). All other passengers pay € 1.50 per trip and per bike within Berlin and up to € 2.70 in the suburbs per trip and bike. Many train stations are equipped with elevators and ramps, which facilitate taking a bike from the street level to the platform and onto the trains (City of Berlin, 2007a).

Caption: Bike and Ride in Berlin: Cheap and easy rental bikes provided by German Railways
Source: Ralph Buehler

Since 2002, German Railways (DB) has offered its "Call-A-Bike" program in Berlin. In 2006, there were 3,000 rental bikes at train stations and distributed all throughout the city. These bikes are clearly marked as DB bikes and have a phone number displayed on them. Everyone who finds a parked bike can call the number, give their credit card information and obtain a pass-code for the bike lock. Once the bike lock is opened DB charges € 0.08 per minute, up to a maximum of € 15 for 24 hours. Owners of railway or S-Bahn season tickets pay only € 0.06 per minute. The bikes can then be used for as long as necessary and can be left at any intersection in the city. German Railways ceases charging as soon as the lock of the bike is closed. In 2005, there were an average of 535 bike rentals a day, with an average use of 50 minutes per rental. Since 2002, the annual number of users of the service has increased fivefold, from 5,000 to over 23,000 in 2006 (German Railways, 2007).

Since 2006, Berlin has joined other European cities and participates in the EU funded program Sustainable Planning and Innovations for Bicycles (SPI-Cycles) (City of Berlin, 2007a and 2007b). The goal of the program is to improve bicycling for everyday use. For example it will enhance bike parking for shopping. Additionally, the city building code for Berlin requires new buildings and existing buildings undergoing major renovations to accommodate bicycling parking (City of Berlin, 2005).

Bicycling promotion

Once a year in May or June, the Berlin branch of the German bicycling federation (ADFC) holds a major bike rally (Sternfahrt), supported by the city government. Major roads in the city are closed for this event, and cyclists converge from all parts of the city towards a large roundabout (Grosser Stern) at the centre of the city. The same event is repeated on a smaller scale in September. In 2005, more than 100,000 cyclists participated - in pouring rain. Cyclists started from 81 origins all over the city and converged on 17 different routes towards the central meeting area (City of Berlin, 2007a).

Furthermore, the city government publishes a comprehensive bike map, as well as many leaflets and brochures containing information for cyclists, such as suggested cycle routes, updates on bike infrastructure construction and new policies to encourage cycling.

In 2003, the city administration of Berlin founded Berlin's first bicycle council (FahrRat). This group consists of bicycle experts from different departments of the city of Berlin, bicycle experts from research centres, representatives from the bicycle industry, bike advocacy groups, and transit

providers. This group meets regularly to discuss relevant bicycling issues in the city and participated actively in formulating Berlin's bicycling strategy. Due to the different backgrounds of the council members many different perspectives on cycling are represented in the discussion process.

One particularly innovative tool is Berlin's online bike planning website. On this internet site, cyclists can enter the addresses of origin and destination of their bike trip and the computer calculates the best route to take. Cyclists can select different options for their trips. The program asks about the desired kind of bicycling facility for the trip. Choices include: the type of right of way: on-street routes, separate bike paths and lanes or off-road trails. Furthermore, cyclists can choose to avoid signalized intersections. The program then maps and describes the suggested route, complete with location of nearest transit stops, traffic signals, and steepness. The program also calculates trip times based on different cycling speeds. The information can be accessed both by computer and with mobile phones so that cyclists can follow the suggested directions while en route (City of Berlin, 2007a and 2007b).

Cycling in Berlin: Some Conclusions

Although Berlin does not come close to the bicycle orientation of the five other case study cities in this article, it has a bike share of trips that is higher than any other European city of comparable size. Moreover, it has roughly doubled cycling levels in the past two decades by a concerted effort to improve cycling conditions in the city, both through the provisions of a growing network of bike paths and lanes and by traffic calming almost all its residential neighbourhoods. Berlin might not be a bicyclist's paradise, but it offers some valuable lessons for cities of comparable size on how best to promote cycling in such a large city.

