World Transport Policy & Practice

Volume 15, Number 1

Sustainable Transport that Works: Lessons from Germany

Bicycle Education

Cycling for a few or for everyone: Social Justice in Cycling Policy

Comment: *The Gravy Chain of Car Support*
Non-oil dependency & 30mph speed limit

Eco-Logica Ltd. ISSN 1352-7614

World Transport Policy & Practice

Volume 15, Number 1

© 2009 Eco-Logica Ltd.

Editor

Professor John Whitelegg

Stockholm Environment Institute at York,

Department of Biology, University of York,

P.O. Box 373, York, YO10 SYW, U.K

Editorial Board

Professor Helmut Holzapfel

Universität Kassel,

Fachbereich 06 - Architektur, Stadt- und

Landschaftsplanung

AG Integrierte Verkehrsplanung

Gottschalkstraße 28,

D-34127 Kassel GERMANY

Eric Britton

Managing Director, EcoPlan International,

The Centre for Technology & Systems Studies,

8/10 rue Joseph Bara, F-75006 Paris, FRANCE

Paul Tranter

School of Physical Environmental & Mathematical

Sciences, University of New South Wales,

Australian Defence Force Academy,

Canberra ACT 2600, AUSTRALIA

Publisher

Eco-Logica Ltd., 53 Derwent Road, Lancaster, LA1

3ES, U.K Telephone: +44 (0)1524 63175

E-mail: j.whitelegg@btinternet.com

http://www.eco-logica.co.uk

Contents

Editorial

We live in interesting times. Almost all the largest world economies are assembling packages of financial support for the car industry and financial incentives to persuade citizens to throw away an older car and buy a new one. The recession and the rise in unemployment is a personal disaster for many and the pressure to "rescue" industries is intense. Sadly global thinking and decision taking on this matter is way out of line with evidence and with the need to identify opportunities out of the mess rather than continue on the same lines that created the mess.

Investing in the car industry is wrong. We need large scale investment in things that create real jobs in real communities and have a huge impact on the big things that we are all trying o address including peak oil, climate change and poverty eradication. Investing in renewable energy anywhere in the world is a "no brainer". It will create lots of jobs in every community. Designing, equipping and retro-fitting every building with whatever is needed to reduce energy use by 50% is also a front-runner for climate and job creation success. Investing in high quality streets for walking and cycling and public transport will do the same but throwing cash at an early 20th century industry based on moving objects that weight about 75 kgs in a metal container weighing about 1 tonne is not very intelligent. We can restructure cities, mobility and accessibility and in one highly co-ordinated policy deal with road safety, health, obesity, climate change and peak oil but it looks like the answer is, as usual, "no".

In this issue of WTPP we introduce a new comment section. Comments are invited for future issues and should be lively, topical and relevant and will be given careful consideration. In this issue Kurt Lesser talks about the urge to rescue the car industry and Glenn Lowcock discusses speed limits and oil dependency.

Our main article (Buehler and Pucher) returns to a theme we often emphasise in this journal. They talk about sustainable transport in Germany especially Freiburg and demonstrate that carefully designed and integrated policies can create an exceptionally high quality of life with high levels of cycling and wide community and fiscal benefits. This should be required reading for every council officer in the UK and North America. We then have an article by Bjorn Haake who takes issue with an earlier Pucher and Buehler article on cycling and promotes education rather than infrastructure change. This is an important debate and even though we disagree with Haake we are delighted to facilitate the discussion. Pucher and Buehler then respond to Haake's arguments and readers are invited to come to their own conclusions and let us know if they want to submit a comment or another contribution to develop the debate further.

John Whitelegg
Editor

Abstracts & Keywords

Sustainable Transport that Works: Lessons from Germany

Ralph Buehler, John Pucher

This paper describes how Germany has balanced high levels of car ownership with safe, convenient, and integrated public transport, cycling, and walking alternatives. Germans walk, bike, and take public transport for 41% of their daily trips, four times more than the 11% share of the green modes in the USA. That helps make urban transport far more sustainable in Germany than in the USA. Since the 1970s, German cities have improved environmentally friendly alternatives to the car while restricting car use. To illustrate how such policies are implemented at the local level, this paper presents a detailed case study of Freiburg, which is widely considered Germany's most sustainable city. The innovative transport and land use policies introduced in Freiburg offer useful lessons on how to increase transport sustainability: First, policies and planning are fully integrated across modes of transport and coordinated with land use policies. Second, public transport systems provide modern, convenient services with deeply discounted fares for frequent riders. Third, planners have implemented controversial policies in stages over an extended period. Fourth, government officials effectively communicate the benefits of sustainable transport to the public. Finally, policies restrict car use and make it less convenient, slower, and more expensive, especially in centre cities and residential neighbourhoods.

Keywords: Sustainability, Policy, Germany, Travel behaviour, Urban transport

The Importance of Bicyclist Education

Bjorn Haake

The goal of increasing bicycle ridership often focuses on providing more bicycle facilities without the necessary concerns of bike safety. Most accidents happen when traffic streams cross each other. Crossing movements are usually increased under typical implementations of bicycle facilities. This article aims to point out the biggest safety problems of current bike infrastructure. The alternative proposed is to increase education of bicycle riders in order for them to steer through traffic safely. Experience with classes designed by the League of American Bicyclists has shown that graduates are more comfortable in traffic and are riding safer. Building confidence keeps new riders riding.

Keywords: Bicycle ridership, Bicycle education, Bicycle infrastructure, Safety

Cycling for a Few or for Everyone:
The Importance of Social Justice in Cycling Policy

John Pucher, Ralph Buehler

This article responds to Bjorn Haake's criticism of our December 2007 article in *WTPP* "At the Frontiers of Cycling," in which we examined cycling trends and policies in Denmark (Copenhagen and Odense), the Netherlands (Amsterdam and Groningen), and Germany (Berlin and Muenster). Haake argues that professional training of cyclists to ride on roadways with motor vehicle traffic is the only strategy necessary to increase cycling safety and raise overall cycling levels. Our research reports overwhelming empirical evidence that a multi-faceted strategy including separate facilities would be far more effective and more equitable.

Keywords: Bicycling, Social Justice, Safety, Bike Infrastructure, Transport Policy

No Stopping the Gravy Train of Car Support?

Kurt Lesser

For months now the auto industry has publicly been seen to be begging for financial help, with dour threats of jobs at risk and promises to 'reform' by committed research for a greener car.

Some nations and the European Union have shown themselves willing to provide aid, with certain conditions.

But how can jobs be guaranteed – if sales don't pick up, if new robots are introduced, if the company or parts thereof are outsourced?

And what investments will go to the only effective reforms in transport, the only ones that are green – investments in public transport (also for transport in the off-hours), and for a greater re-organization of urban space, a de-mobilization that must involve housing and places of work and service?

Words about jobs and the greening of the car seem to have been accepted, with no questions asked by journalists, parliamentarians, and, oddly enough, by green organizations and parties.

Everyone seems to believe that benefits will result from handing money to the auto corporations, that there's a fair tit for tat and it is all for our good. A worthy investment no matter the enormous sums.

The two points very loudly made by the auto industry and its adherents, about job security and 'environmentally-friendly technologies', must be examined, questions asked, and, arguments put from the material available with our past experiences of the industry in mind.

The great question for the unions is: what may we expect of job security from such an automatized and flighty industry? And for green organisations and parties: what can we really expect of an industry that prides itself in producing the one industrial consumer product most harmful for human life and the planet, and with a bleak record of past 'reform'.

The following will question the two conditions for aid we hear most about, job security and green technology.

The conclusions may already be succinctly stated – that putting money in cars is wasting it, it will go towards prolonging our present misery. Let the auto industry embrace the tenets of letting demand shape the market, the "invisible hand" of Adam Smith, and let fall that which cannot stand.

Jobs

How many jobs are at risk? Bernie Ecclestone a few years ago told us that 50,000 jobs could be lost if Formula One folded. No-one, as far as I know, checked the jobs or even asked about them.

As with other jobs in the production of cars one must ask - what kind of job? Perhaps a contract 'agent', a one-man entrepreneur with no pension but, in some countries, with sizable tax-deductions that permit him to keep a car in style. Perhaps the shoemaker has been included in the tally, or the neighbourhood grocer.

Where is the job? Is it with a national 'supplier' – or one in China or Argentina? The auto assembly line has grown since the days of Ford in Dearborn, it encompasses the whole world.

What kind of job would a green organisation or party think worthy of saving? Jobs in tobacco or arms? Is there

a reason for special concern for jobs in carmaking? Why do jobs in this industry make politicians become generous? Woolworth with 27,000 employees (accounted for) was allowed to go to the wall; Wedgewood has moved most of its production to the Far East.

National pride in the car industry? Didn't Britain have pride in the textile industry that was allowed to fold or depart?

The condition for giving money is a demand for 'restructuring' – which sounds like the usual efficiency exercise, making slim and mean, whereby jobs are shed. What alterations in hiring may be expected? More contract labour, without pensions? Or expectations that the workers themselves provide support by doing extra time for less pay?

What plans does a company have for outsourcing? Has it already been done, or partially done?

Where are the director-jobs? In Detroit?

Green Technology

I've seen nothing specific on what may be sought, other than a means of reducing CO_2 by fuel efficiency – which ought to please drivers, as they can believe they have a smaller climate footprint, while at the same time being able to drive more miles per gallon.

Where we can see that any fuel efficiency is spurious, as far as fuel use goes, miles travelled, the car is just cheaper to run.

Thus an inducement for car-use, as are scrapping schemes - where drivers get spanking-new cars at a reduction, and that's always more fun than using the old banger.

The scrapping schemes themselves involve exchanging cars that work, and using energy to scrap them, and as part of the tally there's the energy for making the new car.

Having a fuel-efficient car does not mean that it will poison the environment less by CO and a whole spectrum of toxins from the tailpipe (we may assume that much of the money granted will go, as always, to lobbying for less strict pollution levels), that fewer than 9,000 children will be killed annually on Europe's roads, or that any of the many other iniquities of the motorcar will disappear. It's in the nature of the beast, to go to fast and to pollute.

What about electric and hybrid vehicles? They sound environmentally friendly, and are presented as such by governments and even endorsed by many greens - but why speak of them before there's a real chance of mass production and selling?

The electric car is not a new concept; it's been around as long as the infernal combustion model. The only thing missing so far in the electric has been the same ability to accelerate and go fast, and a net to provide the reach and omnipresence as of the gasoline/diesel car.

To attain mass sales the electric must possess the allure of the gasoline/diesel car. And that will leave us with the problems of speeding and congestion and even pollution. Pollution in the urban environment? You may well ask. Just to mention a few - there's noise and the light and space pollution, asbestos from the brake linings and rubber particles from the tires, and electromagnetic fields.

Heavy investment will be needed for production and power points – and to develop sufficient capacity from a net that's already overcharged.

Green organisations and parties ought to care about all aspects of the car – or have concerns for them become limited to the reduction of a single greenhouse

gas? There's human, animal, and plant health, as well as the more abstract one of planet health.

We may guess at where the public money is headed – a good portion towards advertising (more green-wash, more censorship of the media), more for lobbying, more for rewarding the directorship. Will we ever know?
Will anything that green organisations and parties say change the behaviour of politicians when engaging with the motorcar?
Harald B.Schäfer's words from the 80s are only too true – that the price of petrol today is what the price of bread was before the French Revolution.
He also said that the key to the environmental issue is transport. Meaning that this is the hard knot that, when once unpicked, all else might perhaps be accomplished with less grief and opposition.
Whatever the problems of speaking out might be for politicians, who seem tramlined by the media into fearing many bad days in the papers if they do not act for the car - green organisations and parties need not keep silent, and ought to protest loudly enough to be heard in the media and by our politicians.

This is a forerunner of sorts to a study on the true cost of the car – that includes tax support, policing, the infrastructure, crime, the health service – where the first step must look at the direct forms of public support for the making of cars.
Towards this everyone can help, by supplying information, either from the media or from other sources. (An appeal to whistleblowers)

- How much has been or will be handed to which companies by which states?
- Where is the headquarters of the company?
- In what form has aid been given, as loan or grant?
- What conditions, specifically, were stipulated?
- What is known of previous gifts or loans – and what came of them?

On gratitude, a fable from Aesop – 'The Farmer and the Snake'.
One frosty snowy winter a farmer found a snake under a hedge almost frozen to death with the cold.
He couldn't help feeling sorry for the poor stiff creature, so he took it home, put it on the hearth near the fire and went on about his business. Before very long there was such a shouting and screaming from his wife and children that he came running back to find out what was wrong.
There was the wretched ungrateful snake, hissing and chasing the farmer's wife and children all around the room.
"So!" said the farmer, "this is how you pay me back for being kind to you! Well then, take this little bit of help too", and he picked up a mattock and chopped the snake in two. The point – Returning evil for good is not the way to show your thanks.

The next time you hear a motorist complaining of being soaked, mention the enormous sums in support that is handed to the industry by all taxpayers – where everyone pays for the privileged choice of the driver, directly and indirectly – and that includes paying with lives in fighting the wars for cheap oil.

Author details:
Kurt Lesser is a Writer and a Photographer
kurtlesser@yahoo.fr

Moving toward a non oil dependant society with a proposed road speed limit of 30mph

Glenn Lowcock

It is becoming clearer year by year that not only is the cost of oil certain to continue rising but the reserves on which the economy depends are surely and steadily diminishing. New oil fields will of course help but the best estimates chart a worrying and widening shortfall between supply and demand. Pipelines will not run dry overnight but as China and India claim their fair cut we are all being forced to review our use of oil and how we can manage on less. Much less.

In terms of overall oil consumption transport takes a considerable share. More than this however, oil-based transport and its extensive road infrastructure deeply affects every aspect of our lives. Throughout the 20th century oil has made it possible to travel ever greater distances and, almost unseen, has given us the world we now live in – socially, economically, and culturally. So to the extent that oil-fuelled transport has established the shape of society today I believe it is to transport we should look to find the 'post-oil society' of tomorrow. The suggestion offered is simple though it may not appear easy; that we use road speed as a tool for social change, and cut the national maximum road speed to 30mph. Such a drastic change will require phasing in over a number of years, with speed limits decreasing from 50 to 40 to 30mph. Its implementation will probably also require the use of speed limiters fitted to road vehicles, while government will need to set a framework in which the slowing down of road travel is coordinated with an expansion in rail facilities and the restructuring of towns and cities.

So what might be the implications of such a general and overall 'slowing down'?

As we go about our daily lives, shopping, working and spending time with our families, a reasonable journey generally takes up to around an hour. While a car journey of an hour currently takes us 50 to 60 miles, if our speed is only 20-30mph the radius of regular activity would be reduced to about 25 miles. In effect a smaller and more localised area in which we live.

Since in travel as in many things time is money, an increase in journey time will increase the price of goods carried over longer distances. Goods and services sourced locally would therefore become relatively cheaper and so would compete favourably with those carried long distance without the need for further price regulation. Food especially is a case in point, and as the transport of food from the other side of the world is no longer viable it will be replaced with goods that are home grown or 'near grown'. The recent rise in the cost of fuel means cheap transport is already a thing of the past, and is now causing a general rise in food prices. A proper adjustment to diet that truly takes food miles into account is of course the best way forward.

With a smaller travelling radius the trend toward 'remote working' via the internet would be extended, and long daily commuting will become the exception rather than the norm. Alongside the growth in wireless networks, increased

journey times will see many people needing to live closer to their places of work. As businesses relocate to supply daily and weekly needs within a 25 mile radius, towns and cities will once more develop a more integrated residential and commercial mix, and so stimulate urban re-integration across the country.

There is a logic we currently live under which says that because we can travel great distances, we must travel great distances. Oil is the glue which joins together the dislocated places of our lives such that we currently have no choice but to drive miles to superstores, hospitals, schools and for entertainment. In a '25 mile environment' this trend will be reversed and local schools, community hospitals and shopping will return to our blighted small towns. As the reasons why we travel are gradually removed there will simply be less need to travel and less journeys taken.

In so many ways our lives will adapt to fit the local scale and we will take far more interest in ensuring our home areas are pleasant, safe and are suitable to be called 'home'. We'll become more aware of people living nearby and a greater level of social cohesion will develop, taking a real step toward a more caring society. Local politics will become much more important as local discussions result in local decisions.

Where 30 years ago corner shops disappeared, in the age of wireless communication they may come to be at the forefront of a new way of commercial interaction. Supported by internet ordering small neighbourhood shops, 'mini-distribution depots' at the end of every street will be the means by which goods move from supplier to consumer. Place an order on-line in the evening and next morning simply walk to the end of the road to pick up your internet shopping in a couple of carrier bags. A network something akin to the Post Office we used to have, with a few vans doing the work of car parks full of private cars.

Across the board however, the transportation of all goods is certain to cost more. Durable goods will need to be designed for a longer lifespan and will be repaired rather than replaced - with clear and real benefit to the environment.

Though '25 mile radius living' may appear to be challenging, people are resourceful and society as we know it will not come to an end. Changed for sure, but the life of city, town and country will all remain viable. There are some things we do now and take for granted that will no longer be quite so possible. Regular foreign holidays, green beans from Africa, or travelling 50 miles each way to work, Monday to Friday, sitting in traffic dreaming of moving to the foothills of the Pyrenees. Indeed, much of the slower way of life many seek in rural Spain or Croatia will be found right here at home as the bustle and stress of urban living become a thing of the past and life shifts down a notch to a more manageable pace. A new 'work-life balance' means we may all be a little 'cash poorer' but so much richer in other ways.

At the national scale railways will provide travel beyond the local environment. They will certainly require a high level of public investment but the money continually being spent on extending the road system, or a new runway for Heathrow would go a long way to providing the funds. We may also

envisage a new form of rolling-stock being designed to carry some yet to be developed small vehicles, using trains in a 'roll-on roll-off' manner: compact versions of the Channel Tunnel rail link operating on high speed tracks up and down the country.

As for air travel, aviation fuel is already expensive and surcharges on fuel will by themselves bring to an end the age of cheap flights. If environmental taxes are applied the aviation industry is sure to face contraction on a massive scale.

Government has always used laws as a means to encourage and discourage behaviour, whether it be taxation and age restrictions on the sale of cigarettes, or the low to zero taxing of renewable energy. The control of road speed would be one such use of law as an instrument of social change. While many legal discriminations are financial, however the 30mph limit would apply equally to rich and poor alike.

Across the world countless cities are now using reduced speed as a tool in the fight against pollution, traffic gridlock and road casualties, and as an encouragement to use public transport. Ireland has already implemented a 20mph policy in Dublin and is planning to roll this out to other cities across the Republic. It appears however that the policy is not designed as a tool to reduce oil consumption and so speed has not yet been viewed as an instrument for social change.

The big question remaining in all this is just how are we to get around on the roads?

A new national speed limit of 30mph and below will render the private car industry's fixation with status, speed and glamour rather irrelevant, and the utility value of many vehicles will be cut drastically - as is already happening with larger fuel-hungry cars. Instead manufacturers will design and produce a whole new range of minimal-energy vehicles. These could be in showrooms almost immediately, as cars developed for 30mph are so much more efficient both in terms of cost and environmental impact than a product striving to achieve 60-70mph. People will also choose to walk more, and maybe use other 'slow-transports', such as a cycle fitted with a small fuel efficient engine for uphill climbs. Slower forms of road transport in general would overnight become viable: cycling at 15mph is much safer and more realistic prospect amongst vehicles travelling at 25mph as against a death defying 55mph.

