# The safety of pedestrians

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Abstract

Safety of pedestrians is a vast area where I am afraid that strategies only to a small extent have been built on actual knowledge. Already in the 19th century pedestrians were killed in large numbers and ever since then the red thread through planning has been the balancing of pedestrian interests vs the interests of a steady growing population of car users. In principle authorities are in favour of increased safety for pedestrians but in action there is a lot of hesitation. It is most clearly visible when you come to Speed Management. Interviews with decision makers in Sweden showed that yes, they were in favour of low speeds, but it cannot go too far. The result in most cases is compromises; e.g. effective speed reducing measures like humps are designed in a way that they do not produce "low enough" speeds, and they are located in a non-systematic way. The Vision Zero adopted by the Swedish Government claims that the speed of motor vehicles in interaction with vulnerable road users should be no higher than 30 km/h. Thirteen years after the introduction we have still a very long way to go. There are, however, other measures that are used in a more systematic way. That is small roundabouts that are growing in number every day, in Sweden and in many other countries. If design is correct, pedestrians may benefit a lot from them, and generally roundabouts contribute to a new way of looking at traffic in cities, where interaction to a large extent is built on "man to man" decisions and not on regulations like traffic signals. Thanks to low speeds roundabouts can produce much more "harmony" in traffic with less noise, air pollution, improved safety and a considerably smoother interaction between motorized traffic and vulnerable road users. Engineering plays an important role in the task of controlling speeds. This is highly warranted in light of to-days automobiles. These can easily make up to 250 km/h and are heavily promoted as being safe, comfortable, etc. Authorities have a very weak position when coming with their messages, like "speed is killing", "low speeds improve interaction", etc. At the same time low – and adapted – speeds become more and more important. We all know the very strong relation between speed and safety. It is also well documented to-day that speed and interaction is very important. Low speeds produce remarkable changes in driver' give way behavior. This last result is extremely important in view of the strongest trend to-day, namely that going from safety for pedestrians as a single aspect the scope to-day is a holistic way of looking at "the life of pedestrians". Safety is then only one aspect; in addition we have feeling of safety, comfort, esthetical aspects, environmental aspects, etc. All this form the new traffic concept in cities with the aim of creating cities that are not only safe but also attractive and sustainable. This is a question of surviving for many cities that are fighting against the attractivity of external shopping malls and other activities easily available by car.

## Biography

I have been working at Lund University since 1970. I took my Ph.D. degree there in 1987 on Traffic Conflicts. Since 1993 I am a professor in Traffic Engineering. I am since 1988 the Chairman of ICTCT – International Cooperation on Theories and Concepts in Traffic Safety.

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## Introduction

I first want to make a general statement. The findings in this paper are primarily built on relevant literature I have found combined with a synthesis made by me, based on my experience with pedestrian research in 35 years. I say this because I have of course overlooked interesting developments as I have not been able to cover what is going on in every country. I have mainly considered research and implementation in countries well known for their efforts on pedestrians, e.g. countries like the U.S., U.K., the Netherlands, Sweden. Finally I will make a synthesis of what role pedestrians have played in the workshops that ICTCT (International Cooperation on Theories and Concepts in Traffic Safety; www.ictct.org) has held during more than 20 years.

When I started thinking about pedestrian safety I soon found out even though walking is the original and basic way of moving, the position of pedestrians has almost always been at stake. My main conclusion from this presentation is actually that we to-day are facing a lot of theoretically interesting and sophisticated scopes to make pedestrians safe and well, but we almost never see any implementation of all these good ideas. My interpretation is that societies so far have not allocated sufficient efforts and resources in relation to the importance of walking. This has become quite obvious when the need for sustainable solutions has exploded. There is some hope though; my general understanding is that cities in many countries are threatened because people move outside the city to new housing areas, they go shopping at external shopping malls, etc. The only way to become competitive again is to make the city more attractive and sustainable. In this respect walking is fundamental. Without offering ample space and favourable opportunities for pedestrians life in cities can never be revitalized. So, the focus on safety "one-dimensionally" is about to change slowly to something much more holistic in incorporating qualities for pedestrians like comfort, mobility, security, attractivity (beautiful, silent, free from smog), etc. Looking at the (hi)story of pedestrian safety my main conclusion, as you hopefully will see, is that we are on our way towards "the pedestrian city", but still with a pace that is not very impressing.

First I looked at pedestrian history in general. Thanks to a very interesting and comprehensive article by Ishaque and Noland (2006), I learned that safety for pedestrians is a much older concept than at least I knew. It started already in the beginning of the 19th century(!). Road traffic fatality rates were quite high even long before the automobile had been invented. In 1840 around 1000 persons were killed in UK in accidents involving horses. Between 1840 and 1900 the mortality rate was on average about 50 pMa (per million persons living per annum). To-day – more than 100 years later – the mortality rate due to road accidents is around 40 pMa in countries like UK, Sweden, Norway and the Netherlands. In the U.S. it is as high as 140 pMa. The main differences are that to-day it is the automobile that kills road users and that there are much less pedestrians killed. This is a key theme that I will come back to, as one cause of this situation is simply that walking has gone down. In a synthesis report by FHWA in the U.S. the following comment is made regarding the decline in pedestrian fatalities: "…. decline is presumably the product of: increased attention to pedestrian control and safety measures and pedestrian safety education; and a change in exposure factors on trips that formerly would have been made on foot that came to be made