The 5km bicycling expressway in Muenster, which completely encircles the central city and provides numerous links with bike lanes and paths in all directions.
Source: Peter Berkeley

Muenster

Information on cycling in Muenster was collected directly from German transportation planners and cycling experts. The main bicycling planners for Muenster, Martina Guettler and Stephan Boehme, provided extensive information as well as corrections and improvements to this case study of Muenster.

Information was also collected from the following published sources: City of Muenster (2004 and 2007); Boehme (2005); and Dutch Bicycling Council (2006).

Muenster has a long history of cycling, much like its neighbouring cities in the Netherlands. For many decades, it has had the highest bike share of trips of any German city, thus leading to Muenster's reputation as the most bicycling friendly city in the country.

Muenster is the regional capital of Westphalia in north-western Germany. Located only 70km from the Dutch border, it has 278,000 inhabitants, including about 55,000 university students, who provide an ideal source of potential cyclists (City of Muenster, 2007). Similar to many Dutch and Danish cities, cycling in Muenster benefits from a mostly flat topography. Although the city has a reputation for being cloudy or rainy most days, its moderate temperatures facilitate cycling by avoiding extreme heat and cold.

Another factor promoting cycling in Muenster is its compact urban form, with 71% of the metropolitan region's population living within a 7km radius of the city centre. In spite of continuing suburbanization, the city's historic centre remains strong and vibrant, containing most of the shopping, educational, and employment opportunities in the region. Reinforcing local efforts, the state of North Rhine-Westphalia recently implemented regulations to prohibit large shopping centres and outlet malls outside of established cities. That will strengthen the competitive position of Muenster's centre relative to its suburbs (City of Muenster, 2004 and 2007).

Planning codes ensure considerable mixed land uses (especially commercial, shopping, and residential), which promote short trips that can be covered by bike. Most new residential developments in the suburbs are subject to strict planning guidelines that require bicycling and pedestrian facilities as part of their basic transport infrastructure. Moreover, many residential streets are deliberately circuitous in order to discourage car traffic and to make walking and cycling safer.

Unlike many German cities destroyed in the Second World War, local government officials decided to rebuild Muenster in virtually the same compact, medieval form it had before the war. Thus, there are many winding, narrow streets and no motorways or major arterials passing through the city centre. As a matter of deliberate traffic policy, through-traffic is diverted around the centre by two circumferential bypasses (City of Muenster, 2004 and 2007; Dutch Cycling Federation, 2006).

Travel trends

The bicycling share of total trips in Muenster increased from 29.2% in 1982 to 35.2% in 2001, the year of the most recent comprehensive travel survey. By comparison, walking trips fell sharply, from 25% of all local trips in 1982 to only 13% in 2001 (City of Muenster, 2004 and 2007; Boehm, 2005). Over the same period, public transport's share rose from 7% to 11% of all trips, mostly due to improvements in overall route structure and service quality as well as special discount semester tickets for the many university students.

Especially on rainy days, many students now take a bus instead of cycling. Thus, it is all the more impressive that cycling's share actually increased slightly instead of falling. Overall, the environmental modes (bike+walk+public transport) lost only 2% of their market share to the private car, whose proportion of local trips rose from 39% in 1982 to 41% in 2001 (City of Muenster,

2004 and 2007; Boehme, 2005; Dutch Bicycling Council, 2006).

Overall policy goals

In spite of its already high bike share of local travel, the City of Muenster has continually endeavoured to improve cycling conditions in as many ways as possible. The overall goals of the city are to preserve its position as Germany's premier cycling city, to increase cycling safety, to reduce bike theft, and to implement state-of-the-art measures to enhance the convenience, feasibility, and overall attractiveness of cycling for all age groups. Cycling plays a crucial role in the nationwide image of Muenster, providing yet further motivation to reinforce its position as Germany's No. 1 Cycling City (City of Muenster, 2007).

Safety

Cycling in Muenster is safe. In their official report on the status of cycling, the City emphasizes the low risk of being injured while cycling. In 2001, for example, there were 606 bike crashes. In the same year, the residents of Muenster made over 135 million bike trips, averaging only one cycling injury for every 223,000 trips. Unfortunately, the number of cycling injuries rose from 606 to 843 between 2001 and 2006 (City of Muenster, 2007). City cycling planners attribute the additional cyclist crashes to an increase in motor vehicle traffic. They are now intensifying their efforts to protect cyclists from motorists by implementing yet more pro-bike policies and program than previously.

