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Non-motorised transport and urban form - A review of recent research

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Foreword

This report is part of the research project "Towards Carbon Neutral Settlements" carried out by NTNU’s Faculty of Architecture and Fine Art in collaboration with the local authorities of Trondheim, together with SINTEF as well as other consultancies. This research project consists of several parts. One of these parts, “Part B2, Transport”, particularly examines how planning and urban design can contribute to reducing the environmental impact from transportation in the case of Brøset.

A common strategy of urban planning in this respect is to improve public transport and to restrict the use of private cars. Another strategy for reducing car traffic is to actively improve the conditions for non-motorised transport, which is the major interest of this review.

Even though walking is the oldest and most basic kind of transport, “non-motorised transport” is an issue that just very recently is being developing as an explicit field of knowledge. The purpose of this report is to gather and summarise knowledge on this emerging field by reviewing a selection of publications.

The report consists of an overall summery followed by a more detailed presentation of each publication. Besides being a starting point for us working with the Brøset project, we hope that this review can be useful and inspiring for others interested in subjects related to environmental-friendly development of our cities.

As urban form and non-motorised transport has just very recently become a field of scholarly interest, the field of knowledge is not at all “fixed” and there may be contradictions between the pieces of research that are reviewed in this report. This report does neither point out contradictions, nor evaluate or critically compare the arguments of the reviewed publications. Nevertheless, by reading the literature reviewed, patterns of consistent knowledge occur. In many respects, this knowledge represent interests and understanding of urban form and urban life that was convincingly presented by Jane Jacobs\(^1\) as early as in 1961 but still today is not very present in important aspect of planning and urban design.

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Part 1: Summary

Introduction

This report reviews some recent research on how urban form might influence people’s choice of transport. The overall aim is to gather knowledge on how to reduce emissions linked to transport, and moreover, on how urban planning can contribute to emission reduction in the future.

In particular, this report’s aim is to summarise findings from empirical research on how urban form influences modes of transport, which (urban) characteristics have been identified correlating with non-vehicle transport, and on what should be the implications for future planning and urban design.

Some research has focused on urban form in relation to one particular mode of non-motorised transport, other research has examined more general issues and some have studied neighbourhoods or projects that are based on the concept of “car-free housing”. The main findings of this research are summarised in the following.

How does urban form influence modes of transportation?

Holden et al. (2009)\(^2\) state that urban design and planning is often claimed to be of little importance for people’s choice of type of transport. From a short term perspective it would be much more efficient to raise fuel prices in order to reduce emissions than to bother about urban form aspects. Changes in planning will not show results that quickly and must therefore be regarded as a long term development. Nonetheless, examples show that urban planning has an influence on creating or reducing the need for transportation. For instance, the increasing need for transport during recent decades can be blamed on urban planning allowing for shopping centres or new housing settlements located on the urban fringe, depending on the private car as main means of transport (Holden et al. 2009).

Scheurer (2001)\(^3\) states that it is difficult to predict how the physical environment influences people’s choice of transport modes. Nonetheless, it is commonly acknowledged that the physical environment influences transport quantity. When planning urban settlements, it is important to be aware of that people choose to accomplish their daily tasks with a minimum of obstacles and from this perspective the private car is far too often the most convenient choice.

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\(^2\) Erling Holden et al. (2009) Transport og miljø. Tapir akademisk forlag (Chapter about fysisk planlegging (physical planning) s. 182-215)

\(^3\) Scheurer, J (2001), Car-free housing in European cities. A survey of sustainable residential development projects. Doctoral thesis, Murdoch University, Australia
Therefore, the question is how to encourage people to choose differently and to walk or bike more than hitherto?

**Walking**

Walking is the most basic and universal mode of transport and it is environmental friendly as well as healthy. Litman (2009)\(^4\) argues that walking is generally undervalued in current transportation and planning practices, as the faster means of transportation are given priority; the faster transport is the more focus it receives. Walking is the slowest mode of transport. Pedestrians therefore spend much time in their respective environment. This implies that the surrounding environment is more important for walking than for driving a car (Litman 2009). Walking conditions have a major impact on how people perceive transitions in the transportation system, e.g. walking from the train station to the bus stop. In this context, Litman (2009) states that in many cities improving walking (and biking) conditions improve the urban transport system as a whole.

Walking conditions is the focus of an article by Schlossberg et al. (2006)\(^5\). They investigated environmental aspects that were important for predicting whether children would walk to school. They found that the most important aspect was short **distance to school**, followed by high **intersection density**. The street grid layout was also an important indicator and the survey concluded that **fewer dead-end streets** were predictive of walking. Interestingly, no evidence was found that a **major road or railway**, which could be perceived as a barrier or as unsafe, influenced walking (Schlossberg et al. 2006).

Schlossberg et al. (2006) conclude with some **implications for planners**: Streets around schools, especially on the urban fringe should provide **choices of routes** to and from school. Pupils walk further than 1.5 miles (about 2.4 km), opposing previous assumptions of 1 mile being a maximum radius, implicating that larger areas around schools should be considered and designed for walking.

Lee & Moudon (2006)\(^6\) also focus on the influence on urban form on people’s walking behaviour. Strongly associated with walking is what they call the “3Ds+R”: destination, distance, density, and route. Out of 24 **destinations**, tested for availability and proximity from home in walking distance, four were identified as significant. These were: 1. grocery stores / markets, 2. banks, 3. eating and drinking places (restaurants and bars combined), and 4. schools. These four destinations were positively associated with walking when the **distance** between home and destination ranged from one-quarter and one-half mile (400 m to 2400 m). This corresponds also with Schlossberg et al.’s (2006) finding that pupils walk up to 2400 m to school. Urban form aspects such as high **residential density** was also strongly associated with increased walking, as well as small

\(^4\) Litman, T.A. (2009), Economic Value of Walkability, Victoria Transport Policy Institute
\(^5\) Schlossberg, M. et al. (2006), School Trips, Effects of Urban Form and Distance on Travel Mode, in *Journal of the American Planning Association, Vol. 72, No. 3*, p. 337-346
and longer sidewalks along major streets were significant in one model. **Route directness** to school and grocery stores was significant, too (Lee & Moudon 2006).

As also stated by Litman (2009), Lee & Moudon (2006) conclude that walking is more sensitive to detailed environmental characteristics compared to driving.

Lee & Moudon’s (2006) findings point to a manageable number of specific variables and measures that are associated with walking. Their findings show also that several of the variables commonly believed to be important were **not significant**, such as **traffic volume**, **street width**, **the presence of parks**, and **fitness centres**. They claim that these results show the need to reconsider current theoretical frameworks in transportation and open space planning with respect to walkability.

Another document that is occupied with walking and urban form is the Traffic Safety Center’s online newsletter (2004). The Traffic Safety Center (2004) states that findings from recent studies indicate that residents of neighbourhoods with “high street connectivity” and “mixed use” walked more than people in other neighbourhoods. Nonetheless, they claim that it is difficult to determine whether altering the built environment in “the right way” makes people change their **habits**. Habits should not be underestimated, as well as the wish for safety when walking. The article proposes that **safety** aspects might come more into focus in walkable areas. They suggest that while compact communities may be easy to navigate on foot or by bike, crime, pollution and aggressive drivers may increase and discourage people from walking. “Gridded streets” are also described as positive indicators for walking or biking, but there may also encourage more fast-moving traffic than curved streets and dead-end streets.

The Traffic Safety Center (2004) also refers to studies showing that more pedestrians in the streets actually decrease the number of pedestrian injuries. This may be due to drivers being more attentive when seeing many pedestrians. Their message is: have more pedestrians on the streets if you want a safer walking environment!

**As design implications** improving walkability and pedestrian security, they argue for better roadway design and signage, as well as additional elements such as trees that distinguish pedestrian areas from car areas.

The Traffic Safety Center (2004) also refers to other research findings pointing out that important means for promoting walkability are to **minimise urban sprawl** and to **maximise the use of space** in existing urban developments through house infill, **mixed land use**, and other projects that **increase population density**, as well as to provide **easy accessible transit centres** that link residents to an urban core. The expected results are less traffic, reduced pollution, aesthetically pleasing neighbourhoods, and denser cities with a strong sense of place.

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7 Traffic Safety Center, Online newsletter Vol. 2, No.1, 2004
Elizabeth Macdonald\textsuperscript{8} is interviewed in the Traffic Safety Center (2004) newsletter. She is critical towards the traditional thinking in street design and claims that we need to start thinking in terms of streets as being \textit{mixed use streets}, including motorised and non-motorised transport. She argues for differentiating the street by design in order to emphasise that one place is for pedestrians and one place is for cars. In case of two lanes in each direction, there should be a pedestrian refuge in the middle of the street. Every street should be treated as a place. If fast moving traffic on streets is over-privileged, it cannot be a place that encourages walking.

\textit{Cycling}

Schlossberg \textit{et al.} (2006) state that walking and cycling do not share the same requirements and have to be considered separately.

Raford, Chiaradia, & Gil (2007)\textsuperscript{9} studied cyclists` route preferences. Their results suggest that individual route choice is strongly influenced by other factors than by choosing the fastest or most “integrated” routes. Greater than 54 per cent of all cyclist traces in their study fell off an ideal shortest or fastest route, providing evidence that \textbf{alternative factors strongly influence cyclist route choice}. Qualitative analysis revealed that many routes paralleled ideal routes. Nonetheless, when they examined many journeys, independent of origin and destination, the sum of all route choices appears to conform to a spatial logic. Streets with “low angular change” were much used. The cumulative effect of many cyclist trips between many origins destinations is therefore more likely to follow \textbf{least angular change} routes, even though individual cycle trips (when considered one by one) may not. Although geographic \textit{trip length} is an important factor, they argue that “angular minimization” may be of equal or greater importance for route planning.

\textbf{Implications for planning} according to Raford, Chiaradia, & Gil (2007) are

\begin{itemize}
  \item a) To generate a route set based on “angular segment analysis”, in order to predict which route cyclists may choose,
  \item b) To create a network of alternative route choices accommodating a variety of environmental choices.
\end{itemize}

Pucher & Buehler (2009)\textsuperscript{10} state that a multi-faceted approach is the most effective way to encourage cycling and to make cycling safer. In relation to urban design they suggest \textbf{improving roadway design} to facilitate cycling on roads with and without separate cycling facilities, providing \textbf{ample bike parking, restriction of car use}, especially in residential neighbourhoods and city centres, and land use policies that \textbf{discourage low-density suburban sprawl} and \textbf{foster compact, mixed-use developments} that generate shorter and thus more bike-able trips.