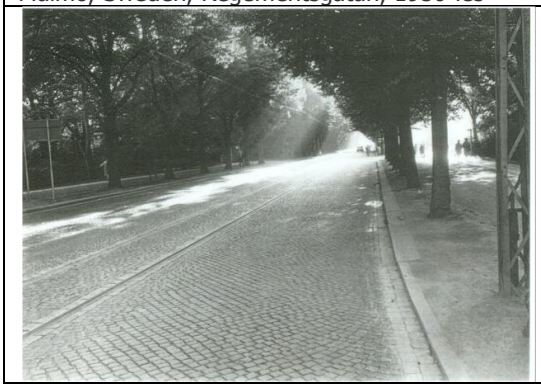
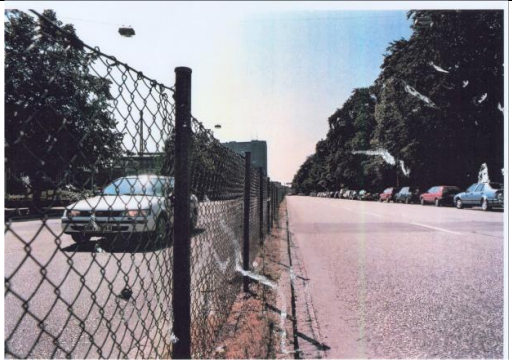
in a motor vehicle. Other factors also may play a role. Detailed pedestrian exposure data are not available that illuminate pedestrian trip choices and amount of walking on a nationwide basis". It is interesting to note that even when one of the largest transportation organizations in the world tries to explain the decline in fatalities for pedestrians words like presume have to be used. It is in a way dramatic that nobody seems to know the exposure of pedestrians. The case with the U.S. is not unique. I have found some figures from a research report from Sweden, based on census data. It showed that the share of trip length for pedestrians had gone down by 30-40% in most cities from 1978 to 1997. If not figures are enough figure 1 gives the empirical evidence..

Figure1 Copenhagen, Denmark in the 1950-ies

## The need for more space for cars and its implications

The decrease of walking thus coincides with the increase in automobile transportation. An important observation then is that with the decrease in walking – and increase in motorized transportation – a decrease in importance of walking as a transport mode followed. The automobile needed more and more space, and as space in most cases was limited because of buildings, the interest of using walking and cycling space for cars was increasing rapidly. This reflects one of the most dominant dilemmas following the "automobile era". People get stuck in their cars and immediately react by frustration. Up till rather recently the prompt reaction has almost always been to give more space to cars. This could solve the problems in a relatively short time. So space was needed and "excessive space" for pedestrians and bicyclists was changed to space for cars. See figure 2.

Figure 2 Transfer of space from pedestrians to cars

| Malmö, Sweden, Regementsgatan, 1950-ies | Malmö, Sweden, Regementsgatan, 1990-ies |
|---|---|
|  |  |

No sophistication was needed; the case was simple and needed no research or other activity to "prove its relevance". The problem was the short-sighted solution. There was no consideration whatsoever of the possible long-term consequences of such a one-dimensional strategy. Pedestrian safety needs was only slowly growing, but was of course growing with the increase in car volumes and with streets getting wider. The first obvious need for pedestrians was to organize foot-paths along the streets. Then came the question about how to organise safe crossing locations. Numerous solutions with and without traffic signals, different markings and signings, tunnels/footbridges, new principles for designing streets, etc have been introduced. My conclusion regarding these efforts is that we still have a long way to go until the position of pedestrians is acceptable, both regarding safety and regarding approaching "the pedestrian city".

## Crossing the street safely – the ever going challenge

Looking at the development I have first tried to find out about the safety effects of solutions trying to safe guard pedestrians trying to cross street and secondly to see how they are balancing the interests of car user's vs pedestrian's interests.

### Signalised crossings and walking speed

In Britain the first trial with a traffic signal took place already in the 1860-ies. It was abolished though fairly soon. Pedestrians only had 30 seconds of "go" for every 5 minutes cycle, and planners thought that this was so inconvenient for pedestrians that they would not accept it, and therefore would start jay walking. Next attempt came more than 50 years later, (Ishaque, M M; Noland, R B. 2006) and it seems as if we have not come very much more forward in using traffic signals to solve the safety problems for pedestrians. In a meta analysis by Elvik et al (2010-1) the effect on pedestrian injuries of traffic signals at junctions is varying from a reduction when there is a separate phase for pedestrians to an increase when there is mixed phase with cars. In Sweden the latter is most common, and I imagine that being the case in most other countries, as it produces the highest mobility for cars. A synthesis from the U.S. highlights this: At intersections with traffic signals, adding a WALK/DON'T WALK signal with a standard timing scheme (i.e., motorists move parallel to pedestrians and may turn right or left on a green light across pedestrians' path) has no significant effect on pedestrian crashes. Providing an exclusive pedestrian interval (i.e., motorists are stopped in all directions during the same interval each cycle while pedestrians cross in any direction) reduces pedestrian collisions by 50 percent. An interesting qualification is added: "However, exclusive timing schemes can increase pedestrian and motorist delay and are most appropriate at downtown intersections with a combination of heavy pedestrian volumes, good pedestrian compliance, and low vehicle volumes." (Ishaque, M M; Noland, R B. 2006). The conclusion seems to be that in a balancing between safety for pedestrians and delay for car users, the latter aspect is much stronger. A clear indication of this is that looking at literature about pedestrians you will find an extremely large group of studies regarding the walking speed of pedestrians. The main aim with these studies was originally to find the optimal timing of traffic signals. The faster a pedestrian can walk, the shorter the pedestrian phase can be and the shorter delay for cars. The result has often been pedestrians who have to run, who do not feel safe, etcetera. So in a second "wave" of studies the walking speed has been decided again, now with the main aim of considering the needs of those with the lowest speed. In my eyes this story about walking speed somehow summarizes the problem. Instead of approaching the real problem – how to ensure that cars and pedestrians can interact in a safe way – we spend our resources on "pseudo research". It would be interesting, and a nice Master thesis task, to sum up all the studies worldwide about walking speed.