Nevertheless, cycling is still viewed by most of Muenster's residents as very safe. Perhaps for this reason, only about 2% of adult Muenster cyclists wear safety helmets, and even among children, only about half wear helmets. The bikes of some young children are equipped with special warning flags on tall poles attached to the back of the bike to alert motorists to avoid endangering these young cyclists, who are less visible than older, bigger cyclists. City officials have been trying to increase the rate of helmet use and have achieved some success among young children. With such low crash rates, however, most cyclists feel so safe that they quite simply do not feel the need for helmets.

Traffic police strictly enforce cycling regulations and regularly give tickets to cyclists riding in the wrong direction, running red lights and stop signs, and not using lights at night. Perhaps even more important, police ticket motorists who endanger bicyclists or otherwise disobey traffic laws intended to promote pedestrian and cyclist safety. That dual strategy encourages safer cycling as well as safer driving behaviour (Boehme, 2005). Most traffic police in Muenster are trained to patrol on bike as well. That ensures more effective policing of bicyclist behaviour on Muenster's extensive pathway system. The widespread presence of police on bikes also tends to further legitimize the rights of cyclists.

One of the most serious problems in Muenster is bike theft. Roughly 8,000 bikes are stolen every year (Dutch Bicycling Federation, 2006). To discourage bike theft, police often set up surprise checkpoints around the city, forcing cyclists to dismount to have the bikes' registration number checked to determine if it is stolen. At the same time, the police check bikes to be sure they are in safe working condition and have the required safety features in order (reflectors, lights, etc.). The other approach to reducing bike theft is the provision of secure, guarded bike parking, as noted below.

Provision of cycling facilities

Muenster and its surrounding suburbs offer an extremely extensive, well-integrated, and high-quality network of bicycling facilities, including bike paths, bike lanes, bicycling streets, traffic calmed neighbourhood streets, rural and agricultural paths (Paettkes), and many lightly travelled roads ideal for cycling. The City of Muenster itself (302 sq.km.) roughly doubled the extent of separate paths, lanes, and combination bus-bike lanes from 145km in 1975 to 320km in 2005. In addition, the city has designated over 300km of lightly travelled roads in its outlying areas as on-street bicycling routes, with motor vehicle use restricted to residents living along the roads and thus excluding through traffic. Within the more Odensely developed area of the city, 12 streets are officially designated as bicycling streets (Fahrradstrassen), where the entire width of the street is intended for cycling, but where motor vehicles are usually permitted provide they travel at cyclist speeds and do not endanger cyclists, who have priority over cars on these streets. The city has plans to designate 10 more streets as bicycling streets, bringing the total number of such streets to 22 (City of Muenster, 2007).

Typical traffic signal in Muenster, where cyclists usually get an advance green light ahead of motorists
Source: Peter Berkeley

Of particular note is the famous bike/walk Promenade, a 4.5-km car-free beltway that encircles the old town of the city and serves as connector and distributor for 16 bike paths radiating outward toward the suburbs and 26 routes leading to the city centre and Cathedral Square. The bike path in the centre of the Promenade is very wide (about 7m) and is flanked by a completely separate pedestrian path on each side, with rows of trees between the bike and pedestrian portions of the beltway. Over 12,000 bike trips per day are made along this facility (1,300 cyclists per hour during the daytime).

Muenster successfully developed a fully integrated, comprehensive system of directional signs for cyclists, separate from those for motorists. They indicate directions and distances to various destinations, and are colour-coded to correspond to the different types of bike route networks in the city and the surrounding Muensterland region. The system is now being adopted in the rest of the state of North Rhine-Westphalia, the most populous in Germany. There is also an Internet bike trip planner for the entire state that permits the user to input the origin and destination of a trip as well as preferences about the type of route, cycling speed, flat vs. hilly gradients, separation from traffic - (http://www.radroutenplaner.nrw.de).

The Internet planner then shows the suggested route on a map, along with various details about the projected time and average speed of the trip.