\textsuperscript{10} Pucher, J. & Buehler, R. (2009), Cycling for a Few or for Everyone: The Importance of Social Justice in Cycling Policy, in \textit{World Transport Policy & Practice}, vol. 15, no.1, p.57-64
Pucher & Buehler (2009) also emphasise the importance of separate cycling facilities. They state that the overwhelming evidence is that cycling is much safer and more popular in those countries where bikeways, bike lanes, special intersection modifications, and priority traffic signals are the key to bicycling policies.

Jacobsen (2009)\textsuperscript{11} has reviewed literature for her Master’s thesis and states that separate cycling facilities should be planned continuous and direct for fast cycling (15-30km/h). Barriers such as crossings and differences in altitude should be prevented as far as possible. Alternative routes through green areas and parks should be given. Ample bike parking should be provided. Most of these points correspond with the findings by Pucher & Buehler (2009).

\textit{Car-free housing}

Car-free housing projects increase the requirements for effective and satisfactory non-motorised transport and public transport. Living without a car was formerly believed to be the choice of fringe groups and had no place in the mainstream society. But in the last decade, proposals appeared that attempted to not only save the costs associated to developing parking facilities, but simultaneously create residential environments that would reflect the benefits of non-car ownership by being relatively sheltered from the noise, pollution, safety and land-grab impacts of automobile traffic. After evaluating several car-free housing projects, Scheurer (2001) concludes that there clearly is a market for car-free housing not adequately served by conventional housing development.

According to Scheurer (2001) a car-free housing project ideally would: integrate frequent public transit service (best as rail), include local services such as basic shopping or be located in easy walking distance from them, be connected to a good cycling network, be sheltered from traffic noise and pollution, include open space safe enough for children and pleasant enough for adults. A car-free housing must emphasise the positive elements, the 'extras' normally difficult to find in conventional development. The character of car-free neighbourhoods varies greatly between the built examples (Scheurer 2001). A case study by Ornetzeder, M. \textit{et al.} (2007)\textsuperscript{12} found that the residents of a car-free settlement have changed their daily mobility routines permanently. Bicycles are the major mode of transport. The car-free project has lower CO2 emissions than a reference settlement and avoiding car use is the most important indicator for low emissions. Nonetheless, the study also shows that emissions connected to the remaining household purchases (food, hotel, travel, other) are substantial in both settlements (Ornetzeder, M. \textit{et al.} 2007).

\textsuperscript{11} Jacobsen, S. (2009), Klimanøytral transport på Brøset, Masteroppgave på Institutt for bygg, anlegg og transport, NTNU, Trondheim (Master thesis at NTNU)
Parameters and design implications

Urban planning parameters, identified in the reviewed research that may influence people to choose non-motorised transport rather than the private car, are:

Distance / trip length
- (Maximum walking distance to school about 2.4 km, to local services 400 m to 2400 m)

Destinations
- Local services, grocery stores / markets, banks, restaurants, schools and kindergarten placed within certain distance (as mentioned above)

Street grid layout
- Intersection density
- Few dead-end streets
- Mixed use streets
- Alternative route choices
- Route directness / least angular change

Other
- Mixed land use
- High residential density
- Small block size / plot ratio
- Building density
- Minimised urban sprawl
- Easy accessible public transport

More in detail, with respect to the different modes of transport:

For more walking:
- Improve roadway design and signage
- Differentiate the street by means that emphasis that one place is for pedestrians and one place is for cars (curb stones, trees, etc)
- Design a street as “place” (people walking perceive the environment more detailed than when driving past)
- Alternative route choices, shortest way

For more cycling:
- Create cycle routes with little angular change / “direct routes”
- Create a network of alternative route choices
- Avoid much difference in altitude
- Provide ample bike parking
• Provide separate cycling facilities including bikeways, bike lanes, special intersection modifications, and priority traffic signals

**For public transport:**
• Shorter walking to bus stop than to private car
• Provide shelter at bus stops
• Information about bus frequency and public system

**For car-free housing:**
• Space usually used for parking can be used differently
• Lower costs when building less parking
• Street design with focus on non-motorised transport
Part 2: Overview of publications

Walking


- Lee, C. & Moudon, V.A. (2006), The 3Ds+R: Quantifying land use and urban form correlates of walking, in *Transportation Research, Part D 11*, p.204-215 [http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VH8-4JMV5XX-1-1&_cdi=6060&_user=586462&_orig=search&_coverDate=05%2F31%2F2006&_sk=999889996&view=c&wchp=dGLzVlz-zSkWb&md5=cc1f5f0d814e0360f512b020efdbc384&ie=/sdarticle.pdf](http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VH8-4JMV5XX-1-1&_cdi=6060&_user=586462&_orig=search&_coverDate=05%2F31%2F2006&_sk=999889996&view=c&wchp=dGLzVlz-zSkWb&md5=cc1f5f0d814e0360f512b020efdbc384&ie=/sdarticle.pdf)


- Traffic Safety Center, Online newsletter Vol. 2, No.1, 2004
  1. Can Pedestrian-friendly Planning Encourage Us to Walk?
  2. Safety in Numbers
  3. Safety and Sense of Place
  [http://www.tsc.berkeley.edu/newsletter/Spring04/TSCNewsletter_Spring04.pdf](http://www.tsc.berkeley.edu/newsletter/Spring04/TSCNewsletter_Spring04.pdf)


Cycling

  [http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1037&context=its/tsc](http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1037&context=its/tsc)
• Tretvik, T. (2008), Sykling og betydning av topografi, arealbruk og reisetid, Sintef-rapport A7057


• Nina Ambro Knudsen, Mari Gabrielsen & Jonas Johannesen Håland (2008), Bærekraftig bytransport, forbedring av Trondheim som sykkelby, Prosjektoppgave i fysisk planlegging, høsten 2008, NTNU

Car-free housing

  http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VDY-4PK8G38-1&_user=586462&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1000743211&_rerunOrigin=google&_acct=C000030078&_version=1&_urlVersion=0&_userid=586462&md5=0c3b3f8ee61ba7f2c56b5fd21a4f5beb

• Brennan Ramirez, L.K. et al. (2006), Indicators of Activity-Friendly Communities, An Evidence-Based Consensus Process, in American Journal of Preventive Medicine, Vol. 36, No. 6, p.515-524
  http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VHT-4MJDFV-6&_user=586462&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1000758762&_rerunOrigin=google&_acct=C000030078&_version=1&_urlVersion=0&_userid=586462&md5=88fc57bad86871e4f9bd936544c92e8f

• Scheurer, J (2001), Car-free housing in European cities. A survey of sustainable residential development projects. Doctoral thesis, Murdoch University, Australia
  PhD thesis available at
Other

- Jacobsen, S. (2009), Klimanøytral transport på Brøset, Masteroppgave på Institutt for bygg, anlegg og transport, NTNU, Trondheim (Master thesis at NTNU)

- Erling Holden et al. (2009), Transport og miljø, Tapir akademisk forlag (Kapittel om fysisk planlegging s. 182-215)

Parking restrictions

- Viikki Helsinki, parkering

- Forum Vauban e.V. (1999), Vauban – Freiburg, A journey through the modell district Vauban, A vision taking shape

- Evaluering av parkerings-bilbruks-konsept Vauban, kvantitative undersøkelse:
  http://www.forum-vauban.de/verkehrskonzept.shtml


- World Exposition and Kronsberg District, Urban development program for the EXPO 2000 Hannover and:
  http://www.ucalgary.ca/cities/Places_and_People/Chapter%204%20-%20Sustainable%20Community%20Case%20Studies.pdf

- Bike City, Vienna
  http://www.eltis.org/study_sheet.phtml?study_id=2112&lang1=en

- Car-free housing in Vienna ("Autofreie Mustersiedlung")
  http://wien.gruene.at/greeningcities/carfree_housing_viena/
Summaries of publications

Walking

Schlossberg, M. et al. (2006), School Trips, Effects of Urban Form and Distance on Travel Mode, in Journal of the American Planning Association, Vol. 72, No. 3, p. 337-346

The article investigates the influence of the built environment on middle school students’ travel behaviour to and from four schools in Oregon, U.S.

The research questions were:
How do children get to and from school and what were their reasons for choice of mode of transport?
What is the relationship between distance from home to school and mode of travel?
Which characteristics of the built environment influence students’ choice of “transport mode”?

Schlossberg et al. (2006) state that “distance to school appears to influence the likelihood of walking there, as would be expected. Those living within one mile of school are the most likely to walk. Other factors such as population density and tree cover close to school have been shown to be positively correlated with rates of walking to school” (p.338).

Factors negatively influencing walking or biking are “parental perception of heavy traffic within their neighbourhood and lack of pedestrian infrastructure such as sidewalks.”

In order to collect data, a survey was distributed to each household of the middle schools. The address allowed to geocode the location of the respondents’ home, and thus also the distance between home and school.

Results
- Distance to school was strongly associated with mode of transportation
- Whether driving children to school was related to distance
- Intersection density was as strong predictor whether children walked to school. (high intersection density had a positive influence on walking)
- Fewer dead-end streets were predictive of walking
- No evidence was found that a major road or railway influenced walking
- The choice of driving children to school is not only related distance but also to other factors independent of the urban form, e.g. fear of strangers, transport of equipment.

Implications for planners
- Urban form matters with regard to walking to school
- Significant predictors are intersection density and dead-end density
- Streets around school, especially on the urban fringe should provide choices of routes
- Students walk further than 1.5 miles. This is opposing usual assumptions of 1 mile radius. Larger areas around schools should therefore be considered and designed for walking.
- The “active transportation modes” walking and biking have different requirements (and should therefore be examined and handled separately rather that as one)
- The authors find it difficult to capture the characteristics of environments suitable for biking
- Planning cannot overcome the other reasons that parents have for driving their children to school, which are unrelated to the urban form

Comment:

Published in a peer-review journal by Schlossberg who is assistant professor at Oregon University, plus 4 other authors; many references to other scientific articles. **Main focus on street grid layout and distance**

This article’s title (“The 3Ds+R”) refers to a study by Cervero & Kockelman (1997) proposing a framework for research on land use and transport summarised as “3D’s“ based on the concept that density, diversity and design are the main aspects of environment associated with choice of mode of travel.

Lee & Moudon focus on objectively measured and individually observable micro-scale environmental variables.