A slower travelling speed is not a recipe for the end of civilization as we know it. On the contrary, the rising price of oil is already reshaping our lives whether we like it or not, but setting in place a controlled approach to the inevitable will enable us to move forward at a pace of our own choosing.

It is impossible to guess the future developments to be made in the area of super-efficient or 'alternative-fuel' vehicles, but if we insist on them achieving 60mph their cost to the pocket and the environment will leave them quite unsuited as a replacement for today's vehicles. As already mentioned, the real need is to engineer a shift toward a low oil-use economy and for this there can be no sustainable answer to enable us to continue the transportation patterns of today. We simply need to restructure society to

require less movement, while on the plus side, this is also where real social benefits will be found.

The planet is overheating and oil is becoming scarce – two good reasons to think about how we want our future to look. It's quite simple: if we remain dependent on oil, when oil runs out everything stops. As we see the first signs of the world's economy shifting from readily available to very expensive oil a strategy in which we accept a partial reduction in the way we travel might actually be a realistic option.

Author details:
Glenn Lowcock studied architecture and the built environment at the Architectural Association in London and currently works in Landscape Architecture in East Sussex. He is a member of the Secular Franciscan Order.

Glenn Lowcock
glennlouis@hotmail.co.uk

Sustainable Transport that Works: Lessons from Germany

Ralph Buehler, John Pucher

1. Introduction. In recent years, countries in Europe and North America have increasingly recognized the need to improve the social, environmental, and economic impacts of transport. Yet most countries are far from achieving the goal of transport sustainability (Banister, 2005, Banister *et al.*, 2007). The USA is perhaps the best known example of unsustainable transport, but most of the world's countries have been heading in the wrong direction as well. That is mainly due to rapidly increasing reliance on the private car for daily travel (Newman and Kenworthy, 1999, Vuchic, 1999, Low and Gleeson, 2002, Tolley, 2003).

The car is popular among consumers because it generally provides high levels of mobility and convenience. As many studies have shown, car ownership and use rise rapidly with increased income. The increasing affordability of cars is the most important explanation for the worldwide growth in motorisation in recent decades (Ingram and Liu, 1999, Schafer and Victor, 2000, Downs, 2004). Moreover, as car use increases to ever higher levels, the car tends to drive out competing modes, thus limiting travel options. That is partly due to the car's genuine benefits, but also results from the negative impacts of car use on other modes. For example, cars are the main source of traffic dangers for pedestrians and cyclists, thus discouraging walking and cycling (Tolley, 2003, FHWA, 2004, IRTAD, 2008, FHWA, 2009). By congesting roadways, cars slow down buses and discourage public transport use(Downs, 2004, Vuchic, 2005). Cars also encourage lower density, sprawled development that is difficult to serve with public transport and generates trip distances too long to walk or cycle (Schaefer and Sclar, 1980, TRB, 1998, 2001, Pacione, 2007). Thus, rising car use reduces the attractiveness of alternative modes and induces a further modal shift toward the car. For all these reasons, the relatively sustainable modes of public transport, walking and cycling have been losing market share in most of the world (Newman *et al.*, 1999, Banister, 2005).

Although the car provides extraordinary mobility and convenience for most travel needs, it also causes serious social, economic, and environmental problems. Technological improvements in recent decades have made cars less polluting, more energy efficient, and safer, but they remain a major source of air and water pollution, noise, energy use, and traffic injuries. Moreover, problems such as congestion, suburban sprawl, and inequity are less amenable to technological solutions. Improving the public transport, walking, and cycling alternatives to the car must be a cornerstone of any program to increase the overall sustainability of our transport systems. It would increase the range of choice for all travellers, even those whose general preference is for the car.

This paper examines the case of Germany, and how it has managed to balance high levels of car ownership with safe and convenient public transport,

cycling, and walking alternatives. It shows that the car can peacefully co-exist with other modes of transport, provided the right policies are adopted to restrict car use in those situations where it is most problematic. The overall result is a transport system that is far more sustainable in Germany than in the USA even though Germans have one of the world's highest car ownership rates. Moreover, Germany was able to implement the necessary transport, land use, and taxation policies in spite of its important car manufacturing industry, a powerful car lobby, and the immense popularity of cars among German consumers (Wolf, 1986, Schmucki, 2001). The German experience suggests that the most feasible way to improve transport sustainability is to tame the automobile, not to eliminate it. At the same time, public transport, cycling, and walking must be improved to provide feasible alternatives to car use, and thus to make car restrictive policies politically feasible.

After examining the overall approach in Germany, we focus on the city of Freiburg in southwestern Germany, which is often called the environmental capital of Germany and widely considered its most sustainable city. The innovative transport and land use policies introduced there since the 1970s have spread to many other German cities. Freiburg offers useful lessons on how to increase transport sustainability, refuting the notion that sustainability cannot be economically viable. As shown in this article, Freiburg's transport reforms have increased the overall efficiency of its transport system and triggered an economic boom that has made Freiburg one of Germany's most sought-after locations both for business and residence. Freiburg demonstrates that sustainable transport can work very well indeed.

2. Comparison of German and US travel trends and sustainability. As shown in Table 1, car ownership increased faster in Germany than in the USA from 1950 to 2006. Indeed, the motorisation rate rose 42-fold in Germany, albeit from a very low base of only 13 cars per 1,000 inhabitants in 1950 (KBA, 2006). In 2006, the USA still had roughly a third more cars per capita than Germany (776 vs. 546), but the German rate is one of the highest in the world and second highest in Europe after Luxembourg. In spite of its high rate of car ownership, Germany's car use per capita in 2005 was less than half that in the USA (7,040 vs. 14,800 veh. km) (FHWA, 1990-2008, BMVBS, 1991-2008, FHWA, 2006). Moreover, the rate of increase in car use in Germany has been less than half as fast as in the USA in recent years. From 1995 to 2006, for example, passenger km of car use per inhabitant increased by 6% in Germany compared to 14% in the USA (FHWA, 1990-2008, BMVBS, 1991-2008, FHWA, 2006).

Table 1: Auto Ownership Trends, 1950 – 2006

	Freiburg	Germany	Europe	U.S.	World
1950	28	13	18	268	25
1960	113	82	41	306	34
1970	248	208	135	389	54
1980	361	375	241	573	74
1990	422	445	288	613	81
2000	420	532	427	746	94
2006	419	546	466	776	97

Sources: *FHWA (1990-2008), BMVBS (1991-2008), Pucher and Clorer (1992), OECD (2003-2007), EUROSTAT (2005-2007), City of Freiburg (2009b)*
Note: Until 1989 West Germany only; West and East Germany after reunification in 1990.

One reason for the much higher level of car use in the USA is the higher car share of trips in the USA compared to Germany. National travel surveys with very similar methodologies and timing measured a car share of 87% for the USA in 2001 and 61% for Germany in 2002 (BMVBS, 2004, ORNL, 2005). The car dominates even for short trips in the USA: 67% of all trips of a mile or less, compared to 27% in Germany (Buehler, 2008). Conversely, public transport accounts for five times as high a share of trips in Germany as in the USA: 8.5% vs. 1.6%. Similarly, walking and cycling account for three times as high a share of trips in Germany as in the USA: 32% vs. 10%.

The greater car-dependence in the USA suggests that its transport system is less sustainable than Germany's, and the available statistics support this impression (see Table 2). In 2006 per capita energy use and CO_2 emissions from personal transport were only about a third as high in Germany as in the USA. Moreover, as with car use, the trend is more favourable in Germany. Per-capita energy use for personal travel fell in Germany by 8.5% between 1999 and 2006, and CO_2 emissions fell by 7%. Over the same period, transport energy use per capita rose by 4% in the USA and CO_2 emissions rose by 2% (BMVBS, 1991-2008, UBA, 2005c, FHWA, 2006, DOE, 2007).

Table 2: Passenger Travel and Sustainability in Germany and the USA

ENVIRONMENT			
Dimension	**Indicator**	**USA**	**GERMANY**
GHG Emission (2005)	Car CO_2 emissions (car and light truck use per capita in kg)	3,900	1,300
Car Fuel Efficiency (2005)	Miles per gallon (existing vehicle fleet of cars and light trucks)	20	30
Passenger Transportation Energy Use (2004/2005)	Mega joules per person year	58,000	18,000
	Mega joules per passenger kilometre		
	Cars and light trucks avg.	4.1	2.0
	Transit bus	4.5	1.1
	Light rail	2.9	1.3
	Heavy rail	2.7	1.5

ECONOMIC & SOCIAL			
Dimension	**Indicator**	**USA**	**GERMANY**
Household Transport Expenditures (2003)	% of household budget for transport (2003)	19%	14%
Traffic Safety (2002-2005)	Traffic fatalities per 100,000 population	14.7	6.5
	Traffic fatalities per kilometre of travel		
	Cyclist fatalities per 100 million km	11.3	2.5
	Pedestrian fatalities per 100 million km	5.0	2.5
	Car fatalities per billion km	9.0	7.8
Transit Subsidies (2006)	Government subsidy as share of public transportation operating budgets in %	70%	33%

Sources: FHWA (1990-2008), BMVBS (BMVBS, 1991-2008), DESTATIS (DESTATIS, 2003), U.S. Department of Labour (2003), Pucher (2004), UBA (2005c), APTA (2006), (2006), FHWA (2006), IRTAD (2006), ORNL (2008), Pucher and Buehler (2008), VDV (VDV, 2008)

In addition to less car dependence, Germans drive far more fuel efficient cars. Cars and light trucks in Germany averaged 30 mpg in 2005, compared to only 20 mpg for cars and light trucks in the USA. Public transport is also more fuel efficient in Germany than in the USA, averaging only half as much energy per vehicle km and only a third as much energy per passenger km.

Social and economic indicators show greater sustainability in Germany. Traffic fatalities per capita in 2006 were 2.3 times higher in the USA than in Germany, indicating an important gap in overall travel safety. The difference is especially pronounced for walking and cycling, which are less than a third as dangerous in Germany as in the USA when measured by fatalities per trip and per km travelled. Even car travel is safer in Germany, with slightly fewer fatalities per km driven than in the USA (7.8 vs. 9.0 deaths per billion km).

Travel in the USA costs more money, both for individual households and for the public sector. On average, Americans spend 19% of their household budget for transport compared to 14% in Germany. That translates into $2,712 more per household per year in the USA than in Germany (DESTATIS, 2003, U.S. Department of Labor, 2003). Clearly, car-dependence comes with a high price tag.

Another aspect of economic sustainability is the degree to which government subsidies are required for transport. Germany has three times as much public transport service per capita as the USA (56 vs. 19 veh. km of service per year) and four times as much public transport use per capita (1,145 vs. 269 passenger km per year) (VDV, 2005, APTA, 2006, VDV, 2006). Nevertheless, government subsidies to public transport are much smaller in Germany than in the USA. Passenger fares cover an average of 72% of operating costs in Germany compared to only 35% in the USA, and the average operating subsidy per passenger trip is twice as high in the USA ($.40 vs. $.20 in 2004) (VDV, 2005, APTA, 2006).

In short, along every dimension transport is more sustainable in Germany than in the USA. The following section examines briefly the overall transport, land use, and taxation policies in Germany that have enabled this achievement.

3. Overview of German transport, land use and taxation policies. There are five categories of government policies that have been particularly important for transport sustainability in Germany. First, taxes and restrictions on car use help limit car use and mitigate its harmful impacts. Second, the provision of high-quality, attractively priced, well-coordinated public transport services offers a viable alternative to the car for many trips, especially in large cities. Third, infrastructure for non-motorized travel has been vastly improved to increase the safety and convenience of walking and cycling. Fourth, urban development policies and land use planning have encouraged compact, mixed-use development, discouraged low-density suburban sprawl and thus kept many trips short enough to make by walking or cycling. Fifth, all of these policies have been fully coordinated to ensure their mutually reinforcing impact.

3.1. Pricing and restrictions on car use. The overall cost of owning and operating a similar car is about 50% higher in Germany than in the USA (AAA, 2007, ADAC, 2007). Most of that difference is due to much higher taxes and fees on car ownership and use in Germany. In particular motor fuel taxes in 2006 were nine times higher in Germany than in the USA. Moreover, the gap between German and American prices has increased over time (EIA, 2008, IEA, 2008). In 1990, petrol cost about 70% more in Germany than in the USA. In 2006, petrol cost 107% more. That is partly due to an explicit policy of regular, annual increases in the petrol tax in Germany during the five years from 1999 through 2003, when the Green Party was part of the coalition government (UBA, 2005a).

As taxes on motor vehicle ownership and use have increased in Germany, the resulting revenues have covered an increasing percentage of government expenditures on roadway construction and maintenance—from 92% in 1975 to 259% in 2006 (BMVBS, 1991-2008). Over the same period, the percentage of roadway costs covered by motorist charges in the USA actually fell from 0.70 to 0.63 (FHWA, 1990-2008).

Compared to the USA, German cities place far more restrictions on car use through limited road supply, lower speeds, and less parking. American metropolitan areas are encircled and crisscrossed by numerous high-speed beltways and expressways that penetrate into the heart of almost every city (TRB, 1998). Even though Germany has the fastest and third largest motorway network in the world, German motorways rarely penetrate into the city centre (Pucher, 1995, IRF, 2007). The greater supply of roadways in metropolitan areas might explain why average car speeds in the USA were 25% higher than in Germany in 2001/2002 (Buehler, 2008).

The layout of roads within German cities also restricts car travel. Extensive car free zones in most German cities—combined with deliberate dead-ends, turn restrictions and one-way street networks—have made it difficult, if not impossible, for cars to get from one side of the city to the other by passing through the city centre (Pucher, 1988, Hajdu, 1989, Hass-Klau, 1993b, Topp, 1993).

Moreover, roughly 70-80% of the road network in German cities and small towns has speed limits of 30km/hr or less (Beatley, 2000, Newman *et al.*, 2009). Almost all residential neighbourhoods employ speed-inhibiting measures such as “Tempo 30” signs,

road narrowing, raised intersections and crosswalks, traffic circles, extra curves and zigzag routes, speed humps, and artificial dead-ends created by mid-block street closures (Topp, 1994, Bundesregierung, 1998, BMVBS, 2002). Many residential streets in Germany—both in the central city and in new suburban developments—impose even lower speed limits, requiring cars to travel at 'walking speed,' set at 7km/hr for legal purposes (Beatley, 2000). Traffic calming is usually area-wide and not for isolated streets. That ensures that thru-traffic gets displaced to arterial roads designed to handle it and not simply shifted from one residential street to another.

The ultimate restrictive measure is to ban cars altogether. Virtually all German cities have created car-free zones in their centres, mainly intended for pedestrian use but generally permitting cycling during off-peak hours (Hajdu, 1989, Hass-Klau, 1993b, Beatley, 2000, GTZ, 2004). Another measure discouraging car use in German cities is the high price and restricted supply of parking (BAST, 2004, Boltze and Schaefer, 2005).

3.2. Public transport improvements

Germany offers far more extensive, higher-quality, and better integrated public transport services than in the USA. Thanks to continuous improvements to German public transport in recent decades, public transport use has continued to grow in spite of rapid growth in per-capita income and car ownership. From 1970 to 2005, for example, public transport trips per capita rose from 116 to 133 in Germany, while they fell in the USA from 23 to 21, less than a sixth the level in Germany (TRB, 2001, VDV, 2005, APTA, 2006, VDV, 2006).

German public transport is far more economically sustainable than American public transport (BMVBS, 1991-2008, VDV, 2005, APTA, 2006). That is due to higher passenger fare revenues in Germany as well as lower costs. The main reason for higher revenues is that German buses, trams, metros, and trains have more than twice as many passengers per vehicle as their American counterparts. Costs are lower for many reasons. German public transport vehicles are generally quite new, thus increasingly reliability and avoiding the high maintenance costs for old vehicles. German buses and trams are often articulated, carrying more passengers and requiring fewer drivers per passenger. That saves on labour costs, which are further reduced through the use of part-time labour to handle the extra service during peak hours. Labour productivity, as well as service quality, are yet further enhanced by signal priority at intersections and by wider spacing of bus and tram stops to avoid frequent stops. The resulting increased bus and tram speeds raise labour productivity by increasing the average vehicle km of service per driver hour (TRB, 2001, VDV, 2008). Thanks to higher revenues and lower costs, German public transport requires much smaller operating subsidies: only 28% of total operating costs, compared to 67% in the USA (VDV, 2005, APTA, 2006).

Another reason for the success of German public transport is the multi-modal coordination of public transport services, fares, and schedules within metropolitan areas. Starting with Hamburg in the 1960s, one German city after another created regional public transport organisations (Verkehrsverbuende), which fully integrated all aspects of public transport

operations and financing (Pucher and Kurth, 1996). By 1990, virtually all metropolitan areas in Germany had such public transport organizations, which have expanded and improved services, vastly improved fare structures, and attracted large increases in passengers (TRB, 2001). As a result, transfers between different types of public transport, different routes, and different operators are virtually seamless for passengers, both in terms of timing as well as distance walked. Additionally, German systems offer deep discounts on weekly, monthly, annual, and semester tickets that make it economical and convenient to use public transport on a daily basis and competitive with cars for the commute to work (VDV, 2005, 2006).

German public transport systems also do a better job of integrating their services with walking and cycling facilities. Wide sidewalks, safe pedestrian crossings, and car-free zones facilitate pedestrian access to bus and rail stops. Virtually all German public transport systems provide extensive bike parking facilities (Pucher and Buehler, 2008).

Public transport is more successful in Germany not because of more money but because of far more effective use of subsidies, much better fare and service policies, and the much higher cost of car use.

3.3. Walking and cycling in Germany

Especially since the 1970s, virtually all German cities have greatly improved transport infrastructure used by pedestrians and bicyclists (BMVBS, 2002, 2008). For pedestrians, that has included car-free zones that cover much of the city centre and wide, well-lit sidewalks on both sides of every street. Other pedestrian friendly design features include pedestrian refuge islands for crossing wide streets; clearly marked zebra crosswalks, often raised and with special lighting for visibility; and pedestrian-activated crossing signals (Pucher and Dijkstra, 2003). All residential and commercial developments have sidewalks for pedestrians, and many feature separate bike paths and extensive parking for cyclists.

The bicycling and walking networks in virtually all German cities include numerous off-street short cut connections for cyclists and pedestrians to enable them to take the most direct possible route from origin to destination. The result of such a wide range of facilities is a complete, integrated system of bicycling and walking routes that permit cyclists and pedestrians to cover almost any trip either on completely separate paths and lanes or on lightly travelled, traffic-calmed residential streets (Pucher and Buehler, 2008).

Most bicycling and pedestrian infrastructure is financed with local funds, but often with substantial state and federal subsidies (Bundesregierung, 1998, BMVBS, 2002). Indeed, a special federal urban transport fund allows 70-85% federal matching funds for state and local expenditures on facilities for cyclists and pedestrians, including paths, lanes, bridges, bike parking, traffic signals, and signs.