The traffic calming of almost all residential neighbourhoods in Muenster is crucial to

Ideal intersection modifications in Muenster: Special bike access lane, advance stop line, and priority green light for cyclists. Cyclists well into intersection before cars can even start to move. Source: City of Muenster, Department of Transport Planning

facilitating cycling on residential streets without the need to provide any special bike lanes or paths at all. Thus, the speed limit on most residential streets is 30 km/hr or less. Many non-arterial residential streets - especially in new residential areas - are yet further traffic calmed, with speed limits of 7 km/hr. They are designated as "Spielstrassen" (play streets), which are equivalent to the Dutch "Woonerf" and the British "Home Zone." Traffic signs clearly notify motorists that they must share the street with pedestrians, cyclists, and playing children, who have traffic priority over cars on such streets (Boehme, 2005; City of Muenster, 2004 and 2007).

In addition, there are many car-free zones throughout the city - including the main street (Prinzipalmarkt) - which are off-limits to cars but permit bike use. Some pedestrian streets only allow cycling at off-peak hours when they are not so crowded as to cause serious conflicts between pedestrians and cyclists.

Intersection treatments and traffic priority for cyclists

Most major intersections in Muenster have special arrangements for cyclists, including special traffic signals for cyclists, usually giving them advance green lights well before motorists. Many intersections also have advance stop positions for cyclists, in front of waiting cars, thus giving them a head start in crossing the intersection, increasing both the speed and safety of cycling. In addition, such intersections offer special bike access lanes bringing the cyclists right up to the intersection so that cyclists do not have to wait behind cars.

Throughout the city, cyclists are generally permitted to cycle in both directions on one-way streets that are restricted to only one direction of travel for cars. Moreover, cyclists are often permitted to make left or right turns where they are prohibited by car. Finally, there are numerous short-cuts for cyclists throughout the city, providing cyclists direct, off-street connections between streets and paths that ensure them quick and convenient access to every part of the city. By comparison, car travel is often detoured by artificial dead-ends and deliberate street blockages of various sorts, reducing the speed and convenience of car travel.

Restrictions on cars

Just as in Odense and Groningen, much of the city centre is off limits to cars. It is not possible for cars to pass from one end of the city to the other through the town centre. That forces car traffic to take circumferential routes and helps mitigate the congestion, environmental, and safety problems that the additional through-traffic would cause in the city centre. As already noted, speeds are restricted to 30km/hr on virtually all residential streets, and a wide range of traffic calming measures restrict both the speed, the direction, and routing of car travel.

The reduction of car parking spaces in the city centre has also discouraged car use there. New car parks have been built near the edge of the city centre, with motorists encouraged to park their cars there and then to walk, bike, or take a bus to the centre. Parking in many residential areas is restricted to neighbourhood residents. On-street parking is usually restricted in duration and its price rises sharply with proximity to the city centre. The restricted supply and high price of parking obviously discourage car use and increase the relative convenience of cycling (Boehme, 2005; Dutch Bicycling Council, 2006).

Coordination with public transport

Muenster greatly facilitates bike and ride by providing ample bike parking at all train stations and many bus stops as well. For example, there are 3,300 bike parking places in the modern, attractive, state-of-the-art bike parking station immediately in front of the main train station. The Radstation (bike station) offers short-term, medium-term, and long-term bike parking as well as bike repairs, bike rentals, luggage storage, and direct access to the train platforms. Immediately next to the bike parking station is the city's main bus terminal serving dozens of bus lines that serve the entire region. The careful co-location of bike parking with the main train station and bus terminal obviously facilitates bike and ride with both transit modes. Bikes can be taken on almost all trains in the Muenster region, but with various fees charged, depending on trip distance and type of service. In contrast, bikes are not allowed on most buses, and almost no buses are equipped with bike racks (Boehme, 2005). The modern bike station was built to help alleviate the so-called "parking chaos" caused by more than 6,000 bikes parked every day on all sides of the main train station. Since that did not succeed, the city has now vastly improved bike parking at the rear of the station as well, with about 800 new bike racks installed. Incredibly the new parking facilities only seem to attract more bikes and more bike trips, since the train station continues to be surrounded on all sides by the same 6,000 bikes. At least the provision of more parking has given cyclists more options for secure, sheltered parking.