The “Behavioral Model of Environment” (BME) guided the selection of environmental variable. BME consists of three spatial constructs associated with walking behavior:

1. the origin and destination of trips
2. the area characteristics around the origin and destination
3. the characteristics of the route connecting the origin and destination

A telephone survey provided socio-demographic and behavioural data and comprises 608 randomly selected respondents over 18 years.

Quantifying the characteristics of the built environment related to slow modes of travel in particular, remains a major challenge because it requires greater details and precision than what is needed to understand automobile travel behaviour. (p.205)

After controlling for socio-demographic and perceived environmental factors, 18 variables fell into four main categories, which are: destination, distance, density, and route (3Ds+R).

**3Ds+R: core constructs to quantify neighbourhood walkability.** (Results, p.212)

**Destinations:**
   tested for significance availability and proximity of locations from home in walking distance.
   Out of 24 destinations, four were significant: grocery stores / markets, banks, eating and drinking places (restaurants and bars combined), and schools.

**Distance:**
   The destinations (see above) were positively associated with walking. Distances between home and routine destinations ranged from one-quarter and one-half mile.

**Density:**
   Density measures significantly associated with walking were net residential density at parcel (lot) level and 1km buffer area level. High residential density of the respondents’ home lot which was also correlated with housing type was strongly associated with increased walking. (quote. Unfortunately not explained more detailed)
Route:
Smaller block size, longer sidewalks, and route directedness to grocery store were significant.

Conclusions

1. Parcel-level data in GIS offer economic and valid ways to quantify the built environment. Walking is more sensitive to detailed environmental characteristics compared to driving, and research on walkability benefits from the fine-grained data and small spatial unit analysis provided by parcel-level data.
2. The variable grouping, selection and prioritisation process points to a manageable number of specific variables and measures that are associated with walking. Several of the variables commonly believed to be important were not significant, such as traffic volume, street width and the presence of parks and fitness centres. These results show the need to revise current theoretical frameworks in transportation and open space planning with respect to walkability. (p.213)
3. In the end only a small number of variables (as mentioned above) was significantly associated with walking.

The article refers to:


Comment:
Published in a peer-review journal. Refers to in many other scientific articles = indicates high scientific value

Focuses on objectively measured and individually observable variables strongly associated with walking.
Identifies variables that are often believed to be important for walkability. May be contradictory to other research!
Gives clear implications for functions that should be available in the neighbourhood, max walking distance, and residential density/plot sizes.

The paper presents preliminary findings of an internship.

A walkability index to rank cities across the world based on the safety, security, and convenience of their pedestrian environments was constructed.

Walkability is defined as a nebulous term and its measurement is prone to debate. The issues that should be included into an index are not agreed on by experts, reflecting diversity of interests in this issue.

Main categories that the authors propose to include in a walkability index:

**Safety and security**
- Proportion of road accidents that resulted in pedestrian fatalities
- Walking path modal conflict (conflict between different types of transport, JT)
- Crossing safety
- Perception of security from crime
- Quality of motorist behaviour

**Convenience and attractiveness**
- Maintenance and cleanliness of walking paths
- Existence and quality of facilities for blind and disabled persons
- Amenities
- Permanent and temporary obstacles on walking paths
- Availability of crossings along major roads

**Policy support**
- Funding and resources devoted to pedestrian planning
- Presence of relevant urban design guidelines
- Existence and enforcement of relevant pedestrian safety laws and regulations
- Degree of public outreach for pedestrian and driving safety and etiquette

Comment:

Internal report for the World Bank by a Master student.
Concludes with many challenges associated with the work and seems to be a kind of working paper.
Some relevant references, but uses as well a lot of websites.
Shift of focus towards how the built environment can be altered to make people less dependent on private vehicles.

The theory goes that by making cities more compact, streets more connected, mixing residential and commercial uses, and increasing transit services, people will drive less and walk, bike, and use public transport more often.

It is however, difficult to determine to what extent altering the built environment makes it more walkable and makes people change their habits.

Ways to measure walkability are still being developed (see Article 4).

“Smart Growth” is introduced as a new approach that aims to reduce people’s use of private cars by promoting compact urban design and “walkable” neighbourhoods.

Different models usually agree that means for promoting walkability are to minimize urban sprawl and to maximize the use of space in existing urban developments through house infill, mixed land use, and other projects that increase population density. Provide easy accessible transit centers that link residents to an urban core.

Expected results are less traffic, reduced pollution, aesthetically pleasing neighbourhoods, and denser cities with a strong sense of place.

The built environment is also related to health. Findings from recent studies indicate that neighbourhoods with high street connectivity, mixed use, etc., did more walking than people in less walkable neighbourhoods. However, no connection between health and neighbourhood’s overall design has yet been made.

It is however, an attractive hypothesis that the creation of communities that minimize the need for cars and invite walking and biking would seem like a positive step towards solving health and obesity problems!

Safety aspects are also important; while compact communities may be easy to navigate on foot or by bike, crime, pollution and aggressive drivers may discourage people from walking. “Gridded streets” may cause more fast-moving traffic than curved streets and dead-end streets.

More pedestrians decrease the number of pedestrian injuries. This may be due to drivers, when they see pedestrians, driving more attentive. For security, roadway design and signage could have a beneficial effect (Ragland & Raford 2003, Jacobsen 2003).

Elements such as trees clearly define pedestrian areas and motorists become more aware that they share the area with pedestrians.
Traffic Safety Center, Safety in Numbers, Online newsletter Vol. 2, No.1, 2004

The article refers to studies showing that improved infrastructure is not the only reason of safer walking environments but that the risk (statistically) that one pedestrian might be hit by a car is often lower at intersections with a greater pedestrian volume – even if there are more collisions.


The Space Syntax model analysed layout and connectivity of urban street grids and generated movement potentials, which were compared to sampled pedestrian counts at key locations and land-use indicators (population density and employment density).

Results show that 10 of 12 dangerous intersections were located in areas with relatively low pedestrian volume. The intersections that have a greater number of pedestrians had fewer pedestrian accidents (when number of pedestrians using the intersection is seen in relation to accidents. The absolute number of pedestrian crashes was higher in the more frequented intersections).

Accordingly to Raford & Ragland (2003), the message of this study is as follows: if you want safer streets (in terms of cars and pedestrians), have more people on them.

Jacobsen’s study from 2003 describes similar findings. Jacobsen interprets the results as the relationship between motorist behaviour and pedestrian activity. Drivers drive more carefully when they observe large numbers of walkers and bicyclists (Jacobsen 2003). These findings may have strong implications for policy.

Traffic Safety Center, Safety and Sense of Place, Vol. 2, No.1, 2004

The article discusses what does work and what does not work when it comes to making neighbourhoods more walkable.

In this context Elizabeth Macdonald is interviewed about her experiences (Jacobs, Rofe, & Macdonald 2000).

In the interview, Macdonald points out the different approaches of engineers and designers when it comes to street design and questions about safety. Engineers rely on abstract, quantitative methods, producing diagrams without going out to see what is happening on the streets.
She is also critical towards the old-fashioned classification of streets based on their movement types. We need to start thinking in terms of streets as being mixed use streets as well. The question here is how to create safety for the pedestrians?

Design options are to e.g. to differentiate the street by curbs (Norwegian: kantstein). Along the curb lines one can emphasise that one place is for pedestrians and one place is for cars. One way is planting a row of closely spaced trees, which can create a sense of enclosure and protection along the street.

If you have two lanes in each direction, there should be something in the middle of the street that can act as a pedestrian refuge.

Existing street standards (as in the U.S.) should also focus on creating a pleasant street environment (e.g. trees before parking meters). If you want comfortable streets for pedestrians, narrow lane width is important.

Every street should also be a place. If movement on streets is over-privileged, it cannot be a place, it disrupts the place possibilities.

The tendency to channel pedestrian activity by e.g. providing only one place to cross or creating some kind of barrier along the sidewalk can result in less safe street environments. One should think about what pedestrians want and then go out in the field to observe before creating obstacles.

The newsletters refer to:


Comment:
Includes concrete advises for street design.

Newsletter, no peer-review, but it is a publication of Berkeley university. Refers to other studies or introduces them. It is however often **unclear if they refer to others or to their own research.**

The paper describes ways to evaluate the value of walking (the activity) and walkability (the quality of walking conditions, including safety, comfort and convenience). The author states that walking is in general undervalued in current transportation and planning practices.

It is important to acknowledge walking as the most basic and universal form of transport. Additionally, it is environmental friendly, economic and healthy.

A traditional assumption is that the faster transport is, the more important it is. Fast transport’s negative effects on slower modes of traffic are often neglected.


In fact, the most efficient way to improve urban transport would often be to improve biking and walking conditions and to reduce car travel. Short trips can easily be undertaken by non-motorized transport.

Walking conditions have a major impact on how people in general perceive the transportation system and the local environment. We measure transportation not only by distance but by the amount of time spent, hence when walking we spent much time in the respective environment. If measured simply in terms of distance, walking seems insignificant but not if evaluated in terms of number of trip, travel time, or exposure to street environments.

(Comment B.M.: The latter is of immense importance for numerous kinds of merchandising and thereby for streets’ commercial potentials. The “longer time spent by walking” can therefore be considered a specific positive feature rather than a disadvantage.)

There is also little value assigned to health and recreational aspects of walking.

Design elements that create barriers to walking are e.g. wide roads, high traffic speed, and large parking lots.

According to the author walking is undervalued in planning due to difficulties to measure, its low status and its low cost. Benefits such as for health and fitness are ignored. It is also taken for granted that one can walk everywhere, thus it does not have to be planned.

Improved walkability increases accessibility, provides consumer and cost saving, increases community livability, improves public health and supports strategic economic development, land use and equality objectives.

Greater appreciation of the full benefits of walking could change planning priorities.
Comment:

Many references; won an outstanding paper award; published in two journals.

**Political and health aspects:**
Emphasises the importance of walking as a mode of transport; time when spent walking; walking conditions influence people’s perception of the transportation system and the local environment; health and recreational aspects of walking.
What makes a neighbourhood walkable?

- A center: Walkable neighbourhoods have a discernable center, whether it's a shopping district, a main street, or a public space.
- Density: The neighbourhood is compact enough for local businesses to flourish and for public transportation to run frequently.
- Mixed income, mixed use: Housing is provided for everyone who works in the neighbourhood: young and old, singles and families, rich and poor. Businesses and residences are located near each other.
- Parks and public space: There are plenty of public places to gather and play.
- Pedestrian-centric design: Buildings are placed close to the street to cater to foot traffic, with parking lots relegated to the back.
- Nearby schools and workplaces: Schools and workplaces are close enough that most residents can walk from their homes.