Germany has greatly increased pedestrian and cyclist safety since 1970, while it has only slightly increased in the USA. For example, the number of cyclist fatalities fell by almost 80% in Germany over the past 35 years, compared to a decline of only 30% in the USA (Pucher and Dijkstra, 2003, Pucher and Buehler, 2008). That is especially impressive given the cycling boom in Germany between the mid-1970s and the mid

1990s, when cycling levels doubled or tripled in most cities. Averaged over the years 2002 to 2005, pedestrian and cyclist fatality and injury rates were only a third as high in Germany as in the USA (IRTAD, 2008).

Greater pedestrian and cycling safety in German is largely due to a range of government policies that promote it. Extensive networks of bike paths and lanes on busy arterial streets, priority traffic signals at intersections, and comprehensive traffic calming of residential neighbourhoods enhance the safety of walking and cycling (BMVBS, 2002). Rigorous training of both motorists and non-motorists in traffic safety is required. These explicitly pro-walk and pro-bike policies generally slow down car use and often shift roadway space from cars to non-motorized users (BMVBS, 2006).

3.4. Urban development and land use policies. Over the last 50 years, cities in both Germany and the USA have been decentralizing (Nivola, 1999, Burchell *et al.*, 2002, Divall and Bond, 2003, DIFU, 2004). Nevertheless, in 2003 the average population density of cities and suburbs was up to three times higher in Germany than in the USA. The greater mix of land uses and higher population densities in Germany lead to shorter average trip distances than in the USA, thus increasing the possibilities for walking and cycling. Moreover, higher population densities make public transport service more economical by generating higher passenger volumes. Differences in spatial development patterns between the two countries are not simply the result of the much older history of German cities. Far more important are differences in the organisation of the land-use planning process, property rights, zoning regulation, and local public finance (Nivola, 1999, Hirt, 2007, Schmidt and Buehler, 2007).

Perhaps most fundamentally, the right to develop property is highly circumscribed in Germany. With few exceptions, new development is limited by law to areas immediately adjacent to already built-up areas, thus avoiding leapfrog development and suburban sprawl (BMVBS, 1993).

In Germany, governments on the federal, state, regional, and local level interact in a bottom-up and top-down land-use planning process, which is based on cooperation, compromise, and mediation (BMVBS, 2000, Kunzmann, 2001). The specificity of land use plans increases from top to bottom. Additionally, at each level of government formal links exist between land use planning and other areas of planning such as transport and the environment (BMVBS, 2000, Fuerst and Scholles, 2003). Coordination of land-use planning in Germany is facilitated by less municipal competition for property taxes (Schmidt and Buehler, 2007).

The key to compact, mixed-use development in Germany lies in horizontal cooperation between jurisdictions at the same level of government, vertical cooperation between different levels of government, strict regulation of private development at the suburban fringe, zoning that encourages high density and mixed use, and tax sharing arrangements that minimize competition among cities and towns for tax base.

3.5. Coordinating policies. It is politically difficult and potentially inequitable to restrict car use and make it more expensive unless there are

feasible alternatives to car use that provide acceptable levels of mobility. Thus, car-restrictive policies must be accompanied by the provision of high quality public transport services as well as safe and convenient walking and cycling facilities.

Starting in the 1970s, German cities started imposing restrictions on car use and parking (Topp, 1994, Blatter, 1995, Topp, 1993). Since then, car-restrictive measures have been successively expanded. But at the same time, conditions for walking, bicycling, and public transport use have steadily improved, and these three alternatives to the car have been better coordinated with each other. As a result, the overall range of transport options improved for everyone. That is what made the entire package of policy reforms publicly acceptable and politically possible. Simply restricting car use, or making it more expensive, without providing good alternatives, would have been viewed as purely punitive measures and thus politically impossible.

The coordination of transport and land use policies is another area where Germany is ahead of the USA. In most German cities, transport and land use planning are usually conducted within the same local government department (BMVBS, 2000, Schmidt and Buehler, 2007). That is also true at the state and federal levels of government. Indeed, there is a combined Federal Ministry of Transport and Land Use in Germany to ensure coordination. There is no equivalent in the USA, neither at the state nor federal level of government. The explicit coordination of transport and land use is another key to the success of sustainable transport policies in Germany, since compact, mixed-use developments and crucial to the viability of walking, cycling, and public transport.

3.6. Transport policy reforms. Land use, urban development, and transport policies in Germany have not always been as sustainable as they are currently. On the contrary, government policies in the 1950s and 1960s generally aimed to adapt cities to the car, vastly expanding roadway supply and parking facilities while permitting car-dependent retail and residential developments on the urban fringe (Hajdu, 1989, Hass-Klau, 1993b, Koeberlein, 1997, Schmucki, 2001, TRB, 2001, BMVBS, 2008). As car use increased, roadway congestion got worse, and traffic fatalities rose sharply. With rising car traffic, noise and air pollution increased as well, and quality of life in many neighbourhoods suffered. These negative externalities of car use triggered a grassroots revolt that generated many of the progressive transport and land use policies in Germany today (BMVBS, 2008).

Stimulated further by the energy crisis of 1973, car-restrictive policies gradually became more widespread and better coordinated throughout the rest of the 1970s and continued to expand in successive decades. Most cities reduced car parking and increased its price, especially in the central city (BMVBS, 2008, Topp, 1993). More and more cities established car-free streets, which increased in number and connectivity over time to form extensive car-free zones (Hass-Klau, 1993a, Beatley, 2000). Over the past three decades, traffic calming of residential neighbourhoods has spread rapidly to virtually all Germany cities and towns.

In short, there was an important turn-around in German policies in the early

1970s. Ever since then, the trend has been toward more restrictions and higher taxes on car use, while walking, cycling, and public transport have been increasingly promoted through a wide variety of measures. That shift in transport policies was coordinated with a corresponding shift in land use policy, which increasingly fostered clustered urban development within walking distance of public transport while discouraging car-dependent development at the suburban fringe.

The German federal government provided the overall framework for sustainable transport policies by raising petrol taxes, decreasing spending on roads, and increasing investment in public transport. Nevertheless, German states and cities played the most important role in moving away from a car-dominated system toward one where there is genuine choice among modes. Most of the necessary land use and transport policies could only be implemented at the local level, and it is precisely there that one finds the most innovations in Germany.

Given that key role of cities, we focus now on Freiburg, which for decades has been at the vanguard of sustainable transport and land use policies. Its reputation for being the 'environmental capital' of Germany derives from the extraordinary range of measures Freiburg has implemented since 1970 to restrict car use, promote walking, cycling and public transport, and encourage development that promotes the quality of life while protecting the environment and saving energy.

4. Freiburg: Environmental capital of Germany

4.1. Background information. Freiburg is a city of about 220,000 inhabitants located in south-western Germany (Gutzmer, 2006, City of Freiburg, 2009b). It serves as the economic, cultural, and political centre of the Black Forest region, which had a population of 615,000 in 2005 (Gutzmer, 2006). Its economy is based on tourism, university teaching and research, government and church administration, and a broad range of services provided to the surrounding region. The development of Freiburg has been favoured by its ideal climate—sunnier and warmer and than other major city in Germany—and its key location at the gateway to the Black Forest and less than an hour's travel from Switzerland and France (Pucher and Clorer, 1992).

4.2. Trends in car ownership, travel behaviour, and sustainability. From 1950 to 1970, car ownership in Freiburg was higher than for West Germany as a whole, but since the dramatic policy reversal in the early 1970s, the rate in Freiburg has fallen further and further below the German average (see Table 1). Moreover, the motorization rate declined slightly between 1990 and 2006, from 422 to 419 cars per 1,000 inhabitants (City of Freiburg, 2009b). Whereas Freiburg had more than twice as many cars per capita as the West German average in 1950, it had 23% fewer cars per capita than the unified German average in 2006. That is a stunning turnaround and dramatic evidence of the impact of Freiburg's range of sustainable transport policies.

Available statistics confirm that Freiburg has become more sustainable over time and is more sustainable than Germany as a whole. In spite of rising per-capita income, vehicle km of car use per capita in Freiburg declined by 7% on all roads and by 13% on residential roads from

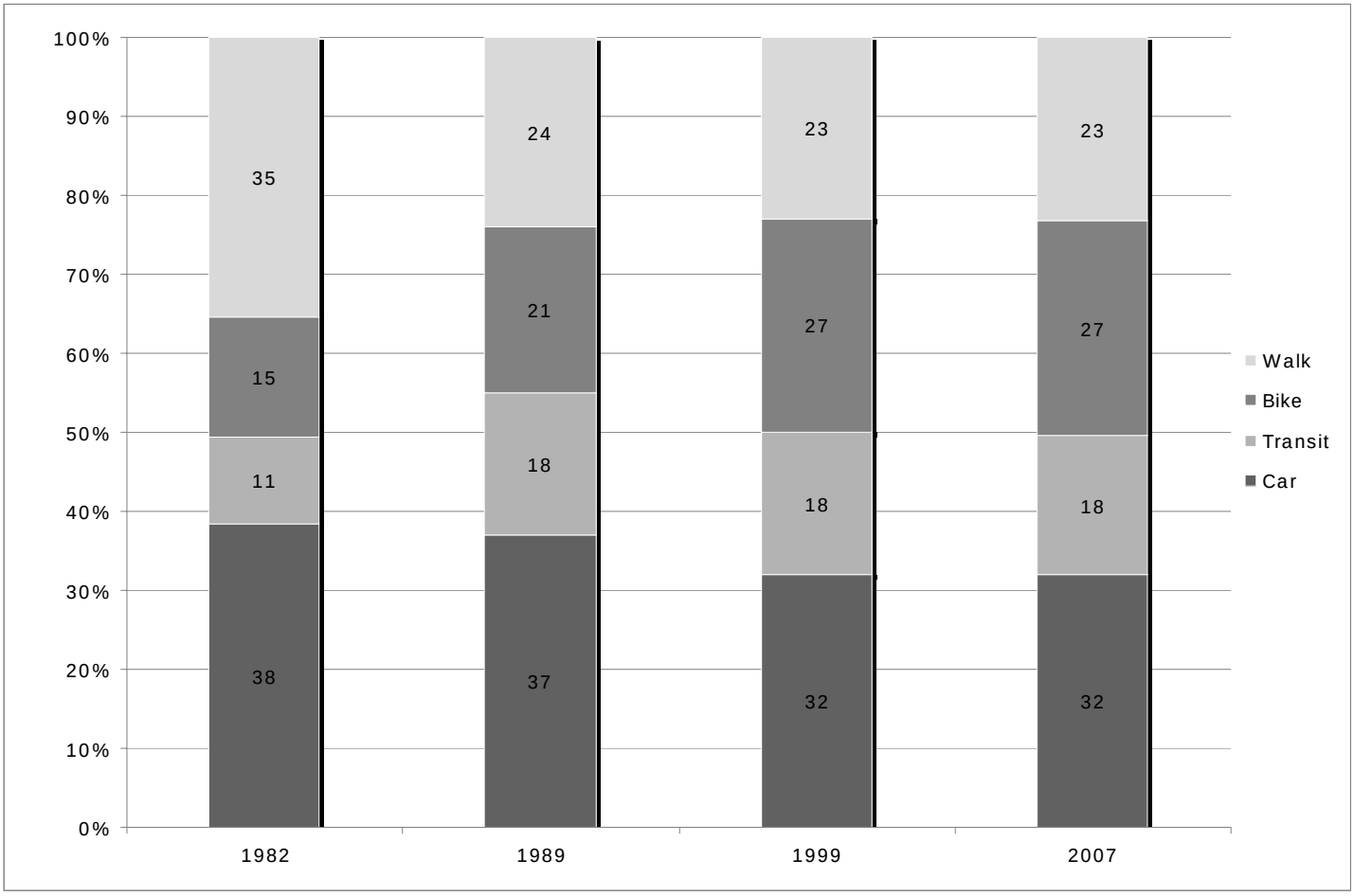
1990 to 2006 (City of Freiburg, 2007a, Oeko Institut, 2007, State of Baden Wuerttemberg, 2008). From 1992 to 2005, transport CO_2 emissions per capita in Freiburg fell by 13.4% to a level that is 89% of the German average and only 29% of the American average (City of Freiburg, 2005, UBA, 2005b, Oeko Institut, 2007, UBA, 2008). Travel is also safer in Freiburg than in Germany as a whole: 3.7 traffic fatalities per 100,000 inhabitants vs. 6.5 in Germany and 14.7 in the USA (NHTSA, 2004, INKAR, 2005, Polizeidirektion Freiburg, 2005). Finally, the financial viability of public transport is extraordinarily high in Freiburg, requiring only 10% of its operating costs to be subsidized through government funds, compared to 28% for Germany as a whole and 65% in the USA (APTA, 2006, RVG, 2008c, VDV, 2008). It is not possible to provide Freiburg's ratings on all the sustainability indicators listed in Table 2, but the available statistics are consistent with Freiburg's image of being a very sustainable city.

A key aspect of Freiburg's sustainability is the dramatic shift in travel behaviour between 1982 and 2007. As shown in Figure 1, the car share of trips in Freiburg fell from 38% to 32% during a period in which the car's mode share was increasing rapidly almost everywhere else in the world (Bratzel, 2000, University of Dortmund, 2001, City of Freiburg, 2008f). At the same time, the bike share of trips in Freiburg almost doubled, from 15% to 27%, and the public transport mode share trips rose from 11% to 18%.

While the car share of trips in Freiburg is only half that for Germany as a whole, Freiburg's bike share is three times as high, and its public transport share is twice as high. Freiburgers average 339 public transport trips per year, four times as many as the average German (84 trips) and 15 times more than the average American (22 trips) (BMVBS, 2004, ORNL, 2005, City of Freiburg, 2008f). Freiburgers average 350 bike trips per year, three times as many as the average German (104 trips) and 29 times more than the average American (12 trips). Differences in walking rates are smaller. Freiburgers walk only about 10% more than other Germans (299 vs. 269 trips per year) but 137% more than Americans (299 vs. 126 trips). Freiburg has avoided car dependence by providing a full spectrum of travel options that offer a genuine choice in ways to get around.

The trends away from car use, as documented above, did not result from a sudden impoverishment of Freiburg. On the contrary, employment in Freiburg grew at three times the overall German rate from 1996 to 2005 (11% vs. 4%) (INKAR, 2005). In 2005, per-capita income in Freiburg was 29% higher than for Germany as a whole (€35,200 vs. €27,200). Freiburg's economy has profited from its increasing focus on sustainability. Since the early 1980s, Freiburg has fostered the development of its environmental, solar, and biotechnology industries. By 2007 Freiburg had become Germany's leader in the area of green industries, with 1,500 companies employing roughly 10,000 people and contributing approximately €500 million to the local economy (City of Freiburg, 2009a). Moreover, Freiburg's tourist industry has boomed thanks to a doubling in the number of tourists since 1995 (City of Freiburg 2009b). Thus, Freiburg has actually profited from its increasing focus on sustainability.

Figure 1: Percentage of Trips by Mode of Transport in Freiburg, 1982-2007



Sources: Pucher and Clorer (1992), University of Dortmund (2001), Gutzmer (2006) City of Freiburg (2008g)

A flourishing economy and high per capita incomes do not necessarily require high levels of car ownership and use. Rising incomes in Freiburg did not stimulate the demand for cars nearly as much as the demand for environmental protection and overall quality of life. That provided widespread public and political support for the policy measures implemented in Freiburg since 1970 that have restricted car use while promoting public transport, cycling, and walking. The rest of this paper examines Freiburg's transport, land use, and housing policy reforms that account for its turnaround in travel behavior and sustainability gains.

4.3. Evolution of land use and transport policie. Freiburg was almost completely destroyed in World War II. In 1948, the city adopted a reconstruction plan to rebuild the city centre in its old, compact form instead of adopting a modern, car-oriented urban structure (Pucher and Clorer, 1992, City of Freiburg, 2008c). During the 1950s and 1960s, however, Freiburg grew rapidly, with the construction of new neighbourhoods on the fringe of the city, especially toward the Rhine River Plain to

the west, where the terrain is flatter. The new residential and industrial districts were more spread out and more car-oriented than the historic town centre, with wider streets, a more regular street pattern, and more parking facilities. During this period, car ownership and use grew rapidly, causing increased air pollution, congestion, and traffic injuries (Pucher and Clorer, 1992, Gutzmer, 2006, City of Freiburg, 2008c). The city's response was to widen roads and build several new arterial roads, including one that connected the town centre with the autobahn. Many tram lines were abandoned in favour of bus services (Nahverkehr Breisgau, 2008). City land use plans gave top priority to increasing the supply of housing by expanding into previously undeveloped areas. Transport plans focused on the need to accommodate increasing car use, even in the historic city centre, where the main town square was used for car parking (City of Freiburg, 2008c).

In the late 1960s and early 1970s, transport and land use policies in Freiburg began a dramatic shift away from the car. The various social and environmental problems caused by car use—combined with the 1973 oil crisis—evoked a grassroots revolt among the citizens of Freiburg, forcing politicians to adopt a series of crucial policy decisions. The city adopted new plans to restore, expand, and modernize the tramway, to establish an integrated network of separate bicycling facilities, and to turn most of the historic old town into a pedestrian zone off limits to cars. Freiburg's first intermodal transport plan of 1972 emphasized the importance of walking, cycling and public transport for the overall transport system, and the 1979 update of the transport plan explicitly called for favouring those 'green modes' over the car. The 1989 transport plan went a step further by endorsing the overall reduction of car use by restricting car use in the city centre and all residential neighbourhoods.

As transport policies in the 1970s and 1980s increasingly restricted car use and favoured the green modes, land use policies shifted accordingly. In particular, new development was to be concentrated along public transport corridors, especially the city's expanding light rail public transport system, the Stadtbahn (City of Freiburg, 2008c). The most recent land use plan of 2008 reiterates the earlier goals of reducing car use but is more explicit about prohibiting car-dependent developments and even supports car-free neighbourhoods. The plan focuses on high-density development along light rail routes, strengthening local neighbourhood commercial and service centres, and mixing housing with stores, restaurants, offices, schools, and other non-residential land use uses (City of Freiburg, 2008c). Central development is explicitly favoured over peripheral development on the suburban fringe. The city has banned all car-dependent big-box retailers such as home improvement stores, furniture stores, and gardening centres, not only because of the car traffic they generate but also because they draw customers away from central city and neighbourhood retailers.

All future development is to be based on the principle of shortening trip distances to make them more walkable and bikeable, ensuring local accessibility to all the daily necessities of life. The 2008 land use plan further strengthens the priority given to public transport, walking, and cycling over the car. More generally, it adopts the goal of preserving the historical character of the

city and increasing the quality of life and overall attractiveness of Freiburg as a place of residence, employment and tourism.

Photo 1a: Freiburg's Cathedral Square was used as a car park in the 1960s.
Source: City of Freiburg

Photo 1b: During the mid 1970s, cars were banned from Freiburg's Cathedral Square. It is now a lively pedestrian zone with an open-air market.
Source: City of Freiburg

There are two recent examples of the complete coordination of transport with land use in Freiburg. Rieselfeld and Vauban are residential developments built from 1993 to 2009 around newly extended light rail lines (Ryan and Thorgmorton, 2003, City of Freiburg, 2007b, 2008e). Both sharply limit car access and parking. All streets are traffic calmed at 30 km/hr or less. Many streets are designated as home zones, with speed limits set at 7km/hr and traffic priority for pedestrians, cyclists, and playing children. Both communities feature high density and the mixing of residential, commercial, educational, religious, and recreational land uses. They provide a wide range of housing types for low-income as well as affluent households and specifically favour inclusion of women, families, the elderly, and persons with disabilities. Rieselfeld and Vauban feature high quality green spaces, low energy construction methods, solar energy, and rain water re-use (Ryan and Thorgmorton, 2003, City of Freiburg, 2007b, 2008e). The residents of Vauban convinced the city government to go one step further and to accommodate car-free living, banning cars from residential streets altogether and restricting parking facilities to the periphery of the community.

