

# ARTERIAL ROADS DO NOT HAVE TO BE BIG, UGLY AND DIFFICULT FOR NON-MOTORISTS

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## ABSTRACT

The objective of this paper is to describe the evaluation and effects of a major reconstruction of an arterial street in Eskilstuna, a medium sized Swedish town. The aim of the reconstruction was to minimize the barrier effects of the arterial street and by that create a stronger connection between the town center, on one side of the street, and the town-river, on the other; but also to create generally better conditions for primarily unprotected road users in that area of the city.

This paper studies how traffic safety, subjective safety, pass ability, accessibility, attraction, aesthetics and air pollution are influenced by this reconstruction. Both objective and subjective measurements have been used.

The reconstruction gave positive effects on most of the aspects studied and although the primary aim of the project was not to improve traffic safety the results were very positive in this respect as well. The most negative outcome was an increase in car emissions due to more accelerations and decelerations. In total the positive effects are overriding the negative ones by far and the study shows that by making some sacrifice in the mobility and comfort for motor vehicle occupants the attraction and esthetics of the area has increased as well as the traffic safety. An attempt has also been made to value the changes regarding different aspects for different types of road users. This clearly shows the stronger benefits for unprotected road users compared with the motorists.

## INTRODUCTION

Hamngatan is a primary road that runs through down town Eskilstuna, a medium sized Swedish town (the municipality has about 90 000 inhabitants). The street formed an efficient barrier between the Eskilstuna River and the town centre. Before the reconstruction it was evident that Hamngatan and the area around was a transportation link for motorists; there were no cycling paths and the pedestrians had only small sidewalks at their disposal. When crossing the street at the most used spot, pedestrians had to cross five to six traffic lanes. The before situation were according to the ideals of the 1960s, and made sure to provide a good accessibility for motorists. The design offered hardly any assistance for unprotected road users. Figure 1 shows Hamngatan before reconstruction.



## METHOD

The aim of the study was to examine how the traffic situation and the area around Hamngatan had changed due to the reconstruction. In order to do so, seven different aspects were examined: **traffic safety, subjective safety, pass ability, accessibility, attraction, aesthetics and air pollution**. These aspects have been examined by eleven different studies:

1. Chasing-car study
2. Spot speed measurement with radar
3. The Swedish conflict study
4. Study of car drivers yield behaviour towards pedestrians
5. Registration of pedestrians and cyclists choice of route
6. Study of the waiting time for pedestrians at crossings
7. Pass ability study at Nybroplan (the major crossing at Hamngatan)
8. Interview study with road-users and residents
9. Questionnaire study with road-users and residents
10. Round-table discussions with visually disabled people
11. Interviews with experts on the reconstruction

The objective was to collect both objective (1 to 7) and qualitative/subjective (8 to 10) data, as well as experts' opinions (11) in order to evaluate the effect of the reconstruction, whether the aims of the project were met and how the new situation was viewed. The experts' opinions are to view both as objective and subjective, depending on that is to be examined. Table 1 gives an overview over which studies that have been used to examine the different aspects.

*Table 1: Studies that have been used to examine the different aspects.*

Aspect	Objective data	Subjective data
Safety	1, 2, 3, 4	11
Subjective safety	3, 4	8, 9, 10, 11
Pass ability	4, 5, 6, 7	8, 9, 10, 11
Accessibility	11	8, 9, 10, 11
Comfort	5, 6, 11	8, 9, 10, 11
Attraction	5, 11	8, 9, 10, 11
Aesthetics	11	8, 9, 10, 11
Air pollution	1	9, 10, 11

### **Chasing-car study**

A random chosen car is followed by an instrumented vehicle. The instrumented car follows the car ahead as exactly as possible. The speed of the instrumented car was registered in a data log once every second and starting point and intersection passed were registered manually by the co driver.

During the study 360 cars was followed at different time during the day (from 7.00 till 18.00). The vehicles speed profiles were used for simulations of the energy consumption and the exhaust fumes. The estimations refer to a car with catalytic converter according to the Veto model version 2000 (Hammarström and Karlsson 1987, validated Hammarström 1999). Both before and after studies were carried out.

### **Spot speed measurement with radar**

Radar is used to measure the speed of vehicles at places where unprotected road users crosses the street. At each point the speed of 100 free cars were measured. The data is collected at working days between 8.00 and 17.15. In all, data from eleven places were collected; three of the places are at the reconstructed part of Hamngatan. With exception of one of the places, both before and after studies were carried out.

### **The Swedish conflict study**

The study was made by a trained conflict observer according to the Swedish conflict technique (Hydén 1987). Three places were studied, two within the reconstructed area (16 hours observation) and one outside (8 hours observation). Each place has both been studied in field and from videotape. In the analysis the computer program CDBace (Ekman 2001) was used. Both before and after studies were carried out.

### **Study of car drivers yield behaviour towards pedestrians**

The study was made by examine videotape 6.5 hours each both in the before and after situation. How the car drivers behaved (yield behaviour and speed chose) at the zebra crossing were registered. Between the before and after study a law concerning motorists obligation to give way at zebra crossings was changed (the law was changed in May 2000). In order to be able to examine how much of the changed behaviour was caused by the reconstruction and how much was caused by the change of the law the same study was carried out at a control place in Eskilstuna.

### **Registration of pedestrians and cyclists choice of route**

The study was carried out in field at the major intersection at Hamngatan. Random chosen pedestrians and cyclists coming from north were studied. The road users were studied in an area along Hamngatan limited by the new signalized zebra crossings about 100 meters east and west of the major intersection. In addition to the choice of route, the age (10-years intervals), sex and if/how they use the signal at the zebra crossings were noted. Pedestrians and cyclist were studied 16 hours each.