Streets Designed for Everyone

Complete Streets are roads are designed for everyone who uses them, including bicyclists, pedestrians of all ages and abilities, and people getting on and off transit vehicles. These streets are:

- Accessible: There are wheelchair ramps, plenty of benches with shade, sidewalks on all streets, etc.
- Well-connected: Streets form a connected grid that improves traffic by providing many routes to any destination.
- Built for the right speed: Lanes are narrow or traffic calming is in place to control speed.
- Comfortable: Pedestrian medians at intersections, count-down crosswalk timers, bicycle lanes, protected bus shelters, etc. make the street work better for those outside of a car.
Cycling


The study was divided into two phases: analysis of cyclist route choice and correlation with cyclist gate counts.

The first part of analysis examined the correspondence between actual cyclist traces and the shortest metric path versus the fastest, “shallowest” angular path between origin destination pairs. Of the cases examined, about 45 per cent displayed predominantly shortest metric path preference, while an equal number displayed predominantly fastest cognitive route preference. This suggests that neither shortest path nor most integrated path logics were dominant for the individual choices. The result (nearly 50/50 per cent) suggests that route choice is influenced by other factors than fastest or “most integrated”.

Greater than 54 per cent of all cyclist traces fell off an ideal shortest or fastest route, also indicating that alternative factors strongly influence cyclist route choice.

Qualitative analysis revealed that many routes paralleled the “ideal routes”. This suggests that cyclists may choose between alternative routes, which do not fall exactly on the shortest or “most integrated” lines.

The second phase compared “actual cyclist counts” (instead of individual cyclist’s routes) with spatial variables. Contrary to the findings from the first phase, it was found that cyclist volume correlated strongly with the configurational variable “mean angular depth” (in space-syntax terms: capturing the “amount of direction change along a route”). Streets with low “angular change” receive more use and there is a relationship between mean angular depth and cycling activity. This appears to contradict the findings from the individual cyclist analysis.

The authors explain the contradictions by individual variations in choice that are difficult to predict. At the individual level, any number of factors may influence a given cyclists’ route choice. Any individual cyclist has his/her particular reason for not following the “ideal route”. These individual choices can be seen in the analysis of the cyclist traces. Nonetheless, when many journeys are examined independent of origin and destination, the sum of all interacting route choices appears to conform to a powerful spatial logic. The majority of cyclist counted varied with mean angular depth, indicating that at a system level the total cycle volume is influenced by configurational features of the bicycle route network.

The cumulative effect of many cyclist trips between many origins destinations is therefore more likely to follow “least angular change routes”, even though individual cycle trips may not.
The presence of cycling routes improved the result slightly however, angular depth was 5 times as important for route choice.

The “natural movement” phenomenon for cyclist has not been found before. Although geographic trip length is an important factor," angular minimization” may be of equal or greater importance for route planning.

For further research it is suggested to combine both methods on individual level and system level, in order to get an accurate picture of cyclist movements.

Implications for planning are a) to generate a route set based on “angular segment analysis”, b) to create a network of alternative route choices accommodation a variety of environmental choices.

Comment:
Focus both on individually perceived and objective measurable qualities of street environment for cycling. Implications for street design (angular depth). Points out differences between individual choice and the sum of all choices. Suggests methods for analysis of cyclist movement.
Article is a part of space-syntax method.
Rapporten studerer sykkelbruk i forhold til data om befolkning, topografi og arealbruk i de kommunene Skedsmo og Tønsberg.

Det som forklarer variasjon i sykkelandelen var primært avstand, dernest høydeforskjell. I Tønsberg var imidlertid bosatte / dekar mer betydningsfull enn høydeforskjell.

Bil er den dominante reisemåten i begge kommuner både på korte turer under 3 km og på lange turer på mer enn 3 km. Bruk av sykkel er svært forskjellig i de to kommunene avhengig om man så på lang eller korte turer. I Skedsmo er bare 10 % av alle sykkelturer lengre enn 3 km, mens i Tønsberg er 42 % 3 km eller lengre.

Nøyaktig betraktning viser en tydelig tendens til avtagende sykkelandel med økende avstand i begge kommuner. Sykkelandelen mellom forskjellige soner i hver kommune er høy når det ikke er noe høydeforskjell mellom sonene.

Både lengde og høydeforskjell hver for seg bidrar til å forklare variasjon i sykkelandelen. Andre viktige variabler er befolkningstetthet og arbeidsplassstetthet.

Yrkesaktive er gruppen som knyttes mest til bilbruk. Hvis yrkesaktive ikke bruker bil, sykler de heller enn å bruke kollektiv. Blant skoleelever og studenter er det flere som bruker kollektiv daglig enn sykkel daglig.

Når man ser på tidsbruk kommer kollektiv transport dårligst ut. Undersøkelsen viser at kollektivreiser til arbeid eller skole tar i overkant av en halv time, mens både bil og sykkel ligger på rundt et kvartier.

Undersøkelsen viser tydelig at høydeforskjell er viktig faktor å ta hensyn til når man planlegger sykkelveier.

Undersøkelsen er omfattende og gir et godt bilde over sykkelbruken.

In their article “At the Frontiers of Cycling”, on cycling trends and policies in six European cities Pucher & Buehler (2007) conclude that a multi-faceted approach is the most effective way to encourage cycling. The conclusions of this article have been criticised by the professional cycling trainer, Björn Haake (Haake, 2009).

The 2009 article by Pucher & Buehler is a reaction to this criticism. In this article Pucher & Buehler emphasize that separate cycling facilities should not be the only approach to encouraging more cycling and making it safer (which was Haakes criticism), but must be complemented by a host of other measures, such as:

- Improving roadway design to facilitate cycling on roads without separate cycling facilities
- Ample bike parking
- Full integration of cycling with public transport
- Comprehensive traffic education and training of both cyclists and motorists
- Severe penalties for motorists who endanger cyclists
- Traffic priority for cyclists at intersections
- Increase wide public support for cycling
- Restriction of car use, especially in residential neighbourhoods and city centres
- Increased taxes and fees on car ownership, use, and parking
- Land use policies that discourage low-density suburban sprawl and foster compact, mixed-use developments that generate shorter and thus more bikeable trips

Bicyclist education is common in a number of European countries. In Dutch, Danish and German cities schoolchildren have compulsory cycle training courses. Cycling training is free and available to all.

Besides educating cyclists, 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. Furthermore, they claim that the legal rights of cyclists on roadways should be strictly enforced.

The critic by Haake (2009) of the findings by Pucher & Buehler opposes any separate cycling facilities in cities. The authors do not agree with this criticism and point out the importance of cycling facilities.

They categorise existing cycling facilities into:

- **Urban cycle tracks**, which are bike only on-road lanes protected from motor vehicle traffic by barriers of various sorts.
- **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: cheaper and easier to build, place the cyclist in view of motorists. Disadvantage: no physical protection (and therefore dangerous)

- **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. Disadvantage: less protection than a full bike lane. Advantage: help signalling the presence of cyclists.

- **Combined bus-bike lanes**
- **Bike paths on sidewalks**
- **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**
- **Shared-use paths (often in parks)**
- **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 travelled roads with minimal truck traffic, and with specific signage directing motorists to share the road with cyclists.
- **Traffic-calmed residential streets**, which reduce speed limits to 30km/hr in Europe.
- **Super traffic-calmed residential streets**, called Woonerfs in the Netherlands, Spielstrassen in Germany and Home Zones in the UK.
- **Bike boxes, advance stop lines, special bicycle traffic signals, special marking and colouration of bike lanes, and various other intersection modifications are also an integral part of the overall cycling network infrastructure.**

Also other critics besides Haake (2009) reject these special cycling facilities in cities as unnecessary, inconvenient, and dangerous, e.g. Forester (1992). They insist 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.

The general argument of Haake (2009) is that separate cycling facilities, by their very nature—even if well maintained—are intrinsically unsafe and inconvenient. Pucher & Buehler state that Haake (2009) does not provide empirical evidence to back up his views.

They refer to their 2007 article and state that 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. Examples show that the modal split share of cycling is more than ten times higher in the Netherlands (27 per cent), Denmark (18 per cent), and Germany (10 per cent) than in the USA, where less than one percent (0.9 per cent) 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.

The example of Berlin is discussed by Haake (2009) and criticised (!) for its extensive bicycle 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).

As a result to this policy, bicycling in Berlin 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).

Referring to these facts, Pucher & Buehler argue that the situation in Berlin cannot be as terrible as portrayed by Haake (2009). They conclude that 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.

Perhaps the strongest argument of all for separate cycling facilities is that they enable a wide spectrum of the population to cycle at the same time they raise overall cycling levels. 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.

The article refers to:

http://www.stadtentwicklung.berlin.de/verkehr/radverkehrsanlagen/de/radwege.shtml


Comment:

The article gives a good overview of the design of cycling facilities. It also refers to well-functioning examples from European cities. Many useful references; published in a peer-reviewed journal.
Oppgavens teoridel
Mange forhold spiller inn på valg av sykkel som transportmiddel, men Grenstad (2008) sier at et godt utbygd nett for sykkeltransport er en forutsetning for mer sykling. En undersøkelse gjort i seks byer i EU som viser en tydelig sammenheng mellom godt utbygget infrastruktur og høy sykkelandel.


Et sykkelnett kan grovt sett bestå av fem hovedløsninger: 1) Sykkeltrafikk blandet med biltrafikk (i veibanen); 2) sykkelfelt i kjør ebanen; 3) sykkelveg, gang- og sykkelveger; 4) sykling i kollektivfelt; og 5) sykling på vegskulder. (s.4)

Et hovedvegnett for sykkel bør ha en "maskevidde" på maksimum 600-800 meter og være enda tettere i sentrum (Grenstad 2008). Videre skal det kunne sykles i alle gater og hovednettet skal gi sikker og god framkommelighet.