Bike Parking

In addition to the impressive bike parking facilities at train stations and bus stops, Muenster has extensive bike parking facilities of various sorts in all parts of the city. The

many thousands of parked bikes throughout Muenster have practically become a trademark of the city, reinforcing its identity as Germany's No. 1 Bicycling City. There is hardly a building or private house without some sort of bike parking. Churches, theatres, schools, university buildings, stores, pubs, cafes, and restaurants are usually surrounded by parked bikes crowded onto nearby sidewalks and public spaces. Since there are never enough bike racks, bikes are often chained to posts of any sort, leaned up against a wall, or parked without securing them to anything at all, resting on their own stands.

Convenient bike wash in bike parking facility at Muenster's main train station
Source: Peter Berkeley

Surely, the most impressive bike parking facilities are at Muenster's main train station. The city has been trying to improve bike parking in other areas of the city as well. The most recent expansion of bike parking was in February 2007, when the city opened a secured, sheltered facility for 286 bikes in the new City Mall downtown shopping area. That also features bike rentals, bike repairs, luggage storage, and bike tour planning advice. Similar to the situation at the main train station, however, this additional bike parking in the city's main shopping district hardly makes dent in the overall bike parking needs of the city. Most bikes are simply parked on sidewalks, in plazas, or anywhere there is space to put a bike.

Above-ground view of bike parking facility at Muenster's main train station and bus terminal, with 3,500 parking spots as well as bike rental and repair facilities.
Source: City of Muenster, Department of Transport Planning

Bicycling promotion in Muenster

Muenster has a long tradition of promoting bicycling among all age groups, starting with school children, who take lessons in bicycling safety in the 3rd or 4th grades. The courses include practice runs on special cycling training courses as well as on-the-road bike rides supervised by traffic police, who administer a cycling test at the end of the safety course. Thus, children are taught safe cycling skills at a very young age, enabling them to bike to school. Cycling training in the schools is only the first step in Muenster's cycling promotion programs. Others include (Boehme, 2005; Dutch Bicycling Council, 2006):

- Annual bicycling festivals that promote the environmental advantages of bicycling, display the latest bike models and accessories, and disseminate various other relevant information for bike enthusiasts

- Annual awards to firms that do the most to increase bicycling among their employees by providing showers, lockers, bike parking, bikes to borrow, and a flexible dress code

- Reflecting its key role, the bicycle was chosen as the official symbol of the city during the celebrations marking 1200 year anniversary of the founding of Muenster in 793

- Extensive bike tour planning offered by city tourism office, including wide range of bike tours with different lengths, durations, themes, and locations

- Superb series of bike maps for every part of the city and the surrounding region, called the Muensterland

- Well signed and maintained bike routes both in the city and the surrounding countryside, with superb connections between different routes, colour-coded, systematic numbering of paths for improved guidance

- Arrangements for cheap, bike-friendly accommodations for cycling tourists on their bike tours through the region

- Internet website for bicycling information in Muenster

- Wide range of informational brochures available from City of Muenster on every aspect of cycling, both in hard copy and downloadable from internet site

- Range of bicycling competitions for different ages of children

Interior view of bike parking facility at main train station in Muenster, with bike ramp from street level to parking level and direct access to train platforms
Source: Peter Berkeley

Summary: Cycling in Muenster

Bicycling is an intrinsic part of life in Muenster. It is not just a normal, accepted way to get around. For most residents, cycling is the primary means of travel within the city. Bicycling is the dominant transport mode for women as well as men and among all age groups, professions, and income classes. Truly, more than any other German city, bicycling is key to the very identity of Muenster.

The high bike mode share in Muenster is an impressive accomplishment given the high incomes and car ownership levels in Germany, as well as a host of worldwide technological, economic, and social trends encouraging lower density suburban sprawl and increasing trip distances. It seems likely that Muenster itself will remain the vibrant, liveable, attractive centre of its region for many years to come.

Although some degree of decentralisation of both residences and workplaces is inevitable, new suburban developments tend to be quite compact and biteable. Thanks to a wide range of pro-bike transport and land use policies, Muenster will surely remain the bicycling capital of Germany.