In addition to walking speed research there are many efforts made in order to find the optimal traffic signal solution. In the U.K. Pelican crossings was a concept for traffic signals. They were push-button-controlled. However, these produced "unnecessary delays for both cars and pedestrians and Puffin ('pedestrian user friendly intelligent') crossings were therefore introduced in the early 1990s. Puffins incorporated pedestrian and vehicle detectors and a variable cycle time that could increase the pedestrian phase if pedestrians were still on the crossing or cancel it if they had already crossed. (Ishaque, M M; Noland, R B. 2006). This is one of the best examples where both pedestrian and driver interests are considered at the same time. However, I have not seen any results of the effects of the Puffin crossing.

## Physical separation

The best alternative for safe-guarding pedestrians without producing delays for motorists is to build footbridges or subways for pedestrians. This was also tried in the late 19th century in London. Again hesitation was demonstrated for partly similar reasons as with the traffic signal, i.e. it would be too inconvenient for pedestrians so they will not use them, etc (Ishaque, M M; Noland, R B. 2006). Not much happened for many decades, primarily only research of minor importance on the behavior of pedestrians. "Useless" results explained that a large part of pedestrians were not using the bridge/tunnel when the walking time via the tunnel/bridge was x% larger than when not using it. It was also concluded that tunnels were preferred by pedestrians because they could then start by going down… This led to the inevitable conclusion that pedestrians must be forced to use the tunnel/bridge. The concept of guard rails was introduced. This was often couched in terms of pedestrian safety but the primary objective was usually maintaining and channeling both pedestrian movement and vehicle flow. (Ishaque, M M; Noland, R B. 2006).

## The zebra crossing

In absence of efficient solutions that could be implemented in large scale slowly efforts were made to try and influence the behavior of the motorized driver. I imagine that U.K. was first even in this case; In 1927 some London boroughs experimented with road markings for pedestrian crossings. 'Please cross here' signs were also erected but they were found not being sufficiently conspicuous and were replaced by upright signs with the letter C. From that on a continuous development started. The zebra crossing was introduced in the 1950-ies after recommendations by the Transport and Road Research Laboratory (TRRL). Approaching a zebra crossing drivers were obliged to give precedence to pedestrians (Ishaque, M M; Noland, R B. 2006). TRRL was heavily involved in research into doing research of the effectiveness of pedestrian crossings. Several new concepts were introduced in order to make the crossing more conspicuous and to reach a high degree of compliance from drivers. Belisha beacons (amber globes) were introduced, replaced by flashing amber beacons in the beginning of the 50-ies, followed by a recommendation to reduce the number of crossing from 30,000 to half because they were so many that the compliance had gone down "too much".

In Sweden the zebra crossing story is quite interesting. In the 1980-ies we had 70,000 such crossings. It was found that even if zebra crossings had been present for more than 50 years there was no evaluation made. So a colleague of mine made a thorough study and found out that a zebra crossing had more than two times higher risk for pedestrians than a crossing location without any facility. (Ekman 1988) The results were so shocking, primarily I guess for those who were responsible for these 70,000 crossings that nothing happened for more than 10 years. Once there was a discussion starting the main conclusion was that the main problem was that car drivers did not yield for pedestrians at zebras. So a new law was introduced in the beginning of year 2000 making yielding for pedestrians mandatory when

pedestrians are on or close to the zebra. A follow-up study showed that the yielding rate went up from 5-20% to 40-50%. However, the number of injured pedestrians increased. The reason being risk compensation. Already in the Ekman study the conclusion was that pedestrians felt safe on the zebra, and there was therefore an obvious risk that when pedestrians observed a much higher degree of driver compliance with the yielding rule, they would feel even safer. So, the result was that zebra crossings were officially classified not any more as safety devices, but devices to improve the mobility of pedestrians. As in U.K. a lot of zebra crossings were removed having too few pedestrians. Instead "safe crossings locations" were introduced, meaning that at those locations special means were done to safe-guard the crossing location. Main features here are the narrowing of the road via median refuges and various other kinds of speed-reducing measures.

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I think that "the story of the zebra crossing" (or other type of crossing) will not end in many years still. My guess is partly built on the meta analysis of the safety effects of zebra crossings made by Elvik et al (2010-2). Their results tell that the introduction of a zebra crossing produces an increase of injury accidents for pedestrians by 4% (-6; +121). My main conclusion from this is that we still have not implemented any solutions balancing safety for pedestrians with keeping up the mobility for motor vehicles in a large scale. However, we know to-day how to improve pedestrian safety. Effective speed reducing measures is definitely the most effective solution. Meta results from Elvik et al (2010-3) clearly show this. The introduction of speed reduction at a zebra crossing reduces injury accidents for pedestrians by 42% (-70; +11). The result is built on different studies of this phenomenon. I have only vague ideas about the actual use of effective speed reducing measures to-day. In India I learned in a two-year study about pedestrian safety that even though there were some measures taken already the "resistance" among decision makers was strong (Hydén, Svensson 2009). We also learned that in small villages along main routes in the state of Rajastan inhabitants themselves had built their own speed humps. My impression from Sweden – and in other European and North-American cities? - is that the situation is much the same even though on a somewhat "higher level of sophistication".