Trondheim kommune har i tillegg definert noen parametere for hva som kjennetegner et hovedvegnett for sykkel (Trondheim kommune, 2006), disse er følgende:

1. Atskilt gang- og sykkeltrafikk
2. Sammenhengende ruter, ikke for mange standardskifter
3. Gjenkjenbar, høy standard (fysisk, merking, skilting, symbol)
4. God belysning, spesielt god opplyste kryssingspunkter
5. Tydeliggjøre vikepliktsforhold ved avkjørsler/sideveger
6. Prioritet i signalanlegg og kryss
7. Sykkelparkering i tilknytning til viktige målpunkt (under tak, innendørs, fastlåsning)
8. Kontinuerlig telling av sykkeltrafikk

Bakgrunn (om Trondheim som sykkelby)
Sykkel har fått stadig økende betydning som transportmiddel i Trondheim. Andelen sykkelreiser i Trondheim ligger på ca 11-12%, noe som er høyere enn landsgjennomsnittet.


Det ble stilt 11 spørsmål i undersøkelsen, og under vises resultatene for Trondheim:
• Hvordan synes du fremkommeligheten er med sykkel? 3,16
• Hvor trygg eller utrygg føler du deg når du sykler? 3,15
• Hva synes du om vedlikehold av sykkelanleggene om sommeren? 3,04
• Hvordan synes du forholdene er for sykling? 3,03
• Er du tilfreds med plasseringen av sykelparkeringsstattrivene? 2,99
• Er du tilfreds med antall sykelparkeringsstativ? 2,77
• Hva synes du om standarden på veganlegg for sykling (sykkelfelt, sykkelveger, gang- og sykkelveger)? 2,72
• Hva synes du om sykelparkeringsmulighetene ved kollektive transportmidler? 2,55
• Hva synes du om vedlikehold av sykkelanleggene om vinteren (brøyting, strøing)?2,36
• Hva synes du om mulighetene til å ta med sykkel på kollektive transportmidler (lokale reiser)? 2,31
• Er du tilfreds med sammenhengen i sykkelvegnettet? 2,27

Metode
Studentene gjennomførte en spørreundersøkelse blant 175 syklister. Disse ble gitt et kart der de tegnet inn sine sykkelruter til jobb. De ble også bedt om å sette kryss ved problematiske punkt, og kommentere hva som var vanskelig/dårlig. (s.14)

Mange respondenter (ca. 45 %) har oppgitt et eller flere punkter på sykkelruten, som problematiske. Problempunkten er samlet i et kart med tilhørende tabell med beskrivelser, bilder og forslag til løsninger.

I analysen av Trondheim som sykkelby har studentene lagt et “aksiallinjekart” (space syntax) over veger som kan sykles for å analysere vegnettet. For space syntax-analysen ble det brukt programmet Mindwalk som er et av flere alternativ for space syntax-analyser. Det er en rekke analysemuligheter i Mindwalk, men “fast choice” var den parameter som ble anvendt.

Resultater
Knudsen, Gabrielsen og Håland, oppsummerer de viktigste problemene slik:
• Kryss: Vikepliktsproblematikk, uoversiktighet, vanskelig med venstresving og lang ventetid.
• Konflikter med fotgjengere, enten på fortau, broer eller andre trafikkområder.
• Rundkjøringer
• Høye kanter/manglende nedsenk.
• Konflikter med biler (i tillegg til kryssproblematikken nevnt over), som ”territoriekonflikter”, lite hensynsfulle bilsjåfører og tuting/aggresjon etc.

Etter å ha gjennomført “fastest route choice” analyse og spørreundersøkelsen vises at noen av rutene som trekkes frem i fast choice-beregningene sammenfaller med rutene respondentene velger å sykle. Studentene konkluderer med at space-syntax metoden var vanskelig å bruke, mens spørreundersøkelsen ga mer nyttig informasjon.

Rutene som sammenfaller i begge metoder er:
• Erling Skakkes gate
• Kjøpmannsgata
• Hlevollen
• Gang- og sykkelveg ved Nidelva på Øya
• Kirkegata
• Klæbuveien
• Vollabakken
• Sandgata
• Fjordgata

Avslutningsvis foreslår forfatterne en del konkrete forbedringene for sykkelnettet i Trondheim (s.38-50), forbedringer som til dels samsvarer men som også på en del viktige punkter avviker fra Trondheim Kommunes eksisterende planer for sykkeltraseer. Eksempler på traseer hvor andre løsninger enn eksisterende planer ble anbefalt er Fjorgata (i stedet for Olav Trygvasons gate) og Erling Skakkes gate (i stedet for Elvegata).

Oppgavens referanser:

Grenstad (2008), dessverre ikke oppført i oppgavens litteraturliste

SLF 2008, Lillestrøm gikk av med seieren
http://www.syklistene.no/Trafikk_sikkerhet/Norske_sykkelbyer_syklistenes_vurderinger/44553

Car-free housing


This is a case study comparing a car-free housing area in Vienna and a reference project, evaluating whether people in the car-free settlement have a more ‘sustainable lifestyle’ than those living in the reference project. Another goal of the research was to identify lifestyle characteristics and household activities that influence environmental impacts.

The research questions were as follows:
Is there a measurable difference in environmental impacts between households owning a car and those who do not own a car?
Do they have systematically different consumption patterns, and – if so - how large is the difference in environmental impacts?

HEI (“household environmental impact”) was calculated to answer these questions. The HEI takes into account direct emissions, such as heating, and indirect emissions that are connected to products, consumed services, and disposal of household wastes. This summary focuses on CO2 emissions.

The results show that the car-free households use more public transport than the inhabitants of the reference settlement. In the reference settlement the car is the most important means of transportation.

Comparison of impacts in the two settlements:
- Emission share for transportation is lower for the car-free settlement (32 per cent of total household emission) than for the reference settlement (42 per cent).
- Households in the car-free settlement use 30 per cent less electricity and have more subscribers of green electricity.
- However, the overall difference of CO2 emissions and energy use is not that high.
- In both settlements, the total emissions are much lower than in Austria on average.
- The little differences in the overall emission of the two settlements is explained by the “rebound effect”; assuming that all income is spent in one way or another and taking into account that any money saved by an environmental-friendly action (such as not owning a car or by reducing indoor temperature) will be spent on some other purpose (a purpose that also has environmental effects, e.g. increasing air travel can offset gains from reduced car use).
- The rebound effect is one way to explain that the car-free households eat more out and have a higher consumption in the category ‘other’. 42 per cent of the emissions of the car-free household are caused by the category other while this percentage is 35 per cent for the reference settlement.
- “Having a car or not” significantly influences Co2 emission per person. However, except from car-owning, Co2 emission is almost linearly related to total income.

The five most important reasons for moving to the car-free settlement were:
- Proximity to a recreational area (85 per cent)
- Generous common areas and facilities (81 per cent)
- Green and healthy environment (73 per cent)
- Quite site/no noise pollution (71 per cent)
- Bright and sunny apartment (68 per cent)

The car-free feature and the ecological aspects were decisive for only a minority of tenants.

Some results from comparing the car-free settlement and the reference project regarding attitudes and perceptions:
- 92 per cent of the respondents in the car-free settlement are of the opinion that there are more eco-friendly in the car-free settlement than in similar settlements in Vienna. In the reference settlement only 27 per cent think this is true for their settlement.
- In the car-free settlement, one third of the respondents consider green consumption to be a relevant topic, while the residents of the comparable settlement do not.
- Ecological behaviour plays a more important role as a part of the social norms in the car-free settlement

Socio-cultural aspects:
- Positive identification with the project is much higher in the car-free settlement. In the car-free settlement 82 per cent were proud of living there, while only 29 per cent were proud of living in the reference settlement.
- People know each other better in the car-free settlement and there is an active community with a good neighbourly relationship
- Social climate is an important aspect to reinforce environmental friendly behaviour

Urban form:
- Mobility patterns are different from the reference settlement and bicycles are a major mode of transport in the car-free settlement. Design for easy access with bicycles and enough space for bikes support their use.
- Car-free village is described as a small scale village where people know each other, with much space for interaction and social institutions.
- The reference settlement is described as a nice place with a higher level of urban anonymity

Summary of the findings:
1. The car-free project has lower CO2 emissions than the reference settlement. Both settlements have lower emissions than the Austrian average.
2. Avoiding car use (not owning car) is the most important factor for low emissions.
3. Environmental concerns and social contacts are more important in the car-free neighbourhood than in the reference settlement.
4. When assessing all purchases, the difference in CO2 emissions between the two settlements is 7 per cent. The reason for this difference being much lower than when focusing only on differences between owning and not owning a car is due to the “rebound-effect” which is expressed through “remaining household purchases” (food, hotel, travel, other) that are substantial and in fact dominate the overall HEI of both settlements.

5. Air transport has the highest emission intensity of all purchases assessed.

6. It was hypothesized that environmentally conscious consumption in the car-free settlement would extend to other areas than car-owning as well. In this survey this hypothesis could neither be confirmed nor falsified.

Lessons:
The residents of the car-free settlement have changed their daily mobility routines permanently. For the stabilization of more sustainable consumption patterns, both factors of social climate and infrastructure are important for facilitating behavioural change.

Comment:
Published in a peer-review journal, by 5 authors.
Many references to other scientific articles and reports.

Focus on emissions in relation to built environment and socio-cultural aspects, rebound effect.

The overall aim of this paper is to identify key indicators of activity-friendly communities that can assess and improve opportunities for regular physical activity. A comprehensive literature review was used to generate a list of indicators.

10 relevant indicators were identified: land use, environment, access to exercise facilities, transportation environment, aesthetics, travel patterns, social environment, land use economics, transportation economics, institutional and organisational policies, and promotion.

Recently, health researchers have begun to focus on the physical environment’s influence on health. This article also refers to evidence from other transportation and urban planning studies suggesting that persons living in neighbourhoods with greater population density, land-use mix, street connectivity, and walking and biking infrastructure tend to walk and cycle more frequently.

Comment:

Article in a medical journal by 13 authors, indicates the relevance of this topic also within other disciplines. **Focus is on indicators of activity-friendly communities.** Not all indicators are relevant for physical planning, but some are: density, land-use, street grid, walking and biking infrastructure. Provides many other references that are occupied with how to increase physical activity through environmental actions, and by that to improve public health.
Jacobsen, S. (2009), Klimanøytral transport på Brøset, Masteroppgave på Institutt for bygg, anlegg og transport, NTNU

**Hovedspørsmål**

Hvordan kan man gjennom transportløsninger og arealbruk oppnå klimanøytral transport på Brøset?

Forfatteren anser **klimanøytralisering transport** som mer troverdig uttrykk enn ”karbon nøytralt”. I første delen av oppgaven oppsummerer hun kunnskapsstatus på fagfeltet, mens andre delen av oppgaven tar for seg situasjonen på Brøset i Trondheim. Hun konkluderer med anbefalinger for utbygging av Brøset området og muligheter for reduksjon av CO2 utslipp fra transport.