Conclusions and Policy Implications

With the exception of Berlin, the cities examined in the preceding case studies are truly models of what bicycling friendly cities should be. Cycling in Amsterdam, Groningen, Copenhagen, Odense, and Muenster is so safe and convenient that virtually everyone cycles: women as well as men, all age groups, and all income classes. Moreover, they cycle for daily travel and for a wide range of trip purposes.

For decades our five model cities have boasted bike shares of travel that have been

among the very highest in the Western World. But they have not rested on their laurels. Although they already provide excellent overall conditions for cycling, Europe's best bicycling cities strive constantly to make things even better for cyclists and thus to raise yet further their already very impressive cycling levels.

Berlin is an anomaly. It is much larger than Amsterdam and Copenhagen, more spread out, and has both colder winters and hotter summers. Thus, it is perhaps all the more impressive that Berlin has been making such a concerted effort to encourage more cycling. City politicians, administrators and planners view cycling as the only mode they can afford to invest in, since the city is bankrupt and cannot afford large expenditures on new rail systems or highways. Berlin even markets itself as the "sexy bankrupt city." At least one advantage of its financial distress is the stark realisation that cycling is the most economical mode of transport, in addition to being environmentally and socially sustainable.

Table 1: Traditional measures used in virtually all Dutch, Danish, and German cities to promote cycling

Extensive systems of separate cycling facilities
• Well maintained, fully integrated paths and lanes
• Connected off-street short-cuts, such as mid-block connections, and passages through dead ends for cars
Intersection modifications and priority traffic signals
• Advance green lights for cyclists
• Advanced cyclist waiting positions (ahead of cars) fed by special bike lanes facilitate safer and quicker crossings and turns
Traffic calming
• Traffic calming of residential neighborhoods via speed limit (30km/h) and physical infrastructure deterrents for cars
• "Home Zones" with 5 km/h speed limit, where cars must yield to pedestrians and cyclists using the road
Bike parking
• Large supply of good bike parking throughout the city
Coordination with public transport
• Extensive bike parking at metro, suburban, and regional train stations
• Bike rentals at train stations
Traffic education and training
• Comprehensive cycling training courses for school children
• Special cycling training test tracks for children
• Stringent training of motorists to respect pedestrians and cyclists
Traffic laws
• Special legal protection for children and elderly cyclists
• Strict enforcement of cyclist rights by police and courts

Source: Information provided directly to authors by bicycling coordinators in the Netherlands, Denmark, and Germany.

To some extent, the cycling successes of the six cities rely on more and better implementation of the same sorts of traditional policies that many other European cities use. We briefly summarize those traditional pro-bike measures in Table 1. Clearly, there is nothing revolutionary in these sorts of measures, but most of the case study cities have done an especially good job implementing them. In addition, the case study cities examined here have been particularly innovative, introducing new approaches to encouraging cycling and making it safer. Table 2 summarises some key examples of such measures, all of which are described in detail in the six case studies.

Table 2: Innovative measures recently implemented in Dutch, Danish, and German cities to promote safe and convenient cycling

Country	City (population in 000's)	% Bike Mode Share	km of separated bike paths and lanes	Innovations
Germany	Berlin (3,400)	10%	900 km	• German railways' "Call-a-Bike" program: 3,000 bikes can be rented by cell phone, paid for by the minute and left at any busy intersection in the city
				• Flexible internet bike trip planning tool allows finding the most comfortable or quickest route by bike
				• 70 km of shared bike-bus lanes and 100km of shared bike-pedestrian facilities
				• 3,800km of traffic calmed streets (72% of all roads in the city)
				• 22,600 bike parking spots at metro and suburban rail stations
				• Land use planning enforces good mix of uses and keeps trips short and bikeable: 45% of all trips are shorter than 3km
				• Bike path connecting Copenhagen to Berlin encourages bike tourism in both cities
				• The "FahrRat" bike council provides a platform for opinion exchange among stakeholders from businesses, the bike industry, the city administration, research institutes, universities, bike experts, and citizen advocacy groups
				• City policies favor cycling as most cost effective transport in a bankrupt city
	Muenster (278)	35%	320 km	• Deluxe full-service parking garages for 3,300 bikes at the main train station and for 300 bikes in the main shopping district
				• 4.5 km circumferential car-free "bike beltway" around old city
				• Extensive bicycling network connecting the city to the suburbs via 26 radial bike routes linked by circumferential bikeway
				• Bicyclist priority signals at most intersections
				• Hundreds of short cuts for cyclists at intersections, mid-block connections, and dead ends for cars
				• Eleven bicycle streets, where bikes have priority over cars
				• Statewide integrated, flexible internet bicycling planning tool allows finding the most comfortable route by bike in Muenster and all of the surrounding areas
				• Fully integrated, separate, and color coded set of signs for bikes