## Educating pedestrians

When different countries realized that the efforts made, e.g. traffic signals or tunnels/bridges, was failing to a large degree my interpretation is that focus was redirected to the pedestrians. They were the cause of producing smaller safety effects than expected. So big efforts were made, starting 50 to 60 years ago, to educate, inform pedestrians and to enforce their behaviour. The most typical examples are all the efforts to teach children how to behave in traffic. There are numerous examples of training programs developed. My best memory of this era is the "Ice cream vendor project" that I came across in the U.S. in the 1970-ies. The scope was to train children to stop at the curb side before crossing the street to an ice cream vendor that just had introduced its presence with a characteristic melody. Without being able to state the safety effects of these training programs, results are not very conclusive (Elvik et al 2010-4), they are of very minor interests regarding pedestrians well-being. They are primarily moving responsibility to the vulnerable ones, and are not supporting the possibilities to relaxed walking in the city, and not the least against basic understanding of how behavior can be influenced. A better insight was slowly introduced. The best example of a shift is Professor Stina Sandels important research about children in traffic, where she pointed at the children's abilities and the obligations of planners to understand and accept the needs of children.

## Low speeds

Another trend change is the understanding of the need for low speeds in the interaction between cars and pedestrians. To-day there seems to be a large consensus among decision makers in Sweden and other countries. In Sweden it is demonstrated by the fact that since the late 1990s over two thirds of municipalities have implemented 30km/h speed zones mainly in residential areas. However, it is also showed that if no other measures are taken the effect on speeds is very low. One of the conclusions was that the speed limits at that time were too few. In Sweden new speed limits are therefore introduced – in cities 40 and 60 km/h – in addition to 30 and 50. The philosophy is that planners should be able to give "the most relevant" speed limit to every street. However, a first follow-up made showed that the speed reduction was very minor; if the speed limit was reduced 10 km/h – from e.g. 50 to 40 km/h – the actual mean speeds were only reduced by a bit more than 2 km/h only (Hydén et al 2008). This resulted in severe reductions of the compliance rate, in the case of 50 to 40 km/h from 80% compliance to 60% which produces a dilemma; even though speeds were reduced a little the change clearly demonstrated that drivers did not take the change "seriously enough". So the underlying question came back; how can better compliance with the speed limits be achieved? And again we are back to the discussion about feasible physical measures. And, again we can see a lot of hesitation to use measures that really produce the low target speeds, primarily 30 km/h. The hump is the best example, the most effective speed reducer, but rarely used in a holistic way. The "mother of humps" is the so called Watts hump (Watts 1973). It is a circular-shaped measuring 3.7 meter long and 0.1 meter high, forcing cars to slow down to 25-30 km/h. This of course does not initially make it popular among car drivers. Planners have therefore tried to avoid using it. They have been quite inventive when trying to find solutions less "disturbing" than the Watts hump. The result is most often a non-systematic use of speed-reducing measures other than humps. One of the few exceptions is the city of Gothenburg in Sweden where effective speed-reducing measures have been introduced in an almost complete way on all streets except for on the largest arterials. The results are very encouraging; this traffic calming in Gothenburg has resulted in a large reduction in the numbers of deaths and serious injuries and a socio-economic benefit of more than 47 times the direct costs (VTI 2004). In spite of this the implementation has in most cases not been holistic and based on pedestrian needs. I think (hope) that the Swedish case can be a typical example. There is to-day a general understanding of the need for safety of pedestrians and a need for more sustainable and attractive cities. At the same time it cannot be "too much" of it. In an interview study with Swedish planners and decision makers they agree that safety is very important and that low vehicle speeds is an important element. However, these low speeds must "be reasonable". "Humps is good, but they cannot be used everywhere; we have received a lot of complaints". Etcetera. As one Swedish planner told in the interviews that "we get a lot of complaints when we introduce humps" (Risser 2010). That can be compared with the experience in the Norwegian city of Bergen where humps are introduced on almost all streets in the city More than 2000 in the city of 230000 inhabitants). Their experience is that once humps are introduced on a street neighbours contact the city asking for humps on their streets as well. Bergen has a more than 20 years experience of systematic introduction of humps, which also has e.g. resulted in humps (or raised crossings) even on streets with heavy bus traffic. This is still something impossible e.g. in Sweden. Another example; the Swedish Vision Zero, adopted in principle in many countries, claims that the long term goal is that there should be no seriously injured or killed in road traffic (http://www.visionzeroinitiative.com/). One of the main principles taken is that the speed of vehicles should be no higher than 30 km/h where motorised and non-motorised traffic interact. Still 13 years later there is a long way to go to reach this target.

## The new era

My general conclusion is that "ideologically" there is a great understanding of the need for redefining city traffic among planners and decision makers. This is impressively described in the Cost project 358: Pedestrian Quality Needs (PQN) that we will hear much more about during the conference. Qualities are defined in the most comprehensive and holistic way, and the results came out of a efficient networking that started with discussions in ICTCT more than five years ago.

### Shared space

So, even though PQN is very sophisticated in its approach I am afraid that I will have to come back to the fact that things are moving so slowly. But, to be a bit more optimistic, there are interesting movements in new directions. One example of a "new ideology" is the Shared Space concept. It is firstly presented by the Dutch traffic planner Hans Mondermann (http://www.rudi.net/books/20024). "Convinced that humans possess skills in negotiating and interaction that are being suppressed by conventional rules and regulations, Monderman idea was to explore the potential for simplicity and integration between engineering and urban design". The Shared Space concept is still only implemented in a small scale and almost not assessed at all. However, there are some quite convincing results. In the Swedish city of Norrköping a signalized intersection with heavy traffic was rebuilt with the Shared Space principles, see figure ). An evaluation showed that to-day there is a great mix of road users, very low vehicle speeds (around 15 km/h) and generally improved conditions for pedestrians and cyclists. However, visually impaired pedestrians who felt that they had no proper guidance through the place. And road users generally complained because rules were not clear which created insecurity and frustration (Jaredsson 2002).