Photo 2a: Klarastrasse in the 1960s. A Street designed for cars, not for people.
Source: City of Freiburg

Photo 2b: Klarastrasse after traffic calming. Today, it is a street that limits car use and thus enhances safety, quiet, and neighbourhood quality of life.
Source: City of Freiburg

Freiburg's transport and land use plans were coordinated with federal, state, and regional transport and land use plans, with the plans of adjacent municipalities, and with local and regional public transport plans (City of Freiburg, 2008c, f). They were developed with extensive citizen participation at every stage and reflect widespread support for environmental protection. As documented in the following sections, the complete turnaround in Freiburg's transport policies resulted in dramatic improvements for public transport, bicycling, and walking, while making car use more expensive, slower, and less convenient.

4.4. Public transport improvements

Freiburg's Stadtbahn, its light rail system, has been the centrepiece of the city's multi-faceted strategy to improve overall transport sustainability. Although a few old streetcar lines were still operating in the 1970s, they were slow and outdated. Construction of the first modern light rail line started in 1978 and was completed in 1983. The Stadtbahn system has since expanded to four lines with a total extent of 36.4 km in 2008 (City of Freiburg, 2009b). From 1983 to 2007, the total supply of light rail service almost tripled, rising from 1.1 to 3.2 million vehicle km (Figure 2). The light rail lines focus radially on the city centre and terminate in various inner suburbs (City of Freiburg, 2009b). Most of Freiburg's population now lives and works within easy walking distance (300 meters) of a light rail line: 65% of

residents and 70% of all jobs (City of Freiburg, 2008f). With further expansions planned, the city's goal is to raise those percentages to 83% of residents and 89% of jobs.

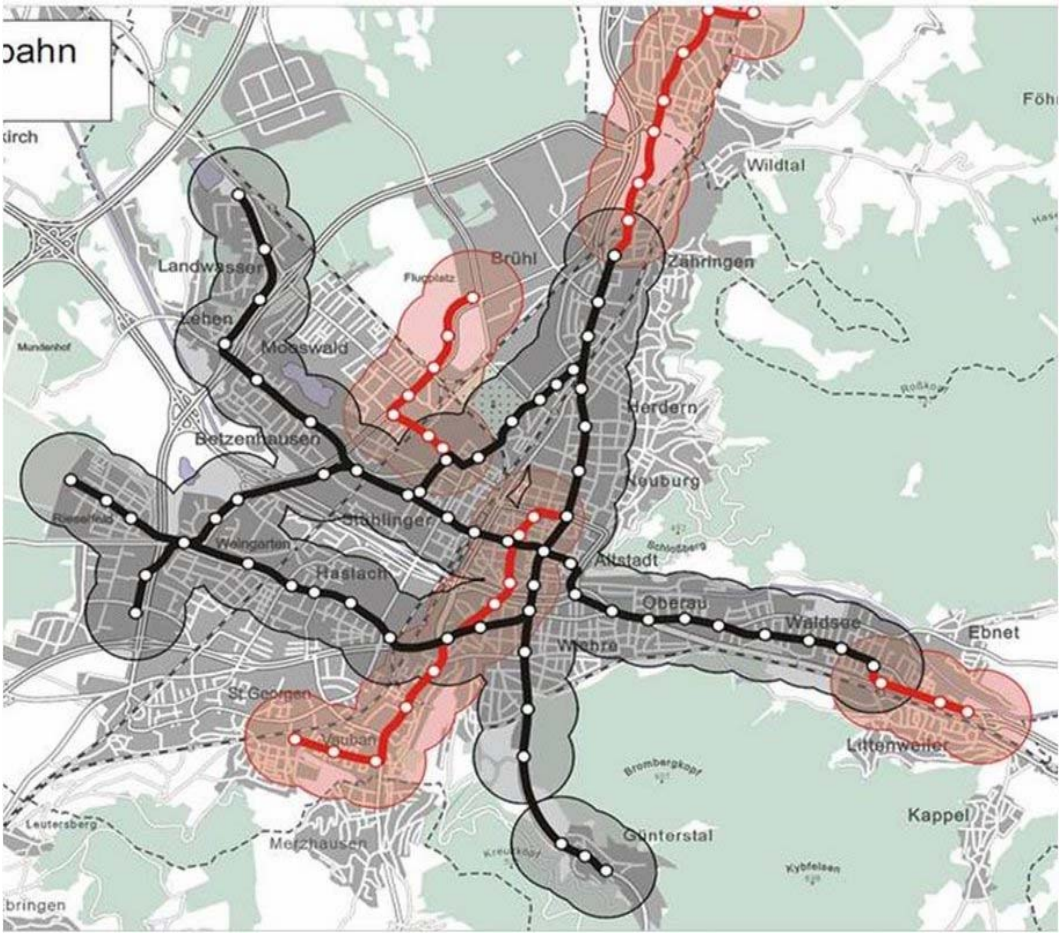
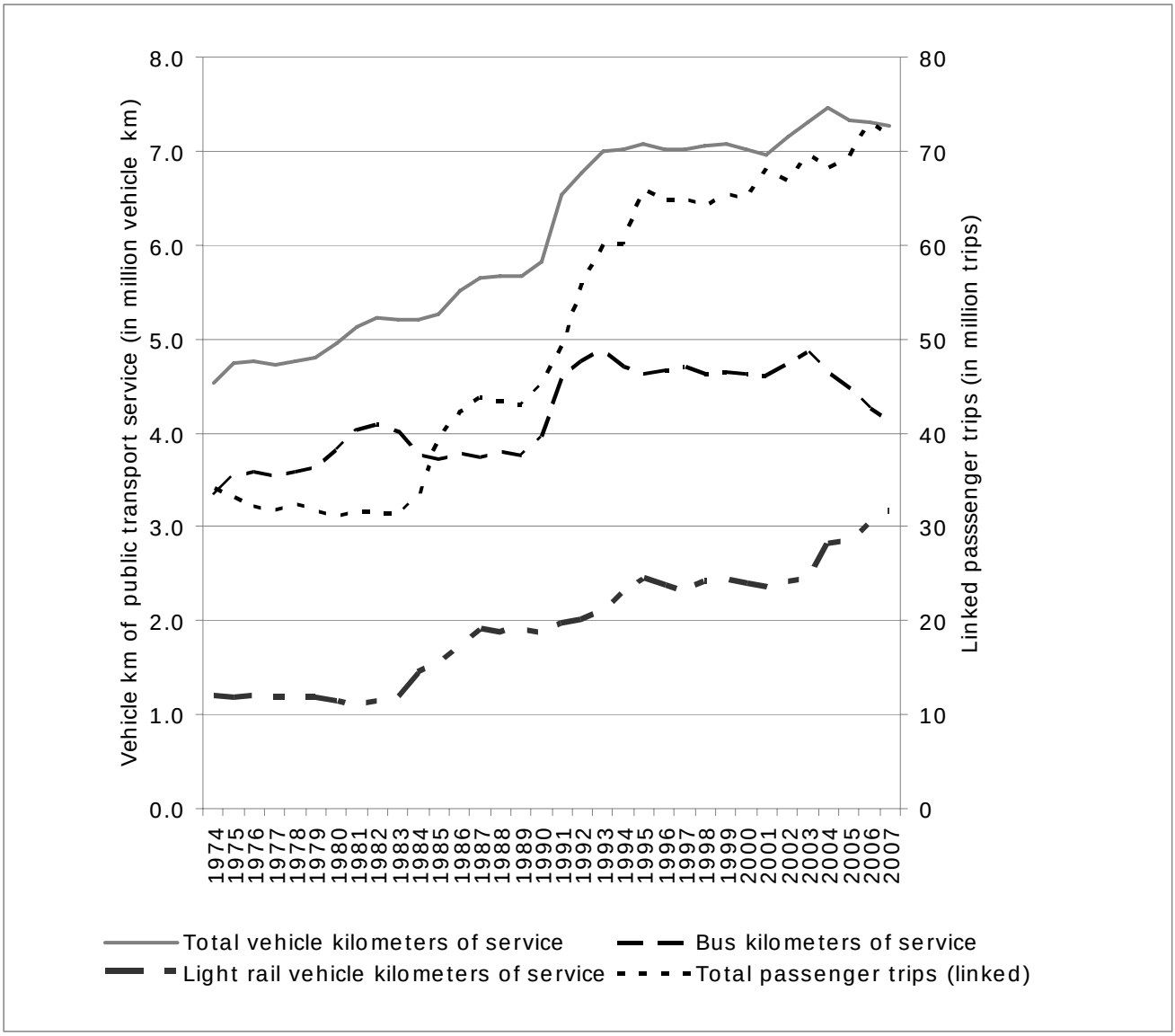


Photo 3: Most Freiburgers live and work within 300m of a light rail stop (grey and red shaded areas).
Source: City of Freiburg

The extent of the bus system has also expanded: from 100 route km in 1974 to 273 route km in 2007 (City of Freiburg, 2009b). Over most of that period, vehicle km of bus services increased, but since 2003 bus services have been cut back as high-volume bus lines are replaced with light rail lines (ZRF, 2003, City of Freiburg, 2009b). The new policy has been to use buses as a feeder mode to bring passengers from outlying neighbourhoods to light rail, which then carries passengers to the city centre. As of 2006, light rail carried 70% of all passenger trips in Freiburg, compared to 30% on buses (Gutzmer, 2006).

Figure 2: Trends in Public Transport Supply and Demand in Freiburg, 1974-2007



(Note: public transport demand reported as linked passenger trips; passengers switching between lines and modes were only counted once)
Source: City of Freiburg (2009b)

As shown in Figure 2, total public transport use in Freiburg fell between 1974 and 1983 (from 34 to 31 million trips), in spite of a considerable increase in bus services. Since the opening of the light rail system in 1983, however, public transport use has risen sharply (City of Freiburg, 2009b). Public transport trips roughly doubled between 1983 and 2007 (from 31 to 72 million passenger trips). Freiburgers average 339 public transport trips per year, or about one per day for each resident. It is the highest rate of public transport use of any German city and four times as high as the German average of 84 (VDV, 2008, City of Freiburg, 2009b).

Freiburg's light rail trains run at intervals of 7.5 minutes or less (Gutzmer, 2006, City of Freiburg, 2008f). They are fully integrated with the city's 26 bus lines, which run every 15 minutes near the centre and every 20 to 30 minutes in outlying areas. Both light rail and buses

in Freiburg benefit from traffic signal priority, with lights turning green for oncoming trams and buses at key intersections. That increases overall public transport speeds. In addition, real-time information is provided on digital displays at light rail stops and key bus stops (ZRF, 2003, City of Freiburg, 2008f, ZRF, 2008).

Photo 4: Freiburg's light rail lines converge in the pedestrian zone, which encompasses the entire city centre. Modern, low floor vehicles, traffic signal priority, and real time information make public transport a convenient, fast and reliable travel option.
Source: John Pucher

The extensive suburban rail and bus services throughout the region are centred on Freiburg and have grown rapidly over the last two decades. Between 1991 and 2005, regional public transport service increased by 24% (from 2.7 billion to 3.4 billion seat kilometers) (ZRF, 2008). Rail services, in particular, have been growing rapidly in recent years, and passenger km of regional rail use rose 6-fold between 1997 and 2006: from 5 million to 31

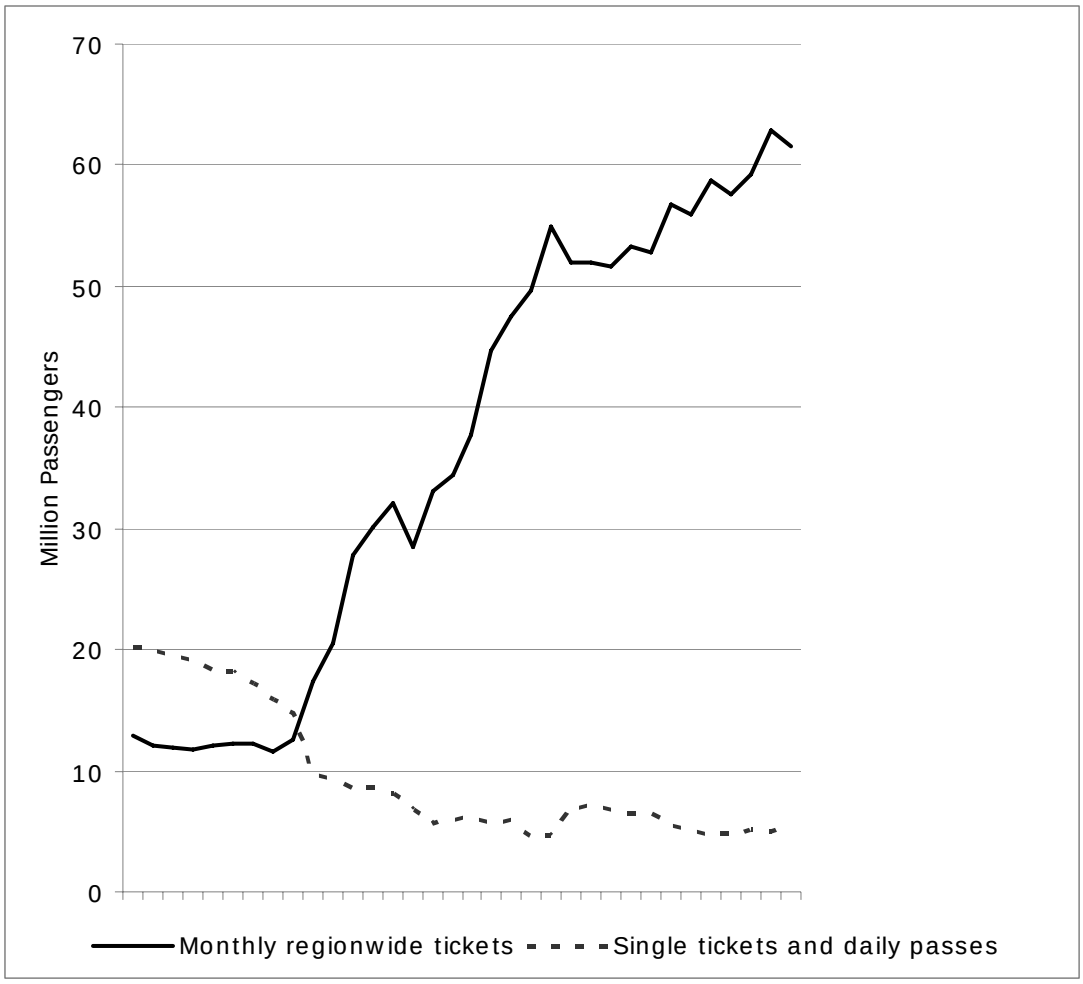
million (ZRF, 2008). Bus services have expanded as well, especially those connecting small towns and villages to regional train stops. Including all public transport services in the city of Freiburg and the surrounding region, demand grew from 57 million trips in 1985 to 109 million trips in 2007, an increase of 89% (RVG, 2008a).

Services, fares, and subsidies for the entire Freiburg region are coordinated by the Zweckverbund Regio-Nahverkehr Freiburg (ZRF), a regional public transport association that includes 187 different bus and rail operators, 90 different lines, and 3050km of routes (RVG, 2008e, g, ZRF, 2008). ZRF serves 625,000 residents in three counties and 75 towns. ZRF sets overall public transport policy in the region and develops an updated public transport plan every five years. It is also responsible for receiving funding from federal, state and local governments and then distributing those funds among the 17 public transport operators to cover investment and operating expenses.

A key aspect of this multi-modal, multi-agency regional coordination is the unified ticketing system, which enables riders to use a single ticket for several trip segments and different types of service. In 1984, Freiburg's VAG public transport system offered Germany's first monthly ticket transferable to other users (Bratzel, 1999, Hilliard, 2006). It was marketed as the 'environmental ticket' (Umweltschutzkarte) to emphasize the environmental advantages of public transport over the private car. In 1991, a region-wide ticket, the RegioKarte, greatly expanded the geographic region covered by the monthly ticket from 153km^2 to 2211km^2 (ZRF, 2008). These monthly tickets have offered bargain fares for regular public transport users (Gutzmer, 2006, RVF, 2006). In 2008 the monthly RegioKarte cost only €45.50, and the annual RegioKarte cost €455 (or €37.92 per month) for unlimited travel within the entire ZRF region. Students can purchase either the discounted €33.50 RegioKarte or the even cheaper Semester Ticket for six months, which costs €69 (or €11.50 per month) (VAG, 2009). For €9.90 a day, holders of the Freiburg RegioKarte can purchase additional unlimited travel throughout the five regional public transport regions immediately adjacent to the ZRF, increasing their travel area to 7235 km^2 (RVF, 2006, RVG, 2008f). Yet another innovation is the RegioMobilKarte, which costs only €47 per month and provides all the benefits of the regular RegioKarte plus car-sharing membership, reduced taxi fares, and discounts on bike and car rentals.

The Umweltschutzkarte introduced in 1984 contributed to the 12% increase in riders between 1984 and 1990, but the RegioKarte introduced in 1991 had an even greater impact (RVG, 2008b). Total public transport trips in the entire ZRF region increased by 70% between 1990 and 2007 (Gutzmer, 2006, RVG, 2008b). Another indicator of the popularity of the monthly cards is that a growing percentage of public transport riders purchase these monthly tickets. As shown in Figure 3, over 60 million of the trips within the city of Freiburg itself relied on the monthly pass in 2007, compared to only 6 million using single tickets or daily passes (City of Freiburg, 2009b). Similarly, 90% of passengers in the entire ZRF region rode with monthly passes in 2005 (RVF, 2006, RVG, 2008d).

Figure 3: Trend toward monthly region-wide tickets in Freiburg, 1974-2007



Sources: City of Freiburg (2009b)

A specific example shows how well public transport competes with the private car, both in terms of cost and time. In 2006, a typical commute from the suburban town of Emmendingen to Freiburg's town centre took 40 minutes by car and 44 minutes by public transport (including walk trips to access stops) (RVF, 2006). With an annual ZRF RegioKarte, the average commuter paid €430 a year. That was only 60% of the annual cost of petrol (€740) for same commute by car, and only 30% of the total annual cost of owning a car and driving daily between Emmendingen and Freiburg (€1570) (RVF, 2006).

One might assume that the massive improvement of Freiburg's public transport system and its extraordinarily inexpensive fare options would have greatly added to government subsidy requirements. On the contrary, the operating subsidy per passenger trip (in constant 2007 Euros) fell from €1.07 in 1984 to only €0.08 in 2007 (Gutzmer, 2006, RVG, 2008c). Currently, Freiburg's public transport system covers 75% of its operating costs from passenger fares, 15% from state government reimbursements for student and elderly reduced fares, and only 10% from direct operating subsidy from the City of

Freiburg, the two adjacent counties, and the state government (RVF, 2008).