Oppsummeringen tar for seg delen som handler om Brøset.

**Brøset – situasjonen i dag**

I kommuneplanens arealdel 2007-2018 er Brøsetområdet vist med formålet eksisterende byggeområde tettbebyggelse. Tettbebyggelse omfatter boligområder men kan i tillegg ha innslag av institusjoner, offentlig og privat service, allmennyttige formål og næringsvirksomhet.

Arealer på mer en 6 dekar skal ha 3-5 boenheter per dekar. Brøset ligger innenfor ”ytre sone” i kommuneplanens arealdel bestemmelse. Det stilles da krav om 1,5 bilparkeringer og 2 sykkelparkeringer per 70kvm BRA eller boligenhed (s.43). Brøset området er bare delvis regulert og hele området skal reguleres på nytt i forbindelse med Brøset-prosjektet. På Brøset er det planlagt ca 1200 boliger.

Fra Brøset til Moholt er det ca 1500 m, til Valentinlyst senter er det 1000 m og til KBS senter er det 2000 m avstand. De kan alle regnes som nærservice, men noen funksjoner burde være enda nærmere. Nærservice som benyttes ofte burde være innen 500m avstand (s.51) for å minske sannsynligheten for å bruke bil. Derfor burde dagligvarebutikken være nærmere Brøset enn i dag.

Eksisterende gange- og sykkelveier er ikke tilstrekkelig utbygd og burde forbedres. Tilgjengelighet til områder burde delvis forbedres og kryssningsmulighetene burde hatt en mer innbydende utforming (s. 55).

Det burde vurderes å tilrettelegge Granåsveien og Bromstadveien som framtidig hovednett for sykling. Fra Brøset til Midtbyen er Granåsveien korteste vei, men pga kraftig stigning velger mange å sykle ”nordruta” rundt Strindheim når de skal hjem fra byen (Jacobsen oppgir ikke kilde for dette). Stigning oppleves som en barriere mot å
velge gange eller sykkel. Ingen av de sentrumsrettede sykkelrutene i dag passerer bydelssentrene Moholt eller Valentinlyst.


Brøset er ikke lokalisert innenfor det som kalles for ”kollektivbuen” i Trondheim. Det går kun en bussrute til Brøset og frekvensen er lav. Det bør være bedre tilknytning til vestdelen av kollektivbuen. Det er opp til 800 m å gå til bussholdeplassen, noe som er altfor langt for å være attraktivt.

Valg av transportmiddel på Brøset

For å vurdere attraktivitet av alternative transportmidler analyserer Jacobsen rekkevidden (i 30 min. avstand) fra Brøset med gange, sykkel og kollektivtrafikk.

Adkomst til Brøset med bil via Omkjøringsveien er effektivt og raskt. Det er derfor en stor utfordring å nå målet om redusert bilbruk på Brøset.

Gange:
Andel gange synker vanligvis kraftig med reiselengde over 1,9 km (Vågane 2006). Med hastighet på 5km/h bruker man 23 min. å gå 1,9km. Fra Brøset ligger Dragvoll innenfor 20 min. gange (dvs. under 1,9km avstand), mens Gløshaugen ligger utenfor rekkevidden på 30min. gange. Det samme gjelder for Midtbyen.

Bruken av sykkel er størst for reiselengde mellom 500 m og 5,0 km (Vågane 2006). Fra Brøset rekker man viktige målpunkter som arbeidsplasser, skoler og universitet i løpet av 20 min. med sykkel. Derfor bør sykkel anses som en viktig transportmiddel fra og til Brøsetområdet.

Kollektiv kommer dårlig ut sammenlignet med gange og sykkel. I løpet av 30 min. nåes kun den østlige delen av Midtbyen. Rekkevidden med 10 min. kollektiv er faktisk kortere enn med 10min. gange når man regner med avstanden til holdeplassen og ventetid. I tillegg er det lav frekvens på bussavganger, noe som gir større usikkerhet med tanke på tidsbruk (s. 61).

Oppsummerende kommer Jacobsen fram til at sykkel og bil er transportmidlene med best tilgjengelighet til de viktigste målpunktene. Kollektiv er reisemiddellet med dårligst rekkevidden på Brøset i dag.

En reisevaneundersøkelse for Trondheimsområdet (RVU 2001) viser at 77 % av husstandene i Brosetområdet har tilgang til bil, mens det er kun 42 % i Midtbyen og i hele Trondheimsområdet 82 % som har tilgang til bil. Undersøkelsen viser ellers at andel kollektivreiser er lav for alle områder og lavest for Brøsetområdet. (s.67)
For alle ”hovedreisehensiktene” viser undersøkelsen en gjennomsnittlig lavere reisetid på Brøset enn i andre områder. Samtidig viste undersøkelsen at reiser med bil er høy. Jacobsen mener at dette tyder på at det er en del korte turer med bil og derfor potensial til å endre valg av reisemiddel (s.69).


**Lokalisering av funksjoner**
Jacobsen mener økt andel arbeidsplasser på Brøset ville gi flere reiser med bil fra byen til Brøset. Målet med å legge nye funksjoner til Brøset burde være å lokaliserere beboernes daglige gjøremål i nærområdet og dermed ikke generere transport til andre områder.

På Valentinlysenter er det et godt tilbud på nærservice og handel, noe som Jacobsen anbefaler å videreutvikle i samband med Brøset. Dagligvaretilbud burde lokaliseres nærmere enn Valentinlysenter og som tidligere nevnt, anbefaler hun å etablere dagligvareforretning på Brøset.

Jacobsen foreslår at nye boliger på Brøset burde ikke lokaliseres rett ved Omkjøringsveien pga støy. Fotballbane eller flerbrukshall her kunne fungere som buffer. I samme området burde også barneskole og barnehage lokaliseres.

**Tetthet og tomtestørrelse**
Jacobsen foreslår opp til 5 etasjers bebyggelse i deler av Brøsetområdet. Kommuneplanens arealdel setter krav om 3-5 boenheter/dekar. Til sammenligning har Vauban 5,3 boenheter/dekar, Hammarby sjöstad har 6, mens Jåttåvågen har 4,3 boenheter/dekar. Jacobsen mener at man burde gå opp til 5 boenheter / dekar på Brøset, noe som sammensvarer med ca 1650 boliger.

**Klimaregnskap**
Jacobsen har prøvd å anslå mulig reduksjon i bilbruks og CO2-utslipp fra beboerne på Brøset. Hun antar at halvparten av framtidige beboere er bevisste på miljømålene og at halvparten vil leve sitt liv som før uten å endre transportatferd. Jacobsens mener at nye Brøset vil kunne få en reduksjon i CO2-utslipp fra transport på 24 % i forhold til dagens utslipp fra beboere rundt Brøset.

Det som ligger til grunn for dette resultatet er at de korte turene (turer under 10 min. som i dag utgjør opp mot 50 % av bilreisene (RVU 2001)) reduseres. Hovedprinsippet er at bil som reisemiddel får lavest prioritert. Virkemidler er for eksempel at avstand til kollektivtransport skal være kortere enn til bil, nærservice skal sammenlocaliseres med kollektivtrasé, og det skal tilrettelegges for gående og syklende. Hun har også antatt at bilparkeringsnormen reduseres til 0,5 plasser per boenhet (vanlig er 1,5 per boenhet) og
at bilparkeringsanlegg ligger ca. 800m unna boligene. Hun mener at **drastiske og restriktive tiltak** er nødvendige for å oppnå redusert CO2-uslipp fra transport på Brøset.

Referanser:


Kapittel om fysisk planlegging s. 182-215

Hvordan påvirker fysisk planlegging reisene våre? Holden belyser her sammenheng mellom plassering av boliger, arbeidsplasser og butikker og hvor mye folk reiser. En grunnleggende antakelse innenfor forskning på sammenhenger mellom fysisk struktur og transport er at den fysiske strukturen utgjør ett sett med incitamenter (stimuli) som påvirker folks transportatferd.

Det hevdes ofte at fysisk planlegging bare har liten innflytelse på hvordan og hvor mye vi reiser. På kort sikt ville nok andre virkemidler være mer effektive. Fysisk planlegging er allikevel et viktig tema. Mye av transportveksten de siste tiårene skyldes fysisk planlegging, f.eks. av store kjøpesentre i utkanten av byene, boliger og arbeidsplasser i utkantstrøk, bygging av veiene som krysser dette sammen. Samfunnet har gjort seg avhengig av mye transport. For å redusere transporten og energiforbruket må denne avhengigheten endres og i denne sammenheng er fysisk planlegging avgjørende. Fysisk planlegging er et langsiktig virkemiddel i motsetning til økning av bensinpris (Næss, 1997). Fysisk planlegging burde forstås som forebyggende virkemiddel for å begrense energiforbruket i framtiden (s.185).

**Regionalt bosettingsmønster**

Holden et al. diskuterer om det er bedre (med tanke på energiforbruk til transport) å konsentrere utbygging i en stor by enn å fordele byveksten på flere tettsteder rundt ”moderbyen”. Han viser til studiene viser at energibruk til transport er mindre blant folk som bor i de indre kjernene av byene, enn for de som bor i utkanten (s.191).

I følge av en undersøkelse av Transportøkonomisk institutt (Vågane 2006) er bilholdet og kjørelengde lavest for dem som bor i Oslo, Bergen, Trondheim og Stavanger. De som bor i byenes omegn har derimot langt høyere kjørelengde og bilhold enn de som bor i sentrum. Bilholdet i mindre byer er like hoy som i byenes omegn men kjørelengden er igjen kortere enn i omegn av de største byene. **Konklusjonen som Holden trekker for utbyggingen: fyll opp de sentrale delene av de største byene, la omegnene til disse byene i fred, men fyll heller opp de mindre byene og tettsteder.**

**Bystørrelse**

Energibruken per innbygger i en by synes å synke med økende folketall opp til et vist nivå, for så å stige igjen. TØI sin reisevækstundersøkelse viser at kjørelengden for innbyggerne i Bergen, Trondheim og Stavanger er langt lavere enn for de som bor i Oslo. Holden argumenterer for at det skjer en endring i energibruk rundt per person ved bystørrelse rundt 200.000 innbyggere (s.187) og at flere mellomstore byer (opp til 200.000) spredt rundt i en region gir minst energibruk per innbygger.