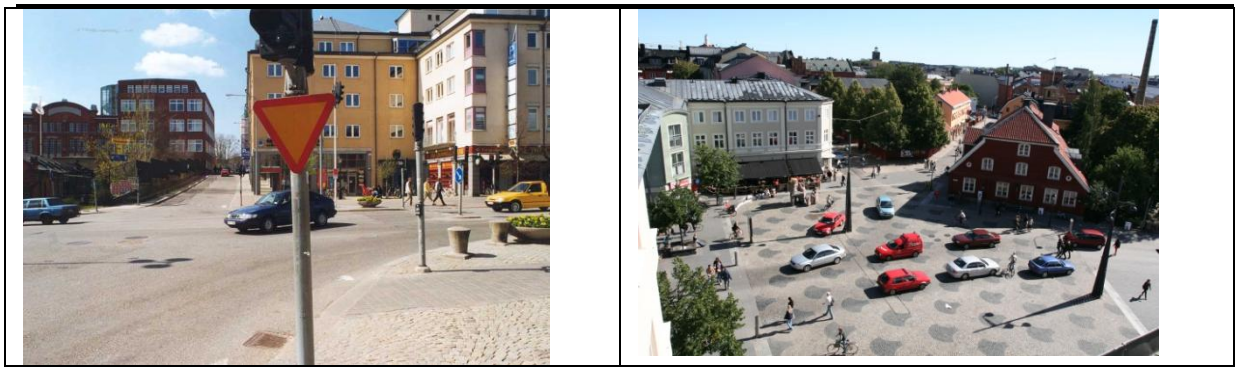

Figure 3: Before and after introducing Shared space in the Swedish city of Norrköping Photo: Sofia Jaredsson

Shared Space was far from the first attempt to control motorized traffic in favour of pedestrians, especially children. The oldest concept is woonerf (the living street invented in Holland in the 70-ies). Foot paths were removed and drivers were to drive in a very slow pace and to give full priority to pedestrians. Woonerf has been followed up by most countries with similar principles. However, the implementation has primarily been focusing on streets were problems were fairly small from the beginning with low speeds and relatively few cars. So, even though planners and decision makers seem to be happy with these new concepts, we still do not know or understand how it can be used in order to redefine the whole city and how to organize traffic in order to reach an attractive and sustainable traffic in towns, with "equal opportunities" for all road users. It is as much true for Shared Space as for any other – similar – concept. The following example from US highlights this when it is first is clearly stated that "According to the American Association of State Highway and Transportation Officials' (AASHTO) "Providing safe places for people to walk is an essential responsibility of all government entities involved in constructing or regulating the

construction of public rights-of-way." Still they define "Shared Streets" as something that only can be used "in very limited unusual circumstances" (FHWA 2004).

I may sound a bit too negative. In a way I am. I am very frustrated by the slow pace of all changes. Woonerf and Shared Space are good examples of how slow the pace is. Shared Space is not tried in large scale and my personal idea is that it is not feasible as an area wide solution. This is key issue, my interpretation is that evaluations of what is done are too scarce and not including all the aspects of pedestrian welfare that should be included. To-day there is too much of taking small steps, which – according to me – creates a lot of frustration with the "non-vulnerable" road users, primarily car drivers. They have no genuine feeling of why restrictions (control) have to be introduced. Because of this decision makers are hesitating and therefore the big steps are not taken.

Again to be a bit more positive I think there is a clear positive long time trend, **because** cities have to reorganize traffic in order "to survive". Actually the trend has been on since the first pedestrian street was developed more than 50 years ago. New pedestrian areas are opened all the time and there are more and more woonerf-like concepts coming also in central areas of cities, with well-defined "play rules" in favour of pedestrians and cyclists. Cars are gradually "moved out from the center" with the help of streets with restricted space for cars and low speeds and drivers have to accept that they are equal (i.e. not stronger) than any other road user. I would say that as long as these measures are introduced in a systematic way nobody has ever seen a "going back to the before situation". There are many tools to use. I have mentioned humps and similar speed reducing measures where there is a lot of knowledge to-day. One of the most interesting elements is the small round-about. Optimally designed it lower speeds to around 30 km/h at all approaches, gives all road users equal opportunity to interact with other road users, improves safety for all road users, and reduce delay (even for car users when the roundabout replace a traffic signal, noise and emissions and can be used for creating an attractive environment. (SKL2008). Elvik et al (2010-5) reports a reduction by 41% (-47; -34) when changing a four-armed, non-signalised intersection to a small roundabout. Such a roundabout can carry at least 25,000 incoming vehicles per day, and can be made quite small which makes it an interesting concept for most intersections. This makes it important as an element in creating new streets, and the popularity of this concept is demonstrated by the rapid development. In Sweden there were around 150 roundabouts in 1980, to-day there are more than 1500.