There are two explanations for the sharp drop in operating subsidy requirements: reduced costs and increased revenue. According to Freiburg's public transport planners, operating costs per vehicle km of service have been reduced by better coordinating and rationalizing services among all providers, purchasing larger and newer vehicles, and hiring more part-time labour (RVF, 2006, Hildebrandt, 2009). With fuller integration of services, duplicative routes have been eliminated. The fleet of buses and trams has been modernized, thus increasing reliability as well as reducing maintenance costs. Freiburg has opted for articulated buses and trams, which require fewer drivers per passenger. Labour costs have also been reduced by hiring more part-time workers, who can help provide extra service during peak hours. Finally, automatic signal priority at intersections speeds up buses and trams, increasing the vehicle km of service that any given driver can produce.

In Germany as a whole, total labour costs for public transport fell by 10% from 1997 to 2006 (VDV, 2008). Over the same period, the number of full-time employees fell by 26%, while the number of part-time employees rose. Since part-time workers are not paid for a full day, they make it less expensive to provide more frequent service during peak hours (VDV, 2008). There has also been increasing competition among public transport operators, as mandated by the EU regulations that require tendering of all services in an EU-wide market (VDV, 2008). Most regional bus services are already run by private operators, who compete for service contracts and receive no operating subsidy at all. City bus and light rail services and suburban rail services have been streamlining their operations in preparation for competitive service tendering in the coming years.

As costs have fallen, revenues have risen. The doubling of public transport use in Freiburg and its surrounding region has increased the number of passengers per vehicle and thus passenger revenue per vehicle mile of service. That suggests that the demand for public transport is elastic in Freiburg, perhaps due to the many severe restrictions on car use and parking as well as the high cost of owning, driving, and parking a car. As car use is made more expensive, slower, and less convenient, public transport obviously becomes a more attractive substitute for the car. Inexpensive monthly passes in Freiburg have an especially large impact on usage because the time and convenience of public transport services are comparable to those of car use, or even better in some instances. That is confirmed by the previous example of the work commute between Emmendingen and Freiburg.

In Germany, capital investments in public transport are covered primarily by federal and state funds (Rönnau *et al.*, 2002, Scholz, 2006). There are many programs and sources of funds depending on the specific type of capital investment. That makes identifying exact funding streams difficult (Scholz, 2006). Neither state nor local government officials have comprehensive data on capital financing for public transport in the Freiburg region.

Even within a single capital project, funding responsibilities and sources can vary between local, state and federal governments. For example, the ZRF estimates that planning and construction costs for the "Breisgau S-Bahn" regional rail expansion will be €400 million

between 1997 and 2018. Federal and state governments will cover 75% of construction costs. Local governments will fund the remaining 25% of construction costs and pay all planning costs. Overall, state and federal subsidies will cover 60% of project costs (RVG, 2008e, g, ZRF, 2008).

Capital investments for the expansion of Freiburg's light rail network averaged €16 million per year from 2000 to 2007 (Hildebrandt, 2009). According to local transport planners, three further extensions planned for the coming years will require significant increases in funding.

In summary, the total government investment in regional public transport has been large in Freiburg, but it has enabled a significant increase in the quantity and quality of public transport services in Freiburg and its surrounding region. Moreover, operating subsidies have fallen sharply, suggesting that Freiburg's long term investments have paid off financially. Not only has total public transport use increased, but its share of overall travel has also increased. These are impressive accomplishments, even relative to the overall German context of successful public transport.

4.5. Bicycling and walkin. Bicycling has flourished in Freiburg over the past few decades. The total number of bike trips rose from 69,500 in 1976 to 211,000 in 2007, nearly tripling (Pucher and Clorer, 1992, University of Dortmund, 2001, City of Freiburg, 2008f). From 1982 to 2007, the bike share of trips increased from 11% to 28%, the second highest of all German cities, exceeded only by Muenster, which has a bike share of 35% (Pucher and Buehler, 2008). As in most German cities, the share of trips by foot in Freiburg has fallen considerably in recent decades, mainly due to lengthening trip distances as cities have been spreading out. The decline in walking was most pronounced in the 1980s, with the walk share of trips falling from 35% in 1982 to 24%, apparently due to a shift from walking to cycling and public transport. Since 1982, however, the walk share has remained stable and was 23% in both 1999 and 2007.

Although Freiburg seeks to promote both cycling and walking, most of its efforts have focused on cycling. The city expanded its network of separate bike paths and lanes from only 29km in 1972 to 160km in 2007 (FitzRoy and Smith, 1998, City of Freiburg, 2008a). In addition, the cycling network includes 120km of bike paths through forests and agricultural areas, 400km of traffic calmed roads, and 2km of bicycling streets, where cyclists have absolute traffic priority (City of Freiburg, 2008b). In total, there were 682km of bike routes in 2007, and they continue to expand. Perhaps most important, Freiburg's cycling facilities have been fully integrated into a complete bikeway network that permits cyclists to ride on separate facilities or safe, lightly travelled streets between virtually any two points in the city.

The traffic calming of residential neighbourhoods has turned almost all residential streets into good bike routes. Roughly 90% of all Freiburg inhabitants live on the 400km of streets where the speed limit is 30km/hr or less (City of Freiburg, 2008f). Moreover, in 2008 there were 177 home zones, where the speed limit is further reduced to 7km/hr, and cyclists and pedestrians have strict priority over cars (City of Freiburg, 2008f, 2009a).

In addition, about half of the 120 one-way streets in Freiburg are 'falsche Einbahnstrassen,' where cyclists can ride in either direction, while motorists are restricted to one (City of Freiburg, 2008a)

Photo 5a: The Wiwili Bridge in Freiburg ca. 1970. Both lanes were reserved for motor vehicles. The former tram line crossing this bridge was removed in the 1960s.
Source: City of Freiburg

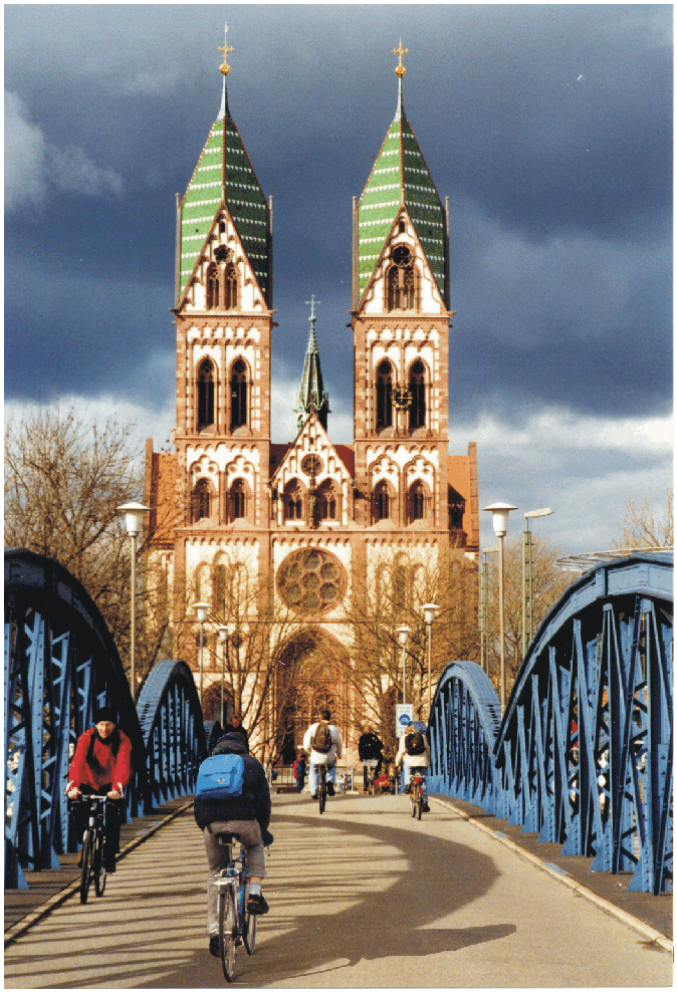


Photo 5b: The Wiwili Bridge today. With motor vehicles banned from the bridge, bicycles have the right of way over the entire width of the roadway. Not visible in this photo, there are pedestrian footpaths to the right and left of the blue steel barriers.
Source: City of Freiburg

Photo 6: Woman cycling in one of Freiburg's 177 home zones, where cars are required to drive at "walking speed" (<7km/hr). German implementation of home zones (Spielstrassen) requires minimal changes to street design and thus are inexpensive.
Source: City of Freiburg

Photo 7: All residential streets in Freiburg are traffic calmed, with a speed limit of 30km/hr or less. This is one of Freiburg's 177 home zones, where the speed limit is further reduced to 7km/hr in order to permit walking, cycling and playing on the street.
Source: City of Freiburg

Over the past three decades, the city has been increasing the supply of bike parking, improving its quality, and integrating it with public transport stops. Between 1987 and 2009, the number of bike parking spaces almost tripled, rising from 2,200 to 6,040 (Gutzmer, 2006, City of Freiburg, 2008f, a). There are now 1,678 bike parking spots at public

transport bike and ride facilities, including 821 sheltered bike racks and 23 secure bike lockers. In addition, there is a major bike station at Freiburg's main train station offering secure, sheltered parking for 1,000 bikes (for €1 per day or €10 per month), bike rental, bike repair, travel advice, and bike shipment to other cities (City of Freiburg, 2008a). Not only does the city provide bike parking directly, but it also requires all new buildings with two or more apartments to provide accessible bike parking (City of Freiburg, 2008d). Building codes require varying amounts of bike parking for schools, universities, businesses, and stores.

The city's three most important approaches to improving walking conditions are car-free zones, traffic calming, and new developments that generate short, walkable trips (City of Freiburg, 2008c). Freiburg was the first German city to create an interconnecting network of car-free streets in its city centre in the early 1970s (Beatley, 2000). The pedestrian zone already covers the entire historic old town and will soon be extended by about 0.5km westward to the main train station, permitting a safe, car-free walking environment between the station and the city centre (City of Freiburg, 2008f).

Photo 8: Interior view of the bike parking garage at Freiburg's main train station, which holds 1,000 bikes and offers bike repairs, bike rentals, and bike touring advice.
Source: Ralph Buehler

Almost all of Freiburg's residential streets are already traffic calmed at 30km/hr or less, and the recent trend has been toward home zones, which further reduce speed limits to 7km/hr. As shown by several academic studies, traffic calming encourages more walking and makes it

safer (Herrstedt, 1992, Webster and Mackie, 1996, Morrison *et al.*, 2003, Tolley, 2003). As described earlier, the city is working to develop more neighbourhoods with a mix of residential, commercial, educational, and recreational facilities so that more trips are short and walkable.

Photo 9: Rathausgasse, part of the extensive car-free pedestrian zone in Freiburg's historic centre. The entire city centre was rebuilt in its historic form after almost complete destruction during WWII.
Source: Ralph Buehler

Freiburg transport planners concede that more needs to be done to encourage more walking (City of Freiburg, 2008f). Some of the new cycling and tramway infrastructure, for example, narrowed pedestrian walkways. The latest plans call for widening some sidewalks as well as improving pedestrian crossings and lengthening the crossing time for pedestrians at signalized intersections. Expansion of Freiburg's pedestrian zone, further implementation of home zones, and mixed-use developments should also promote more walking.

Although Freiburg has ambitious plans for further improving conditions for cycling and walking, it has already achieved a great deal. It has one of the highest non-motorised mode shares in Germany: 50% of all trips were by walking or cycling in 2007.

4.6. Restrictions on car use. Many of the previously discussed measures to promote public transport, bicycling, and walking involve restrictions on car use. Car-free zones and traffic calming are perhaps the most obvious examples. Signal priority for buses, trams, and cyclists also slows down car travel. Even zebra crosswalks restrict motorists who are required to stop for pedestrians.

Since the 1970s, Freiburg has reconfigured its overall roadway network to divert through car and truck traffic onto arterials that bypass residential neighbourhoods as well as the historic centre (City of Freiburg, 2008f). Several key thoroughfares have been either widened or improved in various ways to increase their carrying capacity. Freiburg combines disincentives to car use in the town centre and residential neighbourhoods with improvements in key roadways that actually benefited car users. In this respect as well, Freiburg has carefully balanced the 'stick' and 'carrot' approaches in designing its transport policies (Gutzmer, 2006).

Parking policy is a key aspect of Freiburg's taming of the car (Blatter, 1995). Parking garages are deliberately placed at the periphery of the city centre, thus forcing motorists to walk or take public transport for the remainder of their journeys. In many residential neighbourhoods, parking is reserved for residents only and requires a special permit. On-street parking in commercial areas of the city becomes more expensive with proximity to the centre: €2.20 in the innermost zone, €1.60 in the intermediate zone, and €.60 in the outermost zone (City of Freiburg, 2006, 2008f). Almost all on-street car parking is limited in duration to prevent long-term parking by commuters. Building codes have reduced parking requirements for cars in new residential developments at the same time they increased parking requirements for bikes. As noted earlier, Rieselfeld and Vauban restrict most car parking to the edge of their neighbourhoods in order to prevent the incursion of cars (City of Freiburg, 2008e).

All of these car-restrictive measures implemented at the local level are reinforced by the high taxes and fees levied by the German federal government on car ownership and use, as documented in the first section of this paper. Together, they make car use more expensive, less convenient, and slower than it would otherwise be. That obviously enhances the relative attractiveness of public transport, walking, and cycling. It is the combination of car-restrictive measures with improvements in public transport, walking, and cycling that explains the success of Freiburg in actually reducing car use over recent decades.

5. Conclusions and lessons from Germany. Transport and land use policies help explain the sustainability of urban passenger transport in Germany. In spite of per capita income and car ownership rates that are among the highest in the world, German governments at every level have explicitly encouraged compact, mixed-use developments with excellent facilities for walking and cycling. Similarly, for many decades German public policies have consistently promoted public transport services that are extensive, frequent, convenient, and attractively priced, thus providing a feasible alternative to the car for many trips. At the same time, a wide range of policies in Germany has made car use more expensive and less convenient than in the USA. It is the combination of these policy carrots and sticks that perhaps best explains the greater sustainability of urban transport in Germany. The case study of Freiburg shows how to make urban transport more sustainable:

- Transport policies must be fully integrated across modes of transport and coordinated with land use policies aimed at discouraging car-dependent sprawl.
- Public transport systems must provide integrated, dependable, and convenient services that are priced attractively through discounted region-wide monthly and annual tickets.
- Politicians must garner public support by implementing controversial policies in stages over an extended period.
- Policies must fully integrate public transport, walking and cycling to foster the synergies of these complementary modes of sustainable transport.

- Urban planners and government officials must effectively communicate the benefits of sustainable transport, emphasizing the wide range of economic, environmental and social advantages to everyone.
- Land use and transport policies must be coordinated by planning for compact, mixed-use development that clusters residents and businesses near public transport services and generates a high proportion of trips short enough to cover by walking or cycling.
- Policies must restrict car use and make it less convenient, slower, and more expensive, especially in centre cities and residential neighbourhoods.

Some of the policy measures adopted in Freiburg and in Germany may seem impossible in car-oriented countries like the USA, Australia, and Canada. However, they are likely to become politically feasible as transport problems such as congestion, pollution, energy use, and climate change get so bad that the majority of voters, and the politicians they elect, are finally willing to do something about them. Even now, there appears to be increasing public awareness and political support for energy conservation, environmental protection, congestion relief, traffic safety, financial viability, mobility options, and social equity. There is a growing realization that everyone would benefit from more sustainable transport, and that enhances the political acceptability of the measures needed.

Sudden crises, like the sharp rise in petrol prices in 2008, should be a wake-up call, dramatically demonstrating the importance of sustainable transport system. Many American families, for example, were not able to shift to alternative modes of transport and had to spend an even higher share of their household budget on daily travel. Car-dependence makes transport systems vulnerable to changes in resource availability, threatening the long-term economic viability of cities and countries. By comparison, a transport system with a wide range of travel options, as in Germany, is far more resilient (Newman et al., 2009). Freiburg is a perfect example of a city that is already implementing the measures necessary to adapt to a future with severe resource constraints. The story of its success should be a hopeful and reassuring, showing that a city can flourish by adopting a wide range of sustainable land use, housing, and transport policies. Becoming more sustainable should not be viewed as a burden but rather an opportunity to enhance the mobility of everyone while preserving the environment, conserving natural resources, mitigating social problems, saving money, and even stimulating the economy. One need only visit Freiburg to experience the advantages of sustainability.

Author details:
John Pucher
Rutgers University, New Brunswick, New Jersey, USA
pucher@rutgers.edu
http://policy.rutgers.edu/faculty/pucher

Ralph Buehler
Virginia Tech, Alexandria, Virginia, USA
ralphbu@vt.edu
http://www.nvc.vt.edu/uap/people/rbuehler.html

References:

AAA (2007) Your Driving Costs 2007. American Automobile Association, Washington, D.C.

ADAC (2007) Autokosten 2007. Allgemeiner Deutscher Automobil Club, Munich, Germany.

APTA (2006) Transportation Factbook. American Public Transport Association, Washington, D.C.

Banister, D. (2005) *Unsustainable Transportation*. Routledge, New York.

Banister, D., J. Pucher and M. Lee-Gosslin (2007) Making sustainable transport acceptable. In P. Rietveld and R. Stough (eds.), *Institutions and Sustainable Transport: Regulatory Reform in Advanced Economies*, Edward Elgar Publishing, Northhampton, MA.

BAST (2004) Aktuelle Praxis der kommunalen Parkraumbewirtschaftung in Deutschland. Verkehrstechnik. In B.f. Strassenwesen (ed.), BAST, Bergisch Gladbach.

Beatley, T. (2000) *Green Urbanism: Learning from European Cities*. Island Press, Washington, D.C.

Blatter, J. (1995) Möglichkeiten und Restriktionen für umweltorientierte Maßnahmen im Personennahverkehr - Analyse der Freiburger Verkehrspolitik. *EURES discussion paper*, Institut für Regionale Studien in Europa, Freiburg.

BMVBS (1991-2008) Verkehr in Zahlen. German transport in figures., German Federal Ministry of Transportation and Urban Development, Berlin.

BMVBS (1993) Law and practice of urban development in the Federal Republic of Germany. German Federal Ministry of Transportation and Urban Development, Bundesamt fuer Bauwesen und Raumordnung, Bonn.

BMVBS (2000) Urban development and urban policy in Germany. German Federal Ministry of Transportation and Urban Development, Bundesamt fuer Bauwesen und Raumordnung, Bonn.

BMVBS (2002) Fahr Rad! Ride Your Bike! , German Federal Ministry of Transportation and Urban Development, Berlin.

BMVBS (2004) Mobilitaet in Deutschland - Mobility in Germany Survey. German Federal Ministry of Transportation and Urban Development, Bonn.

BMVBS (2006) Nationaler Radverkehrsplan - National Bicycling Plan. German Federal Ministry forTransportation Building and Urban Development, Berlin.

BMVBS (2008) Rueckblick: Staedtebau und Stadtentwicklung im Wandel - Changes in Urban Planning and Development. German Federal Ministry of Transportation and Urban Development, BBR, Bonn.

Boltze, M. and P. Schaefer (2005) Parkdauerüberwachung und Zahlung von Gebühren. Alternative Systeme. *Internationales Verkehrswesen*.