**Tetthet i bydeler**

”Tetthet” kan defineres på forskjellige måter. Begrep som beskriver tetthet i byplanleggingskontekst er blant annet:
1. Befolkningstetthet, som gir informasjon om hvor mange mennesker som bor innenfor et område/areal.
2. Utbyggingstetthet, som beskriver antall boliger innenfor et område.
3. Bebyggelsesgrad, som gir informasjon om hvor mye areal av et område er bebygd.


I 1989 publiserte Newman & Kenworthy en studie der de sammenlignet bensinforbruk i 32 byer og de fant en klar sammenheng mellom bensinforbruk per innbygger og befolkningstetthet i byen (grafikk s. 188). Høy tetthet gir blant annet mindre avstand mellom ulike funksjoner, slik at gjøremål kan nås på sykkel eller til fots (s. 190).

**Lokalisering av arbeidsplasser og servicefunksjoner**

En sentral lokalisering av arbeidsplasser og servicefunksjoner ser ut til å være energimessig gunstig. Unntaket er arbeidsplasser som klart retter seg mot lokalmiljøet i boligområder, for eksempel dagligværebistikker, postkontor, barne- og ungdomsskoler og barnehager.

**Kollektivtilbud**


**Parkeringsmuligheter**

Holden henviser til flere studier av NIBR (mangler ref.) som konkluderer at sannsynligheten for å reise med bil var 42 prosent hvis parkeringsmulighetene var gode, mot bare 14 prosent hvis parkeringsmulighetene var dårlige. Funnet gjelder parkeringsplasser ved arbeidsplass. Parkeringsplasser ved arbeidet og bolig er viktig for valg av transportmåte.

**Byform**

Hvilken byform ville gi det laveste energiforbruket? Det finnes ikke enighet om dette spørsmålet og de to hovedretningene i diskusjonen om bærekraftig byutvikling er ”sentralistene” og ”desentralistene”. Retningene er ikke noe nytt fenomen men baserer seg på historiske diskusjoner og utvikling innenfor byplanlegging.
Når det gjelder energi-, klima- og tilgjenglighetsproblem er det mye som tyder for at sentralistene har bedre argumenter:

De mener at tettere og konsentrerte byer gir kortere avstand mellom ulike gjøremål og dermed kortere reiser. Dette øker sannsynlighet for bruk av sykkel eller gange, dermed blir energiforbruket og utslipp av klimagasser lavere.

Desentralistenes argumenter er at forurensning, trafikkulykker og helseskadelige forhold er et viktig tema i norske byer og at fortetting vil gjøre disse forholdene enda verre. Grønne områder i byene vil også forsvinne ved ytterlige fortetting.

Allikevel er det fakta at flere og flere bor i byer og tettsteder (79 % i Norge). Dette kan ikke bare velges bort til fordel av desentralistenes argumenter. I framtiden burde ”fortetting med kvalitet” være et viktig stikkord (Næss 1997). Mindre transport og mer kollektivtransport vil også bedre bymiljøet, også i tette byer.

Holden et al. argumenterer at den kompakte byformen er den mest bærekraftige i forhold til å legge til rett for et lavt energiforbruk og lav utslipp fra innbyggerne.

Kompakte byer virker allikevel å ha noen utfordringer, for eksempel ferie- og fritidsreiser. Ferie og fritidsreiser utgjør halvparten av energibruken til transport. Og Holden stiller spørsmålet om det er en sammenheng mellom byform og de frie reisene? (s.208)

En studie fra Oslo (det er ikke tydeliggjort i teksten hvilken undersøkelse det refereres til, antakelig: Vågane 2006,) viser at de som bor i de tettest befolkede boligområdene i de store byene bruker mindre energi til hverdagsreiser enn de som bor i mindre tette områder, men de lange fritidsreisene med fly økte i takt med økende tetthet i boligområdet. Undersøkelsen viser også at de som ikke hadde hage brukte 30 prosent mer energi årlig på lange reiser med fly enn de som hadde egen hage.

Er hyppige reiser en kompensasjon for å bo tett og ikke ha tilgang til grønt areal i form av egen hage?


Den kompakte byen er en tredje modell. Den kompakte byen er sentralisert og konsentrert, noe som reduserer energiforbruket til en viss bystørrelse, men blir byene for store stiger energibruket igjen.

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En fjerde form er desentralisert konsentrasjon, noe som også kan gjennomføres innenfor store byer ved konsentrasjon rundt lokale sentra og gode forbindelser mellom disse.

Holde et al. konkluderer at desentralisert konsentrasjon framstår som den gunstigste byformen med hensyn til å redusere energiforbruket. Dette bekreftes i følge Holden et al. både av teoretiker (Susann Owens 1992) og andre empiriske studier. Om teorien desentralisert konsentrasjon gjelder bare for byer over en viss størrelse blir ikke nærmere beskrevet.

Bokens referanser:


The background of this research is based on the evaluation of a total of eleven ecological residential neighbourhoods in Copenhagen. Advances in resource-efficient technology and enhancement of the local community had remarkable effects on sustainability performance in most of the case study areas.

The result is not as positive when assessing the residents' lifestyle, in particularly with regard to activities outside the home. Little empirical connection was found between the physical, social and environmental setup of a neighbourhood and its residents' travel behaviour as one of the most significant fields of energy consumption. This article (which is a part of Scheurer’s PhD thesis) focuses on examples of sustainable neighbourhoods where this shortfall had been overcome, and specific strategies for mobility management had been incorporated.

**A short history of car-free housing**

Most residential development from the era before mass-motorisation - before 1945 - was planned without parking provision in mind. In Germany and Austria, building codes have required parking provision with residential development since 1939, with quite rigorous enforcement until recently. Examples from Denmark and the Netherlands show that urban renewal that required demolition and new construction within old-growth urban fabric was exempted from such rules.

The first European car-free housing scheme was proposed in Bremen (Germany) in 1992. During this time car-free living was believed to be the choice of fringe groups and had no place in the contemporary mainstream of society. The new proposals for car-free living, attempted to not only save the costs associated to developing parking facilities, but simultaneously create residential environments that would reflect the benefits of non-car ownership by being relatively sheltered from the noise, pollution, safety and land-grab impacts of automobile traffic. They emphasised the positive outcome that reducing car ownership can have on residential environments.

Opposition to car-free housing initiatives can be easily deconstructed where it claims that car-free living is a small minority phenomenon. As Reutter & Reutter (1996a, 1996b) found, 41 per cent of all households in former West German cities are car-free households and in former East German urban centres numbers are close to 50 per cent, as also in other European capitals such as Amsterdam, Copenhagen, Edinburgh and Vienna. While
the proportion of car-free households had declined markedly everywhere after 1945, it now appears to be consolidating at least in these larger cities.

Referring to these numbers, Scheurer states that there clearly is a market for car-free housing not adequately served by conventional housing development. Car-free housing projects are designed to roll back the disincentives (opportuniting) to dependence on car ownership. This is for instance done by **ending the cross-subsidy enabling car owners to park their vehicles at little or no cost on valuable land** (Each off-street parking bay requires a minimum floor area or open space of 25 sqm and costs between EUR 10,000 and 30,000 to build). This contributes to more social justice along the 'user pays' principle and to better housing affordability within the carfree market.

Scheurer summarises the aspects that a car-free housing project, ideally, should have:

- “integrate frequent public transit service (best as rail),
- include basic shopping and services, or be located in easy walking distance from them,
- be connected to a good cycling network,
- be sheltered from traffic noise and pollution,
- include open space safe enough for kids to play outdoors without supervision and pleasant enough for adults to spontaneously congregate and use as a natural extension to the private dwelling”

**In order to promote a carfree housing project it is very important to focus on the positive elements, which constitute the unique appeal of car-free housing. There is little to be gained from discussing regulatory frameworks concerning vehicle bans and the resident's commitment to non-car ownership.**

In many of the carfree housing areas it is common to include a limited number of parking spaces for shared vehicles, usually supplied by car sharing organisations. There are also some provisions made for visitors' cars. In several projects it is aimed to maintain pedestrian-only internal access, however it is normally possible to enter the neighbourhood for emergency vehicles or when carrying heavy items. Enforcement of the car-free character of a neighbourhood varies greatly between the built examples that Scheurer has reviewed.

The article’s references:

Reutter U. & Reutter O. (1996a) *Autofreies Leben in der Stadt - Autofreie Stadtquartiere im Bestand.* Dortmund, Germany

Comment:

Scheurer`s article is referred to by many other of the articles reviewed. He evaluates examples of carfree housing and summarises implications for new developments.
The sustainable construction movement concentrates mainly on the improvement of building systems and not enough on other factors such as people’s behaviour, urban morphologies, and architectural bioclimatic and energy efficient forms. This paper by Salat concentrates mainly on the factor of urban morphology.

Urban texture is described as a key factor that determines energy demand on different levels. The author states that studies on the relations between density and energy remain usually too general to be able to define operational action criteria for existing cities.

To attain operational results, it has become necessary to refine and quantify the morphological description of the various types of density in terms of their impact on mobility and the microclimate. While the urban microclimate affects external spaces, it also has an effect on the internal climate of buildings. It is a key for creating what the article calls as “passive bioclimatic architectures” which are able to reduce energy intensity and the carbon footprint. (For instance: the possibility to use natural ventilation depends on the physical structure as well as on the climatic conditions next to the building).

Traditional urban texture is varied, fragmented and complex. During the 1920’s repetitive mega scale buildings were developed, based on ideas of Le Corbusier. Studies on morphology show that these mega scale structures lead to unsustainable cities. The Martin Centre at the University of Cambridge found that the court form as an urban form is the most efficient (courts, four floors) with regard to energy consumption (Baker & Steemers, 2000).

The results show the efficiency of the traditional urban structure of city blocks and courtyards opposed to the modernist towers and free standing structures. The envelopes before the 20th century performed better than envelopes of the 20th century until 1975, when the first oil crisis demanded focus on energy consumption. The analysis showed that heating consumption was also lower in the traditional urban structures, which is due to the urban form, but depends as well on the heating mix provided (energy source) and on behavioural aspects.

In this study, electric heating is the energy source with the best outcome in regard to energy consumption and calculated CO2 emissions.

The results show also that a multifaceted approach is needed to reduce carbon emissions. Beside the factor of urban morphology, critical factors are people’s behaviour and the “heating mix”, (e.g. kind of energy supply and energy production) provided. If also transportation is considered in these calculations, which is a major part of households CO2 emissions, density can play a dominant role in reducing carbon emissions.