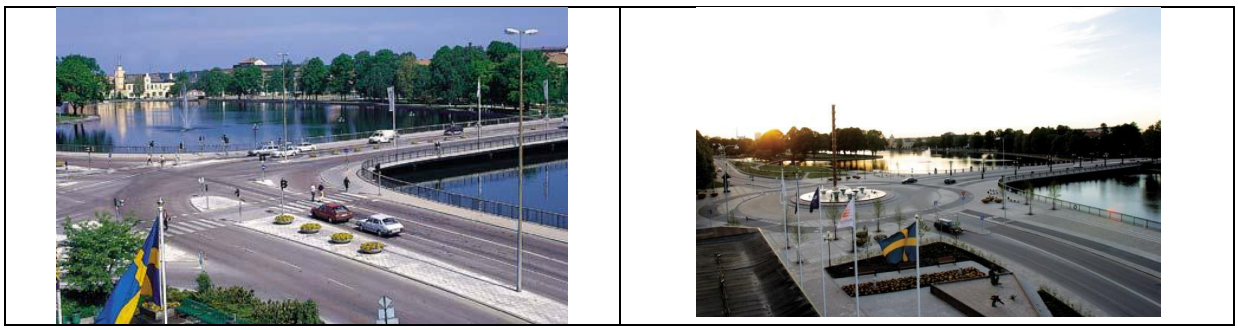

Figure 4 Roundabout in Eskilstuna, Sweden as part of a new street design for revitalization. Before and after reconstruction

## The story of physical separation

I mentioned earlier that separation of pedestrians was abandoned quite early in U.K. Still it was obvious that sooner or later the concept was bound to come back. Sweden, having resources right after the War developed motorisation quicker than most other European countries. One result was of course that problems was evident quite early, and with the resources available it was inevitable to start thinking in separation thoughts. Especially in

view of the very rapid development of new housing areas in the outskirts of cities (the so-called "million program"). It resulted in the 1960-ies in the development of new planning principles called the SCAFT guidelines. (Hagson 2004). The most influential principle was separation of pedestrians and cyclists from car traffic by a completely separated network of routes for these road users. It was implemented in a very large scale during the 70-ies and onward, primarily in connection with the large housing project. Interestingly there have only been a few attempts to assess the effects of this program on the safety of pedestrians and bicyclists. The result is not very conclusive but the discussion has gone on with many – experts and non-experts – skeptical to the concept. Some people were afraid that children would not become prepared to negotiate with traffic in other surroundings when they grew up. Most criticism, however, was based on the fact that this was again a way of offering the best possible roads for motorists; they did no longer have to take care of any conflicts with pedestrians or cyclists. But that was only in theory. It was extremely difficult to reach a high usage rate from pedestrians and cyclists. Still, the result was higher car speeds and greater risk for those who crossed the street at grade. Figure 3 shows a typical "SCAFT-street" built in the 70-ies. Studies in this special case showed a 50% usage of the tunnels, and high speeds, 85-percentile speed being 55 km/h, most probably a rather typical outcome.

Figure 5 "SCAFT-separation" on a street with high speeds and low use of separations

## The Attractive and Sustainable City

The SCAFT-principle has partly survived in the outer parts of cities even though there has been big problems in terms of ugly, narrow, insecure tunnels. It was soon found out that the principle did not work for the inner parts of cities, where there was almost never space available to create something that was attractive and efficient. Besides the opportunities for "town shaping" was almost non-existing. At the same time revitalization of the cities became urgent with large external shopping malls with free parking, etc. Cities only chance was to become more attractive by offering a vivid city life with shopping, cultural activities, cozy walking areas, etc. City streets with 20,000 to 50,000 vehicles per day did not comply with this. Noise, pollution, high risks for pedestrians, restricted space for pedestrians, no attractive housing, etc produced the incentives to start discussions on what could be made. The EU-project ARTISTS was one of the first projects looking at this, but to-day there are numerous examples of domestic projects and EU-projects taking up this scope. In ARTISTS a new approach to planning and designing of urban streets was developed. Traditionally, street planning and design have mainly focused on the streets' function for movement. The new approach is based on the assumption that streets have 'Links' as well as 'Place' functions. As a Link a street is for movement and designed for users to pass through as quickly and conveniently as possible, in order to minimise travel time. As a Place, the street is a destination in its own right, where people are encouraged to spend time taking part in activities. Both functions have their own sets of design requirements. (Svensson 2005). This new principle put a lot of demand on those who had to redesign streets in order to reach both the Link and the Place function. More space for pedestrians and cyclists were

demanded, and the mobility of motorized vehicles had to be "controlled", e.g. with regard to speeds. So, even though the principles of ARTISTS were appreciated in general it is evident that a change takes a long time. But the change is on its way. The "Good city" and the "Attractive city" are concepts that are strongly emphasized during the last years. All Swedish major authorities in transport and housing have together developed a guidance to planners and decision makers, TRAST – Trafik för en Attraktiv Stad (Traffic for an Attractive city. Web version http://www20.vv.se/fud-resultat/Publikationer_000401_000500/Publikation_000483/trast_handbok_utgava_2_webversion.pdf). The aim is to assist these planners and decision makers in the process of developing and gain approval for a local traffic strategy adapted to the local conditions and interests. To me this is just the beginning. I have seen from other countries that the same is going on in many countries, differently phrased but with the same basic concept.
The most important thing that came out of these discussions was the change of focus; from pedestrian safety only to pedestrian welfare in a much broader perspective.