Bratzel, S. (1999) Conditions of success in sustainable urban transport policy - Policy change in 'relatively successful' European cities. *Transport Reviews* 19, 177-90.

Bratzel, S. (2000) Innovationsbedingungen umweltorientierter Verkehrspolitik. Policy-Wandel am Beispiel der "relativen Erfolgsfälle". Amsterdam, Groningen, Zürich und Freiburg/Brsg. *Zeitschrift für Umweltpolitik & Umweltrecht* 1, 49-79.

BTS (2006) Energy efficiency of the vehicle fleet. Bureau of Transportation Statistics, FHWA, Washington D.C.

Buehler, R. (2008) Transport Policies, Travel Behavior and Sustainability: A Comparison of Germany and the U.S., *Dissertation*, Rutgers University, New Brunswick, NJ.

Bundesregierung (1998) Erster Bericht der Bundesregierung ueber die Situation des Fahrradverkehrs in der Bundesrepublik Deutschland - First Report About the State of Cycling in Germany. German Federal Government, Berlin.

Burchell, R., G. Lowenstein, W.R. Dolphin and C. Gully (2002) Costs of sprawl 2000. *TCRP Report 74*, Transportation Research Board. National Academy Press, Washington D.C.

City of Freiburg (2005) Drucksache G-05/234 Klimakonzept. In C. Council (ed.), City of Freiburg, Freiburg.

City of Freiburg (2006) Parkleitsystem in der Innenstadt. City of Freiburg.

City of Freiburg (2007a) Drucksache G-07/102 Klimakonzept. In C. Council (ed.), City of Freiburg, Freiburg.

City of Freiburg (2007b) The new district of Freiburg-Rieselfeld: a case study of successful, sustainable urban development. In P. Rieselfeld (ed.), City of Freiburg, Freiburg.

City of Freiburg (2008a) Bicycling in Freiburg. City of Freiburg, Freiburg.

City of Freiburg (2008b) Fahrradstrassen. In T. Planning (ed.), City of Freiburg, Freiburg.

City of Freiburg (2008c) Flaechennutzungsplan. City of Freiburg, Freiburg.

City of Freiburg (2008d) Richtzahlen zur Ermittlung der Fahrradabstellplaetze. In Ordnungsamt (ed.), City of Freiburg, Freiburg.

City of Freiburg (2008e) Rieselfeld und Vauban Dokumentation 90ger Jahre. City of Freiburg, Freiburg.

City of Freiburg (2008f) Verkehrsentwicklungsplan Endbericht 2008. In T. Planning (ed.), City of Freiburg, Freiburg.

City of Freiburg (2008g) Verkehrsentwicklungsplan Freiburg Breisgau. City of Freiburg, Freiburg.

City of Freiburg (2009a) Freiburg - Green City. City of Freiburg.

City of Freiburg (2009b) FRITZ Daten Online. City of Freiburg.

DESTATIS (2003) EVS Survey. Destatis. German Federal Office for Statistics., Wiesbaden.

DIFU (2004) Suburbanisation and Urban Development in Germany: Trends - Models - Strategies. DIFU. Deutsches Institut fuer Urbanistik. German Institute for Urbanism., Berlin.

Divall, C. and W. Bond (2003) *Suburbanizing the masses : public transport and urban development in historical perspective*. Ashgate, Aldershot, Hants, England ; Burlington, VT, USA.

DOE (2007) Transportation Energy Intensity Indicators. Department of Energy, Washington, D.C.

Downs, A. (2004) *Still Stuck in Traffic*. Brookings Institution Press, Washington, D.C.

EIA (2008) Weekly International Gasoline Prices. Energy Information Administration, Washington, D.C.

EUROSTAT (2005-2007) Energy and transport in figures. European Commission, Directorate General for Energy and Transport, Brussels, Belgium.

FHWA (1990-2008) Highway Statistics. Federal Highway Administration. FHWA.

FHWA (2004) A Review of Pedestrian Safety Research in the United States and Abroad. In F.H. Administration (ed.), U.S. Department of Transportation, Washington, D.C.

FHWA (2006) Transportation Statistics. Federal Highway Administration, Washington D.C.

FHWA (2009) A Resident's Guide for Creating Safe and Walkable

Communities. In F.h. Administration (ed.), U.S. Department of Transportation, Washington, D.C.

FitzRoy, F. and I. Smith (1998) Public transport demand in Freiburg: why did patronage double in a decade? *Transport Policy* 5, 163-73.

Fuerst, D. and F. Scholles (2003) Landes- und Regionalplanung Teil 1: Verwaltungswissenschaftliche Grundlagen. Institut fuer Landesplanung und Raumforschung., Hannover.

GTZ (2004) Urban Transport Strategy Review: Experiences from Germany and Zurich. Deutsche Gesellschaft für Technische Zusammenarbeit, Eschborn.

Gutzmer, B. (2006) Integrierte Stadt- und Verkehrsplanung in Freiburg im Breisgau. In T. Planning (ed.), City of Freiburg, Freiburg.

Hajdu, J. (1989) Pedestrian Malls in West Germany: Perceptions of Their Role and Stages in Their Development. *Journal of the American Planning Association* 54, 325-35.

Hass-Klau, C. (1993a) Impact of Pedestrianization and Traffic Calming on Retailing: A Review of the Evidence from Germany and the UK. *Transport Policy* 1, 21-31.

Hass-Klau, C. (1993b) *The pedestrian and city traffic*. Belhaven Press, New York.

Herrstedt, L. (1992) Traffic-calming design--a speed management method: Danish experiences on environmentally adapted roads. *Accident Analysis and Prevention* 24, 3-16.

Hildebrandt, A. (2009) Transit Supply in Freiburg. Freiburger Verkehrs AG, Presse und Oeffentlichkeitsarbeit, Freiburg.

Hilliard, L.M. (2006) Integrating the Wheels in Freiburg, Germany. How the right plan, process, and politics can create a balanced transport system., Fehr and Peers Transportation Consultants.

Hirt, S. (2007) The Devil is in the Definitions. Contrasting American and German Approaches to Zoning. . *Journal of the American Planning Association* 73, 436 - 50.

IEA (2008) Energy prices and taxes. International Energy Agency, New York.

Ingram, K.G. and Z. Liu (1999) Determinants of motorization and road provision. The World Bank, Washington D.C.

INKAR (2005) INKAR Database. BBR.

IRF (2007) World Road Statistics. International Road Federation, Brussels.

IRTAD (2006) Traffic safety statistics. International Road Safety and Data Analysis Group, OECD, Paris.

IRTAD (2008) Selected Risk Values for the Year 2005. International Traffic Safety Data and Analysis Group, OECD, Paris.

KBA (2006) Zeitreihe Autobesitz pro Kopf. Kraftfahrtbundesamt, Flensburg.

Koeberlein, C. (1997) *Kompendium der Verkehrspolitik - Compendium of Transport Policies*. Oldenbourg Wissenschaftsverlag, Munich.

Kunzmann, K. (2001) State planning: A german success story? *International Planning Studies* 6, 153-66.

Low, N. and B. Gleeson (eds.) (2002) *Making Urban Transport Sustainable*. Palgrave Macmillan, New York.

Morrison, D., H. Petticrew and H. Thomson (2003) What are the most effective ways of improving population health through transport interventions? Evidence from systematic reviews. *Journal of Epidemiology and Community Health* 57, 327-33.

Nahverkehr Breisgau (2008) Geschichte der Freiburger Strassenbahn und Omnibusse. Informationsportal Nahverkehr, Freiburg.

Newman, P., T. Beatley and H. Boyer (2009) *Resilient Cities. Responding to Peak Oil and Climate Change*. Island Press, Washington, D.C.

Newman, P. and J. Kenworthy (1999) *Sustainability and cities*. Island Press, Washington D. C.

Newman, P., J. Kenworthy and F. Laube (1999) *An international sourcebook of automobile dependence in cities, 1960-1990*. University Press of Colorado, Boulder, Colorado.

NHTSA (2004) Traffic Safety Facts 2002. National Centre for Statistics and Analysis of the Highway Traffic Safety Administration, FHWA, Washington, D.C.

Nivola, P.S. (1999) *Laws of the landscape. How policies shape cities in Europe and America*. Brookings Institution Press, Washington D.C.

OECD (2003-2007) OECD Statistics. Organization of Economic Cooperation and Development, Paris, France.

Oeko Institut (2007) Klimaschutzstrategie Freiburg. City of Freiburg, Freiburg.

ORNL (2005) National household travel survey 2001. Version 2004. Oak Ridge National Laboratories/FHWA.

ORNL (2008) Transportation Energy Data Book. Oak Ridge National Laboratories, Oak Ridge.

Pacione, M. (2007) *Urban Geography: A Global Perspective*. Taylor & Francis, Oxford, UK.

Polizeidirektion Freiburg (2005) Verkehrssicherheitsbericht 2005. Polizeidirektion Freiburg, Freiburg.

Pucher, J. (1988) Urban travel behavior as outcome of public policy. *APA Journal* Autumn 1988, 509-20.

Pucher, J. (1995) Urban passenger transport in the United States and Europe: A comparative analysis of public policies. Part 2. Public transport, overall comparisons and recommendations. *Transport Reviews* 15, 211-27.

Pucher, J. (2004) Public Transportation. In S. Hanson and G. Giuliano (eds.), *Geography of Urban Transportaion*, Guilford Press, New York, 199-236.

Pucher, J. and R. Buehler (2008) Making Cycling Irresistible: Lessons from the Netherlands, Denmark, and Germany. *Transport Reviews* 28.

Pucher, J. and S. Clorer (1992) Taming the automobile in Germany. *Transportation Quarterly* 46, 383-95.

Pucher, J. and L. Dijkstra (2003) Promoting safe walking and cycling to improve public health: Lessons from the Netherlands and Germany. *American Journal of Public Health* 93.

Pucher, J. and C. Kurth (1996) Verkehrsverbund: The success of regional public transport in Germany, Austria and Switzerland. *Transport Policy* 2.

Rönnau, H.J., K.-O. Schallaböck, R. Wolf and M. Hüsing (2002) Finanzierung des oeffentlichen Nahverkehrs. Politische und wirtschaftliche Verantwortung trennen. *Der Staedtetag* 12.

RVF (2006) 15 Jahre Regiokarte. Regio-Verkehrsverbund Freiburg, Freiburg.

RVF (2008) Einnahmen des Regio-Verkehrsverbund Freiburg und den Verlehrsunternehmen im RVF. Regio Verkehrsverbund Freiburg, Freiburg.

RVG (2008a) Entwicklung der Fahrgastzahlen 1990-2007. Regio Verbund Gesellschaft mbh, Freiburg.

RVG (2008b) Entwicklung der Fahrgastzahlen RVF. Regio Verbund Gesellschaft mbh, Freiburg.

RVG (2008c) Freiburger Verkehrs AG Entwicklung Fahrgaeste/Defizit 1980-2007. Regio Verbund GEsellschaft mbh, Freiburg.

RVG (2008d) Gesamtstueckzahl Regiokarte von 1992-2007. Regio Verbund Gesellschaft mbh, Freiburg.

RVG (2008e) Organisations- und Finanzbeziehungen. Regio Verbund Gesellscahft mbh, Freiburg.

RVG (2008f) Preisentwicklung der Regiokarte. Regio Verbund Gesellschaft mbh, Freiburg.

RVG (2008g) Verbandsaufgaben. Reio Verbund GEsellschaft mbh.

Ryan, S. and J. Thorgmorton (2003) Sustainable transportation and land development on the periphery: a case study of Freiburg, Germany and Chula Vista, California. *Transportation Research Part D* 8, 37-52.

Schaefer, K. and E. Sclar (1980) *Access for All: Transportation and Urban Growth*. Columbia University Press, New York.

Schafer, A. and D.G. Victor (2000) The future mobility of the world population. *Transportation Research Part A* 34, 171-205.

Schmidt, S. and R. Buehler (2007) The Planning Process in the US and Germany: A Comparative Analysis. *International Planning Studies* 12, 55-75.

Schmucki, B. (2001) *Der Traum vom Verkehrsfluss: Städtische Verkehrsplanung seit 1945 im deutsch-deutschen Vergleich*. Campus/ Deutsches Museum Muenchen, Munich.

Scholz, R. (2006) Woher kommt das Geld fuer den OEPNV? . *Internationales Verkehrswesen* 58, 222.

State of Baden Wuerttemberg (2008) Jahresfahrleistung im Strassenverkehr 1990, 2000 und 2005 - Stadtkreis Freibrug. State of Baden Wuerttemberg.

Tolley (2003) *Sustainable Transport: Planning for walking and cycling in urban environments*. Woodhead Publishing, Cambridge, UK.

Topp, H. (1994) The role of parking in traffic calming. *World Transport Policy and Practice* 1.

Topp, H. (1993) Parking Policies to Reduce Car Traffic in German Cities. *Transport Reviews* 13, 83-95.

TRB (1998) Consequences of the Interstate Highway System for Transit: Summary of Findings. In T.R. Board (ed.), *TCRP Synthesis Report*, National Academy Press
Washington, D.C.

TRB (2001) Making transit work: Insight from Western Europe, Canada and the United States. Transportation Research Board, National Research Council, National Academy Press, Washington DC.

U.S. Department of Labor (2003) Consumer expenditure survey. BLS, Washington, D.C.

UBA (2005a) Oekologische Steuerreform. Umweltbundesamt, Dessau.

UBA (2005b) Vergleich der Schadstoffemissionen einzelner Verkehrstraeger. Umweltbundesamt, Dessau.

UBA (2005c) Vergleich Der Schadstoffemissionen Einzelner Verkehrstraeger - Comparison of Emissions of Different Modes of Transport. Umweltbundesamt, Dessau.

UBA (2008) Politikszenarien für den Klimaschutz IV. Umweltbundesamt, Dessau.

University of Dortmund (2001) Gestaltungsraeume kommunaler Stadt- und Verkehsentwicklung. Universitaet Dortmund Fachgebiet Verkehrswesen, Dortmund.

VAG (2009) Tickets und Tarife. VAG Freiburg, Freiburg.

VDV (2005) VDV Statistik 2005. Verband Deutscher Verkehrsunternehmen, Berlin.

VDV (2006) Jahresbericht 2006. Verband Deutscher Verkehrsunternehmen, Berlin.

VDV (2008) VDV Jahresbericht 2007/2008. Verband Deutscher Verkehrsunternehmen.

Vuchic, V. (1999) *Transportation for livable cities*. Centre for Urban Policy Research (CUPR), New Brunswick, NJ.

Vuchic, V. (2005) *Urban Transit: Operations, Planning, and Economics*. Wiley & Sons, Hoboken, NJ.

Webster, D.C. and A.M. Mackie (1996) Review of Traffic Calming Schemes in 20mph zones. TRL Report 215., Transport Research Laboratory, Crowthorne, UK.

Wolf, W. (1986) *Eisenbahn und Autowahn: Personen- und Guetertransport auf Schiene und Strasse; Geschichte, Bilanz, Perspektiven.* Rasch und Roehrig, Hamburg.

ZRF (2003) Nahverkehrsplan 2004-2008 des ZRF. Zweckverband Regio-Nahverkehr Freiburg, Freiburg.

ZRF (2008) Mobilitaet fuer die Region. Zweckverband Regio-Nahverkehr Freiburg, Freiburg.

The Importance of Bicyclist Education

Bjorn Haake

Introduction

In their article "At the Frontiers of Cycling" (World Transport Policy & Practice, Volume 13, number 3), John Pucher and Ralph Buehler emphasised the need for a bike path infrastructure that is separated from motorised traffic. Their logic is that more people will start riding their bikes because the perceived risk of riding bikes is lower on a separate facility.

Practical experience and studies have shown that while separate bike facilities decrease the risk of collisions between intersections, they increase risk at intersections (Underlien et al., 2005, p. 2).

Figure 1: The freedom ends at the yield sign - The Netherlands isn't always as nice to bicyclists as is commonly believed.

The Berlin police department, which has a wealth of experience studying cycling safety since the 1980's, says on its website (Berliner Polizei, 2008): "It is certain that guiding the bicyclists on the roadway of the moving traffic leads to better visibility between motorists and bicyclists and can reduce the severe turning accidents with often fatal outcome at intersections or driveways."

Head-on collisions and turning collisions are much more common than a "hit from behind" accident, though cyclists tend to fear the latter the most. Studies (Wachtel and Lewiston, 1994, pp 30-35) have shown that rear-end accidents are one of the least likely types of accidents, particularly in the United States of America.

This article is intended to refine Pucher and Buehler's recommendations into policy that can be applied wherever traffic transportation planning is practiced to increase the safety of cyclists. This article is divided into three parts. The first part includes an analysis of some of the dangers stemming from the nature of separate bike paths. The second part focuses on how these dangers can be minimized. The third part offers suggestions for increasing bicycle ridership.

Part I: Problems in the current bike infrastructure

Current bicycle infrastructure has many inherent problems that can't easily be solved from an engineering point of view. Most often, bike paths are separated from the roadway, without taking into account that this increases crossing traffic streams. We will give some examples to point out these problems.

A.) A closer look at the Pucher/Buehler article

Conflicts with bus passengers

The caption to the picture on page 15 reads that the bike path behind the bus

stop avoids conflicts between passengers getting on and off the buses. But in fact it increases them. In countries where people drive on the right hand side, bus passengers get off on the right. Putting the bike path on the right hand side of the bus actually increases the conflicts of bicyclists and exiting passengers.

The author has practical experience of these kinds of facilities in Freiburg/ Germany and Erlangen/Germany. Passengers stepping off buses rarely are aware of the fact that they are about to step onto a bike path. Especially if they are in a hurry, they will exit the bus quickly, without looking. It is the cyclists' responsibility to avoid a collision with a pedestrian. The bicyclist would have to slow down and possibly stop.

The conflict can be avoided if bicyclists would share the roadway with motorists. That way, they would pass on the left and no conflicts would arise.

Bike path congestion

The picture on page 28 shows a congested bike path, forcing everyone to ride the same speed. It is virtually impossible in this scenario to safely pass other bicyclists. Experience shows that cyclists will pass under unsafe conditions if the infrastructure and rules do not provide a safe means of doing so. In a situation like that shown, the safety of cyclists is reduced because the varying speeds of cyclists are not accommodated.

By sharing the roadway with motorists, faster cyclists can more readily pass slower ones.. This shared-road approach also will make motorists more aware of bicyclists and will increase the sense that the roads can be shared.

It will also help in slowing motorized traffic, which will result in safer bicycle trips for everyone. The latter is especially important, as it will further emphasize the bicycle as a faster means of transportation on short trips, especially in the inner cities.

Safer left hand turns

The photo on the right hand side on page 46 shows one of the downfalls of a bike lane. The person riding behind the first car seems to intend to make a left hand turn, as her hand is out. However, her lane positioning indicates she is turning right or going straight. The conflict in intentional and unintentional signals is likely to confuse the driver of the grey car behind her. The contradiction between her lane positioning and hand signal increases the risk of a conflict with another roadway user.

Practical experience shows that lane positioning when approaching an intersection is a very powerful tool for communicating intended movements with motorists. A hand signal will not make drivers aware enough of the intentions of cyclists. A bicyclist turning left from the rightmost lane is very unpredictable.