Parking restrictions


With regards to car-parking spaces, the detailed plan only requires half of the usual car-parking spaces for the plots (e.g. in the 1-2-storey houses the norm is a minimum of 1 car-parking space for every 160m² of gross floor area, a maximum of 1 car-parking space for every 80m² of gross floor area). The aim was for car-parking spaces to be sold separately from the dwellings and thus to target their building and maintenance costs to car owners. The building permit documents were, however, to contain an expansion reservation for extra parking, if necessary.

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Forum Vauban e.V. (1999), Vauban – Freiburg, A journey through the model district Vauban, A vision taking shape

Målet var å ha færrest mulig biler i området. Store deler av området er parkeringsfritt men privatbiler står parkert i et parkeringshus i utkanten av området. Bileiere må akseptere å gå et stykke til bilen sin. Det er ikke lov å kjøre gjennom området utenom når man skal levere eller hente noe. Beboere som ikke eier bil slipper å betale for parkeringsplassene. At området er bilfritt vurderes som positiv for boligområdets kvalitet.

Myndighetene krever at bilfrie hushold måtte disponere areal der det om ønskelig kunne byggges parkeringsplasser i framtiden. Det resultert i at beboerne grunnla en forening (Verein für autofreies Wohnen) som kjøpte et stykke land i nærheten av området. Dette kan brukes til parkeringsplasser i framtiden, men brukes i dag som fotballbane eller til barbecues.

*(det virker som om alle prosjekter som har som mål å redusere antall parkeringsplasser blir pålagt å eie land som kan brukes til parkering ved eventuelt sener behov. JT)*

130 av de 280 første husholdene i Vauban bestemte seg for å ikke ha bil. Sentrum Freiburg er ca 3km fra Vauban, en reise som tar 15 minutter med buss eller sykkel. Det kan sammenlignes med avstand Broset – Midtbyen. Trikken er en effektiv forbindelse mellom Vauban-området og Freiburg sentrum.

Det har blitt gjennomført en kvantitativ evaluering av trafikk-konseptet i Freiburg-Vauban. Undersøkelsen viser at Vauban har 858 sykler og 150 biler per 1000 innbyggere. I Freiburg ellers er tallet 457 biler per 1000 innbyggere.

33 % av dem som deltok i spørreundersøkelsen er medlem av "bilpoolen" (bildelingsorganisasjon). Sammenlignet med resten av Tyskland er dette et unntak (hele Tyskland har bare 55.000 medlemmer i bilpool av 84.mill. innbyggere).

Jobb,- fritid og innkjøp utgjør 80 % av all transportformål i Freiburg. Vaubans innbyggere bruker i hovedsak sykkel til alle tre formål. Sykkelandelen er størst til jobb med 70 % (Freiburg ellers 34 %), til fritidsturer bruker 50 % sykkel (Freiburg ellers 29 %), og for å handle 56 % (Freiburg ellers 29 %).

Vaubans beboere bruker i hovedsak nærmiljøets butikker, 54 % bruker nærbutikken og 18 % svarer at de bruker butikker i sentrum, dvs. ca. 3 km unna.

Tabellen viser endringer i transportatferd etter å ha flyttet til Vauban:

<table>
<thead>
<tr>
<th>Bruk</th>
<th>Sykkel</th>
<th>Gang</th>
<th>Moped etc</th>
<th>Bil</th>
<th>Car Sharing</th>
<th>Taxi</th>
<th>Buss/trikk</th>
<th>Tog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mer enn før</td>
<td>38,4%</td>
<td>27,1%</td>
<td>10,5%</td>
<td>16,1%</td>
<td>55,8%</td>
<td>32,3%</td>
<td>36,7%</td>
<td>20,2%</td>
</tr>
<tr>
<td>Like mye som før</td>
<td>53,5%</td>
<td>58,2%</td>
<td>69,5%</td>
<td>38,1%</td>
<td>36,8%</td>
<td>59,1%</td>
<td>42,0%</td>
<td>68,8%</td>
</tr>
<tr>
<td>min.dre enn før</td>
<td>8,1%</td>
<td>14,7%</td>
<td>20,0%</td>
<td>45,8%</td>
<td>7,4%</td>
<td>8,6%</td>
<td>21,3%</td>
<td>11,0%</td>
</tr>
<tr>
<td>Alle</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
<td>100,0%</td>
</tr>
</tbody>
</table>

Den største forskjellen gjelder bilbruk og bildeling før og etter innflyttingen; 46 % av beboerne kjører mindre bil enn før men bruker bildelingstilbudet tydelig mer.

57 % av husholdninger uten bil har gitt avkall på egen bil først da de flyttet til Vauban. Dette viser at bilfrie boligområder ikke bare er for folk som ikke eier bil fra før.

81 % av de som ikke eier bil mener at hverdagen er veldig lett / lett å organisere uten bil. 79 % svarer at de også kan organisere fritiden sin tilfredsstillende uten bil. Det som virker vanskeligst er å besøke venner eller familie som heller ikke eier bil.
2/3 del sier at de savner bil i noen situasjoner, men halvparten av disse 2/3 del svarer også at det forekommer sjeldent. Hovedgrunnen til at beboerne savner bil i blant er ”å dra på tur, helgeturer, ferie” eller på ”spontane turer”. Beboerne uten bil er imidlertidig gjennomgående godt fornøyd og hele 96 % svarer at de ikke vurderer å kjøpe bil.

Beboere med bil er mindre fornøyd enn beboere uten bil. 26 % svarer at de er misfornøyd / veldig misfornøyd med parkeringskonseptet. 40 % er bare delvis fornøye og 34 % er veldig fornøyd. 67 % svarer at de delvis eller ofte synes det er vanskelig å ikke kunne parkere rett utenfor huset.

Det ble også kritisert at det ikke finnes parkering til besøkende, som ofte kommer med egen bil. Alt i alt virker ”bilfri-konseptet” å fungere bra i dette prosjektet.

**BedZed traffic concept,**
http://www.bioregional.com/what-we-do/our-work/bedzed/

BedZED aims at decreasing car dependency for its residents, and to provide alternative modes of travelling. BedZED’s green transport plan was written into the land purchase contract. Private car ownership at BedZED was therefore limited, with the target for fossil fuel car miles to be 50 per cent of the average. To formalise this agreement the housing developer The Peabody Trust entered into a legally binding agreement. Residents and businesses pay an annual fee to park on-site and parking spaces are prioritised for disabled drivers, electric / LPG vehicles and cars with smaller engines.

The Green Transport Plan reduces car ownership and use in three ways:
1. Offering alternatives to private car travel
2. Promoting public transport
3. Reducing the need to travel

**Alternatives to private car travel**
BedZED incorporates an onsite car club. The club was established in partnership with City Car Club– the UK’s largest car club operator. City Car Club provided vehicles, an internet-based booking system and in-car technology whilst BioRegional employed a development officer.

The car club service was introduced to potential BedZED residents at pre-sales open days and at monthly residents welcome evenings as people began to move in. After the first year the membership had risen to 35 people, sharing the use of three vehicles. Roughly half of the club’s members work for BedZED-based businesses, and half are BedZED residents. The club has also attracted members from the wider community. As a result of the car club service, nine members had sold cars or deferred (utsatt) car purchases by March 2003.
Electric vehicles:

BedZED is equipped to make running an electric car a practical option. Public transport or car club vehicles can be used for journeys beyond the range of an electric vehicle. BioRegional and local cycling group “Cyclism” formed a partnership to run free “Dr Bike” Sessions. The sessions provided a 10-minute bike check and basic repairs for BedZED residents and the local community. There is good cycle storage provision around the site and wall mounted locking points, and there are changing facilities in the club house.

Promoting public transport
The BedZED development site was chosen for its excellent public transport links; close to Hackbridge station (5 minutes walk away and Mitcham Junction station (15 minutes walk away). Moreover, three local bus routes serve the area. When residents first moved in, BioRegional delivered public transport information such as new timetables direct to the households and businesses.

Reducing the need to travel
BedZED’s mix of homes and workspace offers the option of working at home and cutting commuting. On-site facilities enable businesses and residents to meet more of their everyday needs without getting in the car. These include a football pitch with club house, a dance studio, nursery, multi-use centre which can be used for film nights and book clubs etc., village square, recycling bins, home food delivery and garden parcels.

World Exposition and Kronsberg District, Urban development program for the EXPO 2000 Hannover, and:
http://www.ucalgary.ca/cities/Places_and_People/Chapter%204%20-%20Sustainable%20Community%20Case%20Studies.pdf

The Kronsberg area is served by a new tramline with maximum 20 min. journey to the city centre. Three train stations within the community link Kronsberg to the city centre and ensure train service is no more than 600 metres walking distance for residents. Transportation is a vital aspect of the development since Kronsberg is located 30 to 40 minutes by car from the central city and 20 minutes by rail.

An internal street network favours cyclists and pedestrians with traffic calming measures. Underground garages and residents’ surface parking spaces are integrated in the inner courtyards. Parking is reduced to 0.8 per dwelling.

The size of the Kronsberg area is around 120 hectares, 6000 residential units are planned that once everything finished, will house about 15.000 people.

The "Bike City" in Vienna is a housing estate which targets the special needs of cyclists. Specific features integrated in the housing development are e.g. extra-large elevators, a bike-service-centre as well as secured bicycle parking spaces. But also limited parking spaces for private cars are characteristic for the Bike-City.

A total of 300 bike-parking stands are available inside and outside of the buildings. In contrast, only 56 car parking spaces for private use are offered for the 99 housing units in a subterranean garage. The money that was saved was instead used for bike facilities and wellness area, as well as for the design of the surrounding.

Car-free housing in Vienna ("Autofreie Mustersiedlung"), [http://wien.gruene.at/greeningcities/carfree_housing_vienna/](http://wien.gruene.at/greeningcities/carfree_housing_vienna/)

The car-free housing project in Vienna-Florisdorf ("Autofreie Mustersiedlung") with 244 apartments has been constructed for tenants who obligate themselves contractually not to possess a car. The number of parking lots required for buildings in Vienna is regulated by law. For every new flat one parking space is obligatory. This law had to be amended for this project, in order to allow less space to be used for car parking (down to 10 per cent of what would have been obligatory). One condition for this exception is a good connection to public transport. The space not used for cars (and the money saved) has been dedicated to common infrastructure, such as a bicycle repair shop, car-sharing, a sauna, a fitness room, playgrounds for children, a youth room, and roof gardens.