## Speed and automobiles

I have presented a lot of engineering efforts to improve safety and well-being for pedestrians. The red thread is speed. One major problem in this context is the speed and acceleration performance of cars. Every day you can read advertisements for cars with headings like "Zero to 100 km/h in a whisper", and messages saying that strong acceleration power is important from a safety point of view... Why do we to such a great extent neglect the importance of this kind of push on our attitudes? How can we ask a driver to slow down in a residential area when he is sitting in a comfortable car with nice music etc **and** a capability of making 200-250 km/h and an acceleration that takes him to 100 km/h "in a whisper". How can authorities compete with messages like "it is important to adapt speed, 30 km/h is the speed limit, etc". It is no wonder that it is difficult to come through with this kind of perceived negative messages. The industry openly admits that they cannot sell cars with "speed management messages". However, they are now involved in many projects dealing with speed. One of the first – PROSPER – dealt with so called ISA-applications. ISA stands for Intelligent Speed Adaptation, and includes different types of systems; voluntary systems with a beep signal when the desired speed is overridden, active gas pedal that can be overridable or not, etc. To make the story short, in Work Package 4 of PROSPER the following conclusions were presented (Carsten:

* Clear additional benefits from microsimulation modelling for non-overridable system
* ISA has very substantial safety potential
* In macro modelling Authority-Driven Scenario delivers substantially greater benefits than Market-Driven Scenario
* Delay postpones safety benefits and reduces benefit-to-cost ratios

The point is that the authorities have not driven the most efficient systems from a safety point of view – neither in research nor in implementation. My Department carried out research on a non-overridable active gas concept in urban areas in the 1990-ies with quite positive results. However this research was ended in the beginning of 2000, and still to-day there is no research or concept demonstrating any really significant effects regarding controlling speeds and or substantial safety benefits. Instead the industry try to solve the problem in other ways, e.g. night vision, collision warning and other similar systems that could solve problems without "direct" speed management (the aim is of course to give drivers relevant information (e.g. making a pedestrian visible in the darkness) so that they can slow down in time). The most spectacular system to-day I think is the "automatic braking" function, e.g. in Mercedes-Benz PRE-SAFE® Brake and Volvo City Safety. The "simple idea" (not technically…) is to detect obstacles before a collision occurs and thereby introduce an immediate braking thus avoiding a collision or – at least – lower the speed at a

collision. It may very well be that such a system will decrease even pedestrian accidents which of course is quite positive in itself. The problem though is that again we will have a new system introduced where the benefit – **and** welfare for pedestrians is not assessed. How will this system change drivers' behavior, how will it be perceived by pedestrians and what general impact will it have on the attractivity and sustainability of a city? I think that the "pedestrian society" should demand some kind of relevant assessment before these systems are introduced! The problem is that they are already partly implemented. But there will be more systems coming. They will partly "compete" with new ways of organizing traffic so as to make attractive cities for all users. Ideally it would be great if there was an interaction between the two of the most important actors on this scene, namely the road and planning on one side and the industry on the other.

## Education, training, information

I have focused very much on engineering measures simply because the physical environment is what primarily produce the expectations from the users. It does not at all mean that I do not appreciate the importance of communication measures that can change attitudes and norms. However, as individual measures – like education, information and enforcement – they normally do not have the power of making any significant changes. I have already mentioned training of young children, and Elvik et al (2010-6) have for instance shown that "general information campaigns" and campaigns aiming at improving pedestrian safety have no or even somewhat negative effect. And, the main point is still that these kinds of measures can only to a very small degree contribute to the attractive and sustainable city.

## Single pedestrian accidents

So far I have not mentioned may be biggest problem in terms of pedestrians injured. That is single pedestrian accidents. This is a very unfamiliar problem sometimes even for professionals I think. In Sweden 25,000 people have to visit hospital every winter due to falls on slippery pavements. This is a hidden problem, that of course have important implications for pedestrian welfare.

## The need for proper assessment

There is another red thread that I want to bring up in the end of my presentation. That is the lack of "proper enough" evaluation procedures. It is a common phenomenon in safety activities, but probably more critical in pedestrian safety research. We are all pedestrians with everything implied with regard to variation in interests, abilities, needs etc. Pedestrians have in a way the highest degree of freedom in the system, they can move in almost any direction and way. They can be moving from one place to another or they can just take a promenade. All this makes it extremely difficult to predict their behavior and to generalize findings. I will just give you a few examples from a Pedestrian synthesis reports based on U.S. findings. For instance regarding Enforcement: Enforcement of traffic laws and regulations represents another important element in safe pedestrian activity in a roadway environment. While a number of U.S. cities (including Seattle, Milwaukee, and San Diego) have had active police enforcement programs in recent years, no quantitative studies have been done to determine the specific effects of police enforcement on pedestrian crashes and injuries. Such a study would be difficult to conduct because of many other contributing crash factors in a city (FHWA 2004). The same is true for Educational measures have been found to reduce crashes involving child pedestrians to age groups receiving the educational program. However, most U.S. educational programs have received few if any formal evaluations and had limited measurable effects (FHWA 2004).

The conclusion is that assessments are very rare, most probably because they are so complicated to carry out, and also very expensive if you want reliable results. Modeling is almost impossible. Our knowledge about behavior is fairly ok in relation to type of environments etc, but we know almost nothing about what the link is between the ordinary behavior and the risky behavior creating safety problems. This link is simply missing. We in ICTCT (International Cooperation on Theories and Concepts in Traffic safety) started our business by stating that conflicts represent the link between behavior and accidents. The break through is still to come, in spite of the fact that conflicts are used in all other means of transport – air, sea, rail – in order to **understand** what has happened in connection to risky situations. With the other means of transport this benefit (=need) is self-evident without any further discussion of reliability or validity issues. However, when it comes to road traffic the hesitation has been extremely large. There is not much funding spent on "understanding of safety". This almost total hesitation (actually I would like to call it obstruction) has been detrimental in the sense that funding has not been allocated, **and** in the sense that the possibility of sophisticated discussions about how a system works from a safety point of view. Such a discussion would increase the possibility of getting rid of many of the prejudices going around to-day. We love talking about "causes of accidents". In winter time we hear on the radio everyday that there was a car accident and "the cause was probably that the car slipped". As if the driver did not know or understood the slipperiness in advance. We all tend to select "causes" that fits our interests, without any idea about the background for our statements. Habitual drivers tend to blame cyclists and pedestrians, thus causing the accidents. "The cause was that a pedestrian stepped out in front of a car which could not be stopped in time". As if the pedestrian just stepped out deliberately in front of the car!). And the opposite is of course also usual: "The driver saw me but did not stop…"