This is really not surprising, as the same would be true for cars. Imagine a motorist travelling on the right lane of a four-lane highway. Shortly before an intersection, the motorist uses the left turn signal and crosses two lanes to get into the left-turn lane. Other car drivers would never expect such a manoeuvre.

Predictability is one of the cornerstones of vehicular cycling, described in detail in section II. Two examples should serve as a reminder that predictability is of paramount importance, no matter which continent one is riding on.

Example 1, Santa Barbara, USA:

Approaching a four-way intersection, the cyclist made a clear left-turn signal, but

was riding on the very far right of the travel lane. A car approaching from behind was passing, even though it was very close to the intersection and despite the cyclist making a clear left-turn signal. Had the cyclist ridden further to the left, the motorist would have better registered the intention of the cyclist and stayed behind.

Example 2, Bordeaux, France:
Riding down a four-lane road, the cyclist wanted to turn left. There was only one car approaching, on the left lane. The cyclist gave a clear hand signal to move over to the left lane, but stayed in the right lane. The motorist did not slow down. The cyclist's hand signal was simply not enough.

Had the cyclist moved over into the left lane, the motorist would have either slowed down or moved to the right lane and passed there. This is a difficult manoeuvre for beginning cyclists, but it reduces the chance of getting hit by telegraphing the intentions of the cyclist more clearly and making the cyclist more predictable.

The construct in that photo on page 46 discourages safe, predictable left-hand turns by bicyclists. The only time this will work is when the light is red long enough to allow the cyclist to move over into the front, left-turn pocket. Practically speaking, such a scenario is unlikely to occur. It is very likely that the light changes to green while the cyclist is trying to get to that front box, creating an ambiguous situation.

Education
Page 39 and 49 mention that in most German cities, school children in third or fourth grade will take bicycle safety lessons. While this is correct, it's worth reiterating what the author remembers from the class. The test was divided into a theory part, consisting primarily of learning the relevant traffic signs. It concluded with a written test.

The practical part consisted of training with the local police on a parking lot, with a practical test in the end. There was no on-road training.

Typically, schools are leery of the liability of putting students into on-road maneuvers, so the course was held on a parking lot. But all the students were riding bikes through the city to get to the parking lot in the first place. It would therefore make sense to teach the children proper techniques in what they already do.

The police showed up by car rather than by bicycle. Police instructions included to ride 30 centimeters from the curb, which is certainly not a safe practice.
Education is the most underrated point, and will be examined further on page 10.

B.) Other examples of bicycle infrastructure problems
Confusing right-of-way situations
Figure 1 shows a bike path in Germany. It is a dual direction bike path, e.g. bicyclists heading north (as shown in the picture) are required to ride against traffic. The four-way intersection has no signage, which means that cars appearing from the right hand side have the right-of-way.

Figure 2: Who has the right of way? Bike paths can add unnecessary complexity to traffic situations

The scenario for the bicyclist is interesting. Approaching the intersection he has the right-of-way over the car coming from the left (west). Would he go straight he also would have the right-of-way over cars coming from the north and turning west. But if the bicyclist would want to make a right off the bike path and then go straight across the intersection (towards the east) he would have to yield to cars coming from the right (e.g. south), but would have the right-of-way to cars from the left (e.g. the grey car) and to cars coming from the east, wishing to turn towards the south.

If this seems confusing, it is. But it gets worse. Some argue the bike lane doesn't have the right of way, since there is a (small) curb. In which case the bike path has a different right-of-way rule than the roadway – i.e. it is not accompanying the roadway in a legal sense, one of the prerequisites to make the bike path mandatory…

Unnatural right-of-way situations

Imagine you drive in a car and you wanted to go straight and the straight through lane would be on the right hand side of the right – turn - only lane. Would this make it easy for someone to turn right? Would it make you feel comfortable to go straight? Would it matter if it would happen at slower speeds?

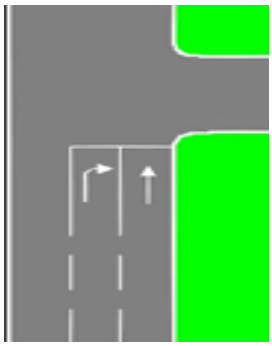


Figure 3: Does this make sense? (Graphic courtesy of Klaus Müller)

But this is exactly how separate bike paths work.

The fact is that unnatural behavior is awkward and often dangerous. This applies to both motorists and cyclists.

The following picture shows Drachten, Netherlands, and a bus driver not seeing the cyclists. The cyclists have the right of way but by putting them away from traffic bus drivers are unable to see them.

An intermediate report on bicycle accidents (Alrutz and Prahlow, 2008, p 9) in Freiburg stated that from four fatal commercial truck/bike accidents, three were likely caused by the "blind spot" problem – such as shown in Figure 4.

Figure 4: Who would expect to be passed from the right hand side?

Maintenance neglect

Bike paths will usually look nice and shiny when they are newly built. But bike paths will be first to be cut from any available funding in a community. There are numerous examples of neglected bike paths all over Europe. The pictures show some bike paths in the Netherlands – pictures usually not to be found in articles praising the advantages of bike paths. These are by no means the worst example to be found. The interested reader with a sense of humour should check out the Warrington Cycle Campaign (Warrington Cycle Campaign, 2008 – Facility of the month link).

The problem is that when maintenance stops, bike paths can become a serious safety hazard, as the following photos show.

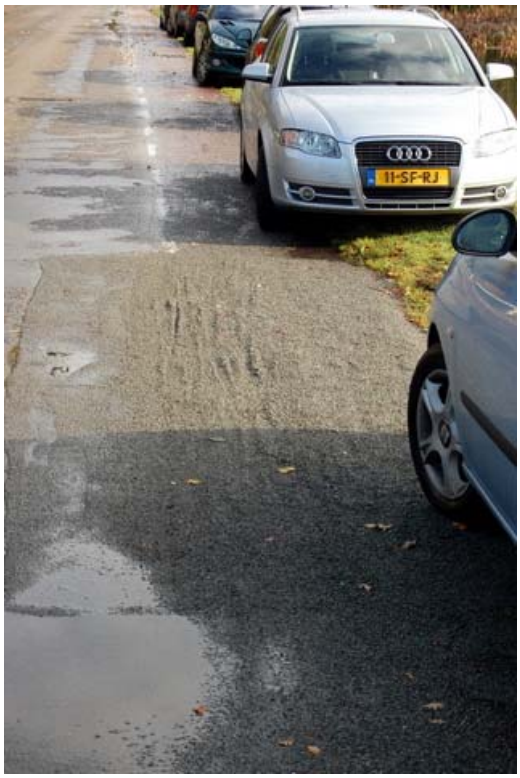


Figure 5: This bike path is badly maintained, and due to its location inside the zone of opening car doors is also unsafe to use.

Figure 6: Slippery when wet - and who knows if there is a gully hiding underneath?

Construction costs (versus cycling class costs)

The building of a completely separate (class I[1]) bike path can cost $1.3 million per mile (Roseville, 2008, p. 51). Even the simple signing and striping of a bike lane costs $60,000.

Based on current class costs of $40 per student for the onroad bike classes in Roseville, the striping of one mile of bike bath could teach 1,500 students! As shown, separate facilities are much more expensive. Three miles of a class I bike path would finance bike classes for the entire city of Roseville! Because the classes are very successful and all graduates say they ride with more confidence, the impact of such an outreach should not be underestimated.

Also, building bike paths is a long and arduous process that will take many years to complete. Roseville has built 10 miles of class I bike paths between 2002 and 2007. A class that will make riders more confident in traffic takes about eight to nine hours. [1] Class I: Separate bike paths that are away from traffic, with a minimum number of road crossings.

Part II: Vehicular cycling

One of the big advantages of countries that do not have a separate bicycle infrastructure is that bicyclists get to use the same roads as motorists and as a result, enjoy the same convenience of those roads. There are fewer problems with cars or other obstacles blocking the path. Because when such obstacles are encountered on a separate bike path with a high curb, then it is sometimes necessary to get off the bike and walk it around the obstacle. When bicyclists are on the road, they can steer around obstacles just like a motorist.

Bike paths are generally less well maintained than the road (see). They are cleared of ice and snow in the winter sooner than the side paths. In fact, the German traffic code says that if the bike paths are not clear from ice, then bicyclists can ride on the road. The opposite doesn't exist and based on practical experience, it is generally true that bike paths are cleared later or not at all from snow and ice, compared to roadways.

One approach for cyclists to share the roadways effectively is known as *vehicular cycling*. One of the early advocates was John Forester (Forester, 1992), who nicely summed it up in one sentence:

Cyclists fare best when they act and are treated as drivers of vehicles.

Vehicular cycling is based around the following principles:

- Predictability
- Visibility
- Assertiveness
- Obeying traffic laws
- Lane and intersection positioning
- Communicating with others

Having a detailed look at vehicular cycling is impossible in this article, but because it is an integral part of safer bicycle riding and a compelling alternative to separated cycling facilities when combined with roadway design that supports safe integration of bicycles and motor vehicles, it deserves a short overview.

Predictability

Nobody likes (negative) surprises, and traffic participants are no exception. If you have ever been cut off by another motorist you will probably agree. The same holds true for bicyclists. It is always the unexpected that causes trouble. A bicyclist going the wrong way. A bicyclist riding at night without proper lighting equipment. A bicyclist making a sudden lane change, especially without looking back first.

Some people ride their bicycles against the flow of traffic, arguing they can see the oncoming traffic better. They fear a rear-end accident. This leaves the bicyclist vulnerable at every intersection and driveway. Motorists often do not expect traffic from the wrong side of the road and do not pay attention to it.

If bicyclists govern their behaviour with the same principals as motorists that follow the traffic code, there would be far fewer conflicts between the two groups. The Roseville Bike Master plan shows that during the six-month period from August 2006 to February 2007, there were 19 bicycle accidents. Eight involved wrong-way riding and ten involved sidewalk riding (Roseville. 2008). While sidewalk in Roseville is legal in most places, the statistics confirm that it is not a safe way of riding. Sidewalk riding is similar to bike path riding.

Visibility

Visibility is very important, but is not limited to a lighting system. A lighting system is certainly very necessary when

riding in poor visibility conditions and its usage is mandatory in many western countries.

But visibility extends to broad daylight as well. It is noticeable that some cyclists are afraid of traffic, trying to make themselves as small as possible. They may ride as close to the right as they physically can. This makes them much more likely to be overlooked by motorists. Motorists can better respond to cyclists when the motorists can see the cyclists.

Many people find cycling where motorists can see a cyclist counter-intuitive, but positioning a cyclist for visibility provides motorists much more time to respond appropriately (by slowing, giving way, etc.). This minimises the chance of side swipe or rear-end accidents – the ones cyclist typically fear the most. They already happen much less frequently than other types of car-bike accidents. In a Palo Alto study (Wachtel and Lewiston, 1994) out of 314 bicyclist-motorist collisions, there were five from behind (1.6 %). With proper riding techniques, these accident rates can be further reduced.

Assertiveness

This is the point that beginning cyclists often struggle the most with. Cyclists not comfortable in traffic often will ride hesitantly. This can increase dangerous situations.

For example, imagine the following scenario. A bicyclist approaches an intersection and a motorist waits on the street coming from the cyclist's right. The bicyclist has the right of way. Some bicyclist will stop pedalling and slow down. This in turn may signal to the motorist the bicyclist is slowing to make a turn and therefore the motorist pulls out.

In this case it would be better to keep pedalling at a high cadence and not unnecessarily slow down. It is of course always good to check if the motorist is paying attention and be ready to hit the brakes.

Assertiveness does not mean aggressive. It just means to ride in a more intentional manner to avoid ambiguous situations.

Obeying traffic laws

Traffic laws exist to keep traffic flowing smoothly and safely. If everyone drove as they pleased, it would be impossible to make headway. This is true for any kind of vehicles – the "Vienna Convention on Road Traffic" (United Nations. 1968, p5) had the foresight in 1968 to define the bicycle as a vehicle with the same rights and responsibilities. The major offences – wrong-way riding and running red lights – should be ticketed to increase bicycle safety.

Lane, speed and intersection positioning

Lane positioning is very important for safe bicycling. Especially in Europe, many lanes are narrow, not allowing for safe in-lane passing. However, some cyclists will encourage in-line passing by riding as far to the right as they possibly can. This can lead to a motorist to attempt passing without enough space and create dangerous situations.

Intersection positioning is also important to avoid confusion. A motorist approaching an intersection on a four-lane road would confuse everybody in the attempt to make a left hand turn from the rightmost lane. The same principle applies for bicyclists. Whether in an automobile or on a bicycle, gradual lane changes to the rightmost lane that serves the destination keep intentions

clear and allow traffic to accommodate the changes without increased danger.

Communicating with others

Things are easier when we communicate well. It's common to see motorists or bicyclists do sudden, unexpected maneuvers. As a bicyclist, it is much easier to communicate with other roadway users because our body is more visible than a motorist's.

Next time you ride a bicycle in traffic, try turning your head to look back at the driver of the car behind you. (Practice this maneuver in a parking lot first if you cannot maintain a straight line while doing so.) You will notice that you get the attention of the driver behind you. This is an effective means of opening a line of communication, and typically results in a slower-driving, more alert motorist. Hand signals can complete the communication by clearly expressing intention.

Part III: Proposing viable solutions

Education

A review of Pucher and Buehler's article shows the authors do not believe spending money to separate bicycle and motor vehicle traffic is the sole solution. In the USA, the League of American Bicyclists (www.bikeleague.org) offers classes to help people understand the concept of vehicular cycling. The goal is to get people to ride comfortably in traffic.

The classes are successful, and most graduates say they feel more confident riding in traffic after taking the course.

The increase in gas prices has caused more people to ride their bikes. Especially for those who have not ridden in traffic for years, such a class can be very beneficial.

Not many people would advocate driving a motor vehicle without proper driver's education. Today's traffic has complex rules, but some bicyclists don't feel the need to follow them. Education could help to increase awareness that if everybody follows the rules, traffic will become smoother and safer.

A proper education should be given to bicyclists. Hopping into traffic may have worked years ago, when fewer cars were on the road. But in today's complex traffic situations, bicyclists can easily be overwhelmed, and ignorance of traffic rules and laws becomes an increasingly disturbing source of accidents.

Students of the author's classes have generally felt safer and more confident riding in traffic. In the classes conducted in 2007, there was only one student that was not comfortable riding on the road (and only attended the first class). All the others felt confident enough to lead the ride.

Bike classes in schools

Germany has made a good start with bicycle classes for third or fourth graders, but the classes often have poor quality because they are not taught by people with bicycle knowledge.

In the USA, it would be very helpful to teach vehicular cycling practices in schools. The scope of such education should be expanded when the kids are older, for example in 10th grade.

Shared Space

Traffic planners should also work to create shared spaces, where motorists, cyclists and pedestrians work with each other, rather than against the other groups. This concept was made very popular by Dutch traffic engineer Hans Monderman.

Monderman advocated that traffic participants should pay attention to each other, rather than to traffic signs. His traffic designs removed signs like stop signs, yield signs and stop lights.

In Drachten, Netherlands, it seems that motorists and bicyclists are more aware of each other, although there are still separated bike paths, with all its dangers (see Figure 4).

Tighter inner cities

Rather than looking into spending a lot of money on bicycle infrastructure, concepts need to be developed to design cities that make cars less attractive to use in the first place. This will be far more beneficial to bicycling than spending a lot of money on infrastructure.

Gent, Belgium, is good example. Even though it could be improved for cyclists (besides many dangerous side paths, bicyclists are also allowed to ride against one-way streets, even when they are too narrow), the tight inner city discourages driving. The only problem is that there is too much parking available.

Gent is indeed a great city for walking and it has a decent public transportation system.

More selective bike facilities

There are cases of good bicycle facility designs, mostly in inter city traffic. These should be the ones to focus, rather than building a large number of facilities, just to claim success in the pro-bicycling community.

In Germany, many farmer's roads for field access are open to bicyclists, but are closed to general motor traffic. These are great connections between cities and they don't cost any money to build.

Rivers also have good separate facilities, such as the American River Bikeway, between Folsom and Sacramento, in California.

It is much more difficult to create separate paths inside a city. It is inevitable that bicycle and motor traffic will cross at intersections. The strategies to decrease accidents at those intersections should be highlighted

Summary

In order to increase the number of bicyclists, it is of utmost importance to provide the necessary education. Even in many so-called bicycle-friendly countries in Europe, like Germany, the Netherlands or Belgium, dangerous behaviour from cyclists can be seen frequently. Educating cyclists will be far more beneficial than spending a lot of money on a concept that has been proven to be dangerous over four decades in Europe.

Spending money on bike facilities should be limited to those paths that really make sense (mostly inter city traffic). Paths that do not help to increase bicycle safety, should be avoided to use the money in other areas needed. In times of a world-wide financial crisis, fiscal responsibility is a good thing.

Every rider that has graduated from the Roseville Bike Safety Classes have said that they feel more confident. Spending resources on education to increase the number of bicyclists seems a more appropriate use and will help to not only increase the number of bicyclists, but will help keep them safe.

Author details:
Bjorn Haake
League of American Bicyclists Cycling Instructor #1436
bjhaake@yahoo.com

Reviewed by David Allen, League of American Bicyclists Cycling Instructor #1644 (dmallen100@yahoo.com) and Chris Ewers, League of American Bicyclists Cycling Instructor #1643

References:

Alrutz, Dankmaar and Prahlow, Heike. 2008. "Radverkehrssicherheit in Freiburg". Hannover, Germany

Berliner Polizei. "Wissenswertes zum Straßenverkehr" http://www.berlin.de/polizei/verkehr/liste/archiv/28671/. Accessed October 25, 2008

Forester, John. 1992. Effective Cycling. MIT Press, USA.

Roseville. 2008. Bike Master Plan update. Roseville, California, USA.

Underlien, Søren; Rosenkilde Claus; Jensen Niels. 2005. Road safety and percieved risk of cycle tracks and lanes in Copenhagen. Road & Park, City of Copenhagen, Denmark. (http://www.trafitec.dk/pub/Road%20safety%20and%20percieved%20risk%20of%20cycle%20tracks%20and%20lanes%20in%20Copenhagen.pdf)

United Nations. 1968, Convention on Road Traffic. Economic commission for Europe, Vienna.

Wachtel, Alan; Lewiston, Diana. 1994. Risk Factors for Bicycle-Motor Vehicle Collisions at Intersections. ITE Journal, published by the Institute of Transportation Engineers. Palo Alto, CA, USA.

Warrington Cycle Campaign. 2008. http://www.warringtoncyclecampaign.co.uk/. Website accessed on December 1, 2008.

Cycling for a Few or for Everyone: The Importance of Social Justice in Cycling Policy

John Pucher, Ralph Buehler

Introduction

In his article "The Importance of Bicyclist Education," Bjorn Haake, a professional cycling trainer, criticizes the research findings reported in our article "At the Frontiers of Cycling" (Pucher and Buehler, 2007). Our case study analysis of cycling trends and policies in six cities and three European countries concluded that a multi-faceted approach is the most effective way to encourage cycling. In particular, Haake rejects our finding that an integrated, comprehensive network of well-maintained, well-designed cycling facilities, such as bike paths and lanes, is a key element in any package of policies to promote cycling.