Denmark	Copenhagen (500)	20%	375 km	• Annual bicycle account survey that tracks cyclists' satisfaction with bike infrastructure • Bike path connecting Copenhagen to Berlin encourages bike tourism in both cities • Separated bike paths turn into brightly colored bike lanes at intersections • 20,500 on-road bike parking spaces in the city • Free city bikes for cycling within the city
	Odense (185)	25%	500 km	• Traffic signals are synchronized at cyclist speeds assuring consecutive green lights for cyclists • Bollards with flashing lights along bike routes signal cyclists the right speed to reach the next intersection at a green light • City provided modern magnetic-electric bike lights to 4,000 cyclists for free • A special vehicle with laser x-ray technology regularly inspects all bike paths and lanes for potential surface repair needs • Cyclist short cuts to make right-hand turns at normal intersections and exemption from red traffic signals at T-intersections, thus increasing cyclist speed and safety • Deluxe bike parking garages at the main train station, with video surveillance, special lighting, and music • Firms provide free bikes for employees to make trips during work hours • Many intersections are equipped with advanced bicycling waiting positions (ahead of cars) as well as priority traffic signals • Free-lance trouble shooting cyclists survey bike infrastructure and are paid for each reported necessary repair
The Netherlands	Amsterdam (735)	35%	400 km	• Special program to prevent bike theft, by engraving owner postal code into the frame of the bike to discourage theft • Large guarded bike parking garages at all train stations • "Park and Bike" : discount bike rentals for motorists parking cars • Special cycling courses for immigrant women and children
	Groningen (181)	40%	420 km	• Strict land use policy keeps settlement dense (78% of residents and 90% of jobs within 3km radius) • Europe's first guarded parking facility opened here in 1982; expanded to 30 guarded facilities by 2007 • Extensive bike parking at all transit stops • Bike network built to avoid traffic lights and speed up bike travel • Short cuts for bikes at intersections, mid-block connections, and through dead ends for cars

Source: Information provided directly to authors by bicycling coordinators in the Netherlands, Denmark, and Germany.

In our sample of six Dutch, Danish, and German cities, the most important approach to making cycling safe, convenient, and attractive has been the provision of separate cycling facilities along heavily travelled roads and at intersections, combined with extensive traffic calming of residential neighbourhoods. Safe and relatively stress-free cycling routes are especially important for children, the elderly, women, and for anyone with special needs due to any sort of disability. Providing such separate facilities to connect practical, utilitarian origins and destinations also promotes cycling for work, school, and shopping trips.

As noted in this article, separate facilities are only part of the solution. Dutch, Danish, and German cities reinforce the safety, convenience, and attractiveness of excellent cycling rights of way with extensive bike parking, integration with public transport, comprehensive traffic education and training of both cyclists and motorists, and a wide range of promotional events intended to

generate enthusiasm and wide public support for cycling.

At the same time, car use is made expensive, less convenient, and less necessary through a host of taxes and restrictions on car ownership, use, and parking. And land use policies foster relatively compact, mixed-use developments that generate more bikeable, shorter trips.

The key to the success of cycling policies in the Netherlands, Denmark, and Germany is the coordinated implementation of this multi-faceted, self-reinforcing set of policies. Precisely because the policies are sensitive to the very different needs of different social groups, they also succeed in making cycling possible for virtually everyone. The Netherlands, Denmark, and Germany, as countries, have led the world with their wide range of cycling policies and programs. Similarly, Amsterdam, Groningen, Copenhagen, Odense, and Muenster have been at the leading edge of cycling in their respective countries, and surely at the frontiers of cycling in the world.

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