We need a holistic view on assessment to understand pedestrian safety **and** pedestrian well-being in general. This holistic view makes it even more important to understand the links between behavior and different unwanted events. ICTCT's motto is "We need no accidents". It is about time to convince professionals dealing with assessment activities. One important step forward will be taken thanks to "Image processing". Both at TNO here in Holland, at Lund Institute of Technology and elsewhere, important steps forward are made during the last years, enabling sophisticated analysis of road user behavior and – soon – also being able to analyze behavior, conflicts **and** accidents from the same samples.

## ICTCT:s role in relation to pedestrians

ICTCT has been an active actor regarding pedestrians, not only safety but also pedestrians well-being in general.

I mentioned ICTCT – the International Cooperation on Theories and Concepts in Traffic Safety (www.ictct.org). We organize one so called regular workshop in October/November each year and one Special workshop in Springtime almost every year since year 2000. I have taken the opportunity to look through what topics we have covered at the altogether 28 workshops we have held – see table 2.

We have by now organized almost 30 Workshops over the last 23 years. In table 1 below, I have listed all the 85 presentations that are made with special focus on Pedestrians. In addition a large majority of our presentations are focusing on topics more or less valid also with pedestrians. For instance we have had 3 workshops on Speed Management in different forms, workshops on traffic planning, programs, the future, east and west, etc, see table 2. So on behalf of my organisation, I welcome you all to this 23rd workshop of ICTCT. This will be a fantastic opportunity to improve our knowledge and understanding of every possible aspect on Pedestrian welfare.

Table 1 Pedestrian presentations and themes at ICTCT Workshops

| **Topic** | **No. of pedestrian pres.** |
|---|---|
| Pedestrian qualities in general | 15 |
| Engineering measures for pedestrians | 12 |
| Accidents and Accident modeling | 12 |
| Pedestrians in Programs | 11 |
| Road user behavior | 9 |
| Elderly | 8 |
| Children | 8 |
| Perception and Cognition | 3 |
| Risk modeling, Conflict studies, Simulation | 3 |
| Single pedestrian accidents | 2 |
| Speed Management | 1 |
| Alcohol and drugs | 1 |

Table 2 Themes at ICTCT Workshops1988– 2009

| **No.** | **Year** | **Place** | **Theme** |
|---|---|---|---|
| 1st, | 1988 | Vienna | |
| 2nd | 1989 | Munich | |
| 3rd | 1990 | Cracow | Accidents/near accidents models |
| 4th | 1991 | Vienna | |
| 5th | 1992 | Helsinki/Tallinn | |
| 6th | 1993 | Salzburg | |
| 7th | 1994 | Prague | Pedestrian problems |
| 8th | 1995 | Paris | |
| 9th | 1996 | Zagreb | East and west |
| 10th | 1997 | Lund | New approaches |
| 11th | 1998 | Budapest | |
| 12th | 1999 | Kaiserslautern | Speed Control; principles, methods, measures |
| 1st Extra | 2000 | Delhi | Traffic Calming; From analysis to solutions |
| 13th | 2000 | Corfu | Evaluation, validation, implementation of measures to improve transport safety |
| 2nd Extra | 2001 | Nagoya | Intelligent speed adaptation |
| 14th | 2001 | Caserta | Road user characteristics with emphasis on lifestyles, quality of life and safety |
| 15th | 2002 | Brno | Speed management strategies and implementation planning, evaluation, behavioural, legal & institutional issues |
| 3rd Extra | 2003 | Vancouver | Safe non-motorised traffic planning, evaluation, behavioural, legal & institutional issues |
| 16th | 2003 | Amersfoort | Improving safety by linking research with safety policies and management models for analysis, implementation of measures and solutions, and evaluation |
| 17th | 2004 | Tartu | Cost-effective solution for improving road safety in rural areas; Integrating the 4 Es: education, enforcement, engineering and electronics |
| 4th Extra | 2005 | Campo Grande | Measures to assess risk in traffic as reflected by individual test performance, in attitude measurement and by behaviour and interaction |
| 18th | 2005 | Helsinki | Telematics and Safety, technical, social and psychological aspects |
| 19th | 2006 | Minsk | National traffic safety programs: concepts and practice<br>Technical, behavioural and organisational aspects. |
| 5th Extra | 2007 | Beijing | Road user behaviour with a special focus on vulnerable road users Technical, social and psychological aspects |
| 20th | 2007 | Valencia | Towards future traffic safety - Tendencies in Traffic Safety Research based on 20 years of experience |
| 6th Extra | 2008 | Melbourne | Intersections: Points of communication and points of risk Innovative intersection design for safety and mobility |
| 21st | 2008 | Riga | Engineering solutions to improve traffic safety in urban areas - Addressing technical, social and behavioural aspects |
| 22nd | 2009 | Leeds | Towards and beyond the 2010 road safety targets - identifying the stubborn issues and their solutions |

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