At the outset, we would like to emphasize that separate cycling facilities should not be the only approach to encouraging more cycling and making it safer. Our research shows that such facilities are not sufficient but must be complemented by a host of other measures, such as:

- Improving roadway design to facilitate cycling on roads without separate cycling facilities (e.g. fixing potholes, clearing of debris, wide outside lanes, bike-friendly drain grates, etc.)
- Ample bike parking, including secure and sheltered facilities
- Full integration of cycling with public transport
- Comprehensive traffic education and training of both cyclists and motorists
- Severe penalties for motorists who endanger cyclists, especially in those cases resulting in serious injury or death
- Traffic priority for cyclists at intersections, combined with various intersection design modifications to mitigate car-bike conflicts at crossings
- Promotional, marketing, and informational events to generate enthusiasm and wide public support for cycling
- Restriction of car use, especially in residential neighbourhoods and city centres
- Greatly increased taxes and fees on car ownership, use, and parking to reflect the high social and environmental costs of the car
- Land use policies that discourage low-density suburban sprawl and foster compact, mixed-use developments that generate shorter and thus more bikeable trips.

Importance of bicyclist education

As readers can confirm, our cycling publications have always emphasized the crucial role of education and training, both for cyclists and for motorists (Pucher, 1997; Pucher et al., 1999; Pucher and Dijkstra, 2000 and 2003; Pucher, 2001; Pucher and Buehler, 2005, 2007, 2008a, 2008b). We have never expressed opposition to the sort of on-road cycling training offered by professional cycling trainers such as Haake.

Moreover, our research highlights the importance of comprehensive, mandatory cycling training for all school children so that they can have the necessary cycling skills and knowledge even at a young age. Haake criticises the cycling training

efforts in Berlin's schools. On the basis of his personal experience as a child, he maintains that there is only theoretical and off-road training of schoolchildren. Our own survey indicated that many Dutch, Danish and German cities do indeed offer on-road training, accompanied by a police officer. Even in those cities where on-road instruction is not offered, surely it is preferable to provide schoolchildren with at least theoretical and off-road cycling training rather than nothing at all, as in American cities.

As so often in his critique of our article, Haake finds one or two specific examples of problems with this or that program and then condemns the entire category of such programs on the basis of a few particular instances of problematic implementation. The solution to inadequate training programs in schools is improving them, not eliminating them. We did not claim in our article that the cycling training in Dutch, Danish, and German schools is perfect, but surely it is better than nothing at all. And since it is already in place and accessible to every young schoolchild free of charge, it is surely the best basis for any improvements.

Haake claims that the only good cycling training is the kind of on-road cycling training that he and his fellow trainers offer, with their exclusive focus on cycling together with vehicular traffic on regular roads. Surely, this is also an important skill, and such training programs make a contribution to overall cycling safety, but they cannot be the only answer. Although such vehicular cycling training courses are offered in many cities in North America, only a tiny percentage of cyclists take such courses on a voluntary basis. Thus, limiting cycling training to the sorts of courses that Haake teaches would reach only a minute percentage of the population. By comparison, the cycling training courses offered in the Netherlands, Denmark, and Germany reach almost all schoolchildren by the 3rd or 4th grades. Whatever their limitations, there can be no question that they have far more impact than the fee-based, voluntary courses offered by Haake, however good those on-road training courses might be. Social justice is also at issue here, since cycling education in the schools is free and available to all, while the vehicular cycling training courses offered by Haake usually involve a charge.

Haake claims that his cycling courses are successful, since many participants report feeling more comfortable cycling on roads after completing the course. It is important to note that those participants voluntarily sought out his on-road bicycle training course. Thus, Haake observes individuals who were committed to on-road cycling before the course even began. This self-selection of participants undermines the validity of his conclusion. Few Americans would even consider taking the sort of on-road cycling course offered by Haake and his colleagues. Most people would feel uncomfortable looking backward while cycling forward, a technique that Haake teaches his students and considers essential to vehicular cycling skills.

Importance of motorist education and law enforcement

In his critique, Haake ignores the equally important problem of inadequate motorist education and training. As we have documented in all our publications, it is crucial that motorist training and licensing procedures focus on the need for motorists to share the road with cyclists and to avoid endangering them.

In fact, that is a central part of motorist education and testing in the Netherlands, Denmark, and Germany, while it is totally neglected in the USA. Furthermore, it is crucial that the legal rights of cyclists on roadways be strictly enforced, and that motorists who violate them be punished in a meaningful way to reinforce what is taught in driver training. The police and courts in the USA have almost entirely ignored cyclists' right to be protected from motorists while riding on the road (Komanoff, 1999). Even in cases where motorists are unquestionably at fault, summonses are rarely issued to motorists for causing crashes that kill cyclists.

In short, we find Haake's call for focusing solely on on-road cyclist training too narrow. Traffic education must be far more comprehensive, including both cyclists and motorists. And it cannot be limited to vehicular cycling training courses for adults but must start with schoolchildren, as in northern Europe, at an age young enough that children can cycle to school on a daily basis and continue cycling for the rest of their lives.

Separate cycling facilities

Haake acknowledges the potential of separate cycling facilities between cities or in rural areas, and specifically cites the American River Trail near Sacramento, California. However, he opposes any sort of separate cycling facilities within cities, where almost all daily trips are made. There are many different kinds of cycling facilities, which vary in location, design, and degree of separation from other modes. Depending on cost, space availability, and roadway traffic conditions, different facilities are appropriate in different situations. There is no universal consensus on the exact terminology, but the general categories of cycling facilities include the following:

- ***Urban cycle tracks***, which are bike-only on-road lanes protected from motor vehicle traffic by barriers of various sorts. Such cycle tracks provide separation from both pedestrians and motor vehicles while keeping cyclists in view of motorists to a greater extent than bike paths (sidepaths) on the sidewalks.
- ***On-street bike lanes*** that are not protected by physical barriers and are often blocked by double-parked cars, delivery vehicles and endangered by car doors being opened into the path of on-coming cyclists. The main advantage of such lanes is that they are cheaper and easier to build and place the cyclist in view of motorists. Their main disadvantage is that they provide no physical protection at all from motor vehicles.
- ***Protective lane striping for cyclists*** ("Suggestivstreifen" or "Angebotsstreifen" in Germany), which are similar to bike lanes but narrower (due to space limitations on the particular roadway) and are demarcated by dashed striping instead of a solid stripe. They provide less protection than a full bike lane, but help signal the presence of cyclists to motorists.
- ***Combined bus-bike lanes,*** which are extra-wide lanes for accommodating both buses and cyclists, common in many northern European cities.
- ***Bike paths on sidewalks (sidepaths)***, which have a distinctive pavement or color to demarcate them from the footpath.
- ***Off-road bike-only paths*** parallel to urban roads but set off from the

roadway and completely separate from footpaths.

- ***Bike-only paths through parks***, forests, and open space, sometimes referred to as green cycle tracks
- ***Shared-use paths (often in parks)*** that are separated from motor vehicle traffic but permit use by pedestrians, joggers, in-line skaters, skateboarders, rollers, and various other non-motorized users.
- ***Bicycle streets*****,** which are common in many northern European cities, and give cyclists absolute right of way priority over the entire width of a narrow urban street with light traffic. Car use is permitted provided it is at very low speed and does not interfere with cyclists.
- ***Bike boulevards*****,** which are being implemented in North American cities, generally on lightly traveled roads with minimal truck traffic, and with specific signage directing motorists to share the road with cyclists. While bicycle streets in Europe give cyclists absolute priority, bike boulevards simply emphasize cyclists' equal rights to the road with pavement markings and signage.
- ***Traffic-calmed residential streets*****,** which reduce speed limits to 30km/hr in Europe (20mph in the UK), both by posting reduced speed limits and by various kinds of physical modifications to roadway to prevent high speed use by motor vehicles. The greatly reduced speeds and light traffic volumes make these traffic calmed streets ideal for cycling without any special cycling facilities of any kind.
- ***Super traffic-calmed residential streets,*** called Woonerfs in the Netherlands, Spielstrassen in Germany and Home Zones in the UK. Speeds are further reduced in these zones to walking speed (officially 7km/hr).
- ***Bike boxes, advance stop lines, special bicycle traffic signals, special marking and coloration of bike lanes, and various other intersection modifications are also an integral part of the overall cycling network infrastructure.*** European cities have been constantly improving the design of these intersection facilities for cyclists to improve safety, especially by reducing the problem of conflicting traffic streams at intersections.

Haake rejects virtually all of these special cycling facilities in cities as unnecessary, inconvenient, and dangerous. Similar to Forester (1992), Haake insists on one and only one way to bike: vehicular cycling. According to this approach, all cyclists should be forced to learn to operate their bikes as they would motor vehicles and ride in mixed traffic on roadways, even on urban arterials. No special protection or physical separation is to be allowed for cyclists, regardless of the speed and volume of motor vehicle traffic, the presence of large vehicles such as trucks and buses, and the carelessness or outright hostility of motorists toward cyclists on the roadway. Haake cites a few anecdotal examples of cycling facilities that are badly designed or poorly maintained. He explains why specific cases of such facilities are unsafe and inconvenient, and then concludes that all separate cycling facilities are unsafe. For example, Haake shows a photo of a bike path covered with leaves one particular day in autumn and suggests that all bike paths are poorly maintained. One could just as easily

show a photo of a roadway perforated by dangerous potholes or littered with glass, trash and other debris. Both are specific examples of bad situations but hardly provide proof of a general problem. There can be no question that some cycling facilities are badly designed and poorly maintained. But many roads are also badly designed and poorly maintained. The solution is to work on improving the design of both cycling facilities and roads, not doing away with them.

The more general argument of Haake is that separate cycling facilities, by their very nature—even if well maintained—are intrinsically unsafe and inconvenient, and thus should rarely if ever be built, although Haake makes the exception of inter-urban trails. He provides no empirical evidence to back up his views. He makes a variety of theoretical arguments about the dangers of separate facilities and cites a few especially egregious examples of badly designed facilities. But he does not provide a comprehensive statistical analysis that actually measures cycling speed, volumes, and safety in a large sample of representative facilities.

In fact, the overwhelming evidence is that cycling is much safer and more popular precisely in those countries where bikeways, bike lanes, special intersection modifications, and priority traffic signals are the key to their bicycling policies. As shown in our article "At the Frontiers of Cycling," the modal split share of cycling is more than ten times higher in the Netherlands (27%), Denmark (18%), and Germany (10%) than in the USA, where less than one percent (0.9%) of urban trips are made by bike. Moreover, the fatality rate per 100 million km cycled is almost six times as high in the USA (5.8) as in the Netherlands (1.1) and over three times as high as in Germany (1.7).

Haake does not dispute these statistics, and he cannot explain away the greater safety and popularity of cycling in northern Europe. If bikeways and bike lanes are so dangerous, slow, and inconvenient—as he claims—then why is cycling overall so safe and popular in the Netherlands, Denmark, and Germany? Conversely, if vehicular cycling is so much safer, faster, and more convenient, then why is cycling so unsafe and so unpopular in the USA? Vehicular cycling, as Haake points out, is already possible on most urban roads in the USA (except limited access highways). Yet with vehicular cycling already possible, and with Forester-inspired 'effective cycling' classes offered all over the country, cycling still accounts for less than one percent of all trips.

Within the USA, Davis (California), Portland (Oregon), and Boulder (Colorado) are famous for their extensive systems of separate bicycling facilities. Moreover, they are the only three American cities that have earned the coveted "platinum" level status awarded by the Bicycling Friendly Community program of the League of American Bicyclists—for which Haake himself is a cycling trainer. Davis, Portland, and Boulder all have high cycling rates (relative to other American cities) and excellent safety records. That directly contradicts Haake's claim that separate facilities are slow, unpopular, and dangerous.

Haake fails to provide empirical evidence for his claim that separate facilities are unnecessary and that on-road cycling training is sufficient for everyone's cycling needs and abilities. He does not provide any specific examples of cities in Europe or North America that have raised

the share of bike trips to ten percent or more by focusing exclusively on vehicular cycling, while providing no separate cycling facilities at all. If cycling on roads is so safe, convenient and popular, then surely he must be able to find that sort of evidence. In fact, he provides no such evidence, while he ignores the overwhelming empirical evidence that separate facilities are crucial to raising cycling levels and improving cycling safety.

Haake criticizes several aspects of bicycling policy in Berlin, especially its extensive cycling network. Berlin has over 1,000km of separate cycling facilities: 620km of separate cycle tracks and bike paths, 60km of on-road bike lanes, 50km of bike lanes on sidewalks, and 190km of off-road bikeways through forests and parks. There are also 70km of combined bus-bike lanes and 100km of shared-use paths (City of Berlin, 2009a). In addition to that separate cycling infrastructure, 3,800km of residential streets are traffic calmed with a speed limit of 30km/hr or less. Thus, the total network of separate cycling facilities and traffic calmed streets in Berlin is almost 5,000km long.

As the network of cycling facilities in Berlin has expanded in recent decades, bicycling has boomed. The bike mode share in Berlin increased from 7 percent in 1992 to 10 percent in 2006. That is the highest bike share of trips in any European city of comparable size, and about ten times higher than any American city of comparable size. At the same time, cycling safety increased. Between 1992 and 2006 cyclist fatalities decreased by over 60 percent (from 24 to 9) (City of Berlin, 2009b). Clearly, the bicycling facilities and training programs in Berlin cannot be as terrible as portrayed by Haake. Most large American cities would consider it an unimaginable success to have a tenth of their trips by bike.

In short, those countries and cities with extensive bicycling facilities have the highest cycling mode shares and the lowest fatality rates. Those countries and cities without separate facilities have low bike mode shares and much higher fatality rates.

Importance of social justice in cycling policies

Our research shows that separate paths and lanes are especially important for those unable or unwilling to do battle with cars for space on busy roads such as arterials with heavy traffic and many large vehicles such as trucks and buses. Training courses may help, but they do not eliminate the inherent danger of cycling on the same right of way with motor vehicles, particular for those whose mental or physical conditions limit their ability to safely negotiate heavy traffic. The slowed reflexes, frailty, and deteriorating eyesight and hearing of many elderly make them especially vulnerable. Limited experience and unpredictable movements put children at special risk on streets. Moreover, regardless of age, many people prefer to avoid the anxiety and tension of cycling in mixed traffic, aside from the safety hazards. Most Europeans believe that bicycling should not be reserved only for those who are trained, fit, and daring enough to navigate busy traffic on city streets.

In the vehicular cycling model, cyclists must constantly evaluate traffic, looking back, signalling, adjusting lateral position and speed, sometimes blocking a lane and sometimes yielding, always trying to fit into the 'dance' that is traffic. Research shows that most people feel

very unsafe engaging in this kind of dance, in which a single mistake could be fatal. Children as well as many women and elders are excluded. While some people, especially young men, may find the challenge stimulating, it is stressful and unpleasant for the vast majority. It is no wonder that the model of vehicular cycling, which the USA has followed de facto for the past forty years, has led to extremely low levels of bicycling use.

Once more, the important issue of social justice arises. As documented in detail in our July 2008 article "Making Cycling Irresistible," countries with extensive cycling facilities (such as the Netherlands, Denmark, Germany, Belgium, and Sweden) have roughly the same number of women as men cyclists. By comparison, men account for 75%-80% of cyclists in countries such as the USA, Canada, and Australia, with far fewer and less integrated cycling facilities. Similarly, cycling is fairly evenly distributed among all age groups in countries with extensive cycling facilities, while in countries without them, cycling is mostly for young adults.

Here, then, is perhaps the strongest argument of all for separate cycling facilities: they enable a wide spectrum of the population to cycle at the same time they raise overall cycling levels. And that is the real choice. Do we really want to restrict cycling to a tiny percentage of the population and exclude most women, children, and seniors? Or should we be truly inclusive and design our cycling policies for everyone? Clearly, most people will not cycle without separate cycling facilities. They are not a panacea for cycling, but combined with the full range of pro-cycling measures listed at the outset of this paper, separate facilities are the key to raising overall cycling levels by appealing to the broadest possible range of social groups. Cycling should be for everyone, not just for the few who are willing to undergo extensive training as vehicular cyclists and only ride on the road.

Author details:

John Pucher
Rutgers University, New Brunswick, New Jersey, USA
pucher@rutgrs.edu
http://policy.rutgers.edu/faculty/pucher

Ralph Buehler
Virginia Tech, Alexandria, Virginia, USA
ralphbu@vt.edu
http://www.nvc.vt.edu/uap/people/rbuehler.html

References

City of Berlin (2009a). Wege für den Fahrradverkehr - Bicycle Facilities. Berlin, City of Berlin. Accessible online at: http://www.stadtentwicklung.berlin.de/verkehr/radverkehrsanlagen/de/radwege.shtml accessed on 03. February 2009.

City of Berlin (2009b). Verkehrunfaelle in Berlin nach Beteiligtengruppen - Traffic Accidents in Berlin by Mode of Transportation. Berlin, City of Berlin. Accessible online at: http://www.stadtentwicklung.berlin.de/verkehr/verkehr_in_zahlen/download/s_057.pdf accessed on 03. February 2009.

Forester, J. (1992). ***Effective Cycling***. Cambridge, Mass: MIT Press.

Haake, B. (2009). The Importance of Bicycling Education. ***World Transport Policy and Practice 15,1.***

Komanoff, C. (1999). ***Killed by Automobile: Death in the Streets of New York City, 1994-1997***. New York: Right of Way. Accessible online at:

http://www.rightofway.org/research/kba_text.pdf

Pucher, J. (1997). Bicycling boom in Germany: A revival engineered by public policy. ***Transportation Quarterly 51, 4***: 31-46.

Pucher, J, Komanoff, C, and Schimek, P. (1999). Bicycling renaissance in North America? Recent trends and alternative policies to promote bicycling. ***Transportation Research 33-A***, ***7/8***: 625-654.

Pucher, J. and Dijkstra (2000). Making walking and cycling safer: Lessons from Europe. ***Transportation Quarterly 54, 3***: 25-50.

Pucher, J. (2001). Cycling Safety on Bikeways vs. Roads. ***Transportation Quarterly***, Vol. 55, No. 4, autumn 2001, pp. 9-11.

Pucher J. and Dijkstra, L. (2003). Promoting safe walking and cycling to improve public health: Lessons from the Netherlands and Germany. ***American Journal of Public Health, Vol. 93,9***: 1509-1517.

Pucher, J. and Buehler, R. (2006). Why Canadians Cycle More Than Americans: A Comparative Analysis of Bicycling Trends and Policies. ***Transport Policy***, 2006, Vol. 13, pp. 265-279.

Pucher, J. and Buehler, R. (2007). At the Frontiers of Cycling: Policy Innovations in Dutch, Danish, and German Cities. ***World Transport Policy and Practice***, Vol. 13, No. 3, December 2007, pp. 8-56.

Pucher, J, and Buehler, R. (2008a). Making Cycling Irresistible: Lessons from the Netherlands, Denmark, and Germany, ***Transport Reviews***, Vol. 28, No. 4, July 2008, pp. 495-528.

Pucher, J. and Buehler, R. (2008b). Cycling for Everyone: Lessons from Europe. ***Transportation Research Record: Journal of the Transportation Research Board***, No. 2074, November 2008, pp. 58-65.

World Transport Policy & Practice

Volume 15, Number 4

Eco-Logica Ltd. ISSN 1352-7614