### **Study of the waiting time for pedestrians at crossings**

The study is made from analysing videotapes from three different intersections, two within the reconstructed area and one outside of the area. Four measurements were examined.

1. The waiting time: how long the pedestrian has to wait at the sidewalk before being able to cross.
2. (No waiting time: percentage of pedestrians that do not have to wait before crossing.)

3. Walking time 1: walking time when not disturbed by other road users
4. Walking time 2: walking time when the pedestrian has to stop or slow down at the island due to approaching vehicle.

The study is carried out both before and after reconstruction.

### **Vehicle's pass ability study at Nybroplan (the major crossing at Hamngatan)**

The time from when the vehicle gains contact with the intersection (could be traffic jam, waiting before entering the intersection or when entering the intersection) until the vehicle passes a fix point on the other side of the intersection is measure from videotapes. The study is carried out at pike-hour in the morning (8.00) and at of-pike-hour (11.00) both before and after the reconstruction. Each time 100 vehicles have been studied. Only vehicles on Hamngatan coming from east, going west have been studied.

### **Interview study with road-users and residents**

The study is carried out as a comparative study after the reconstruction. Pedestrians, cyclists, elderly road users (65 years and above), disabled road users, car drivers and residents were interviewed about the changes at Hamngatan with open questions. In total were 52 persons interviewed: 11 pedestrians, 9 cyclists, 10 elderly road users, 4 disabled road users, 8 car drivers and 10 residents.

### **Questionnaire study with road-users and residents**

With the interview study as underlying information, a comparative questionnaire study was carried out after the reconstruction. The respondents were asked to state the effect of the reconstruction in different parameters. Most of the statements were given on a 1-5 scale; a couple of questions were answered with an open answer. In total 445 road users answered the questionnaire; 159 pedestrians, 59 cyclists, 16 disabled road users, 127 elderly road users (65 years and above), 100 car drivers and 122 residents.

### **Round-table discussions with visually disabled people**

During a three-hour long round-table discussion the traffic situation for visually handicapped people, both generally and at Hamngatan, was discussed. Participants in the discussion were five people with different degree of visually handicap and one discussion leader; minutes were taken by two people. The discussion took place after the reconstruction.

### **Interviews with experts on the reconstruction**

10 of the people that were responsible for the reconstruction were interviewed one at the time after the reconstruction was finished. Among the respondents were decision-makers, planners and practitioners. Each interview took about one hour and had two main parts: The first part was a set with open questions that considered aim, motive and realization aspects. In the second part (also with open questions) the respondents were asked to make assumptions of different road users preferences and criticism.

## RESULTS

### The traffic safety

According to both the chasing-car study and the spot speed measure, the speed at Hamngatan has decreased. The spot speed measurement shows that the mean speeds at intersections where unprotected road users cross has decreased with between 15 % and 50 %. If Nilsson's (1984) power model is applied, this indicates a reduction of the injury accidents by 28-75 %. This, however, can be an overestimation of the effects. Experiences from other studies where similar reduction of speed have occurred indicate a reduction of injury accidents by 40-45 %.

At the same time other measurements increasing the traffic safety have taken place, for example has the street width decreased strongly (from at some parts six traffic lanes to two traffic lanes) and at two of the intersections roundabouts have been constructed. All in all, the total effect of the changes is estimated to a reduction of the injury accidents by 40-45 %. The time passed after the reconstruction is however too short to confirm this. The conflict studies that have been made support this estimation; however, the estimation made by the conflict studies is uncertain because of the small number of conflicts occurred.

### Subjective safety

The unprotected road users say that they feel a bit safer to cross the street after the reconstruction compared to before the reconstruction. They also state that the speed of the traffic has decreased and that the motorists behave better after the reconstruction.

A factor that can influence the unprotected road users' opinion about their safety is the increasing demand of cooperation between different categories of road users. The responsibility for the traffic has shifted from for example traffic signals to the road users. The majority of the unprotected road users state however that they feel they have more control over the traffic situation after the reconstruction than before. The change in how the cooperation in traffic works, in combination with low speeds, is a basic principle of a safe teamwork between car drivers and unprotected road users. It is however not certain that the subjective safety is increased by this; especially groups of road users with special needs can experience this demand of teamwork troublesome, as the people with impaired vision in this study expressed.

### Pass ability

The unprotected road users pass ability has increased strongly. The average waiting time at the zebra crossings has decreased by 56-97 %, and about 80 % of the pedestrians do not have to wait at all before crossing the street. The average waiting time per person after reconstruction is about 1-2 seconds. This increase in pedestrians pass ability is, among other things, due to the drivers' improved yielding behaviour. Also the time to cross the street has decreased; the average time to cross the street is after reconstruction is 7-8 seconds, which is a decrease with 35-62 % compared to the before situation.

The pass ability for the car drivers has, however, decreased. At the 1055 meter long street that was examined, the time consumption increased by between 41 % and 45 %; this means an average increase on the whole stretch with about 45 seconds.

### **Accessibility**

The accessibility has according to the standards increased. This is according to the experts opinions. If the wider concept "usefulness", that contains a strongly subjective part, is used there are some problems for people with impaired vision. The usefulness for this group could increase if the indications for guide dogs were improved and/or through more systematic use of tactile surfaces, contrasts, lines and posts that leads and give limitations and directions. Systematic information about the changes helps this group to adjust quicker to a new environment.

### **Comfort**

The majority of the unprotected road users (62 %) think that it after the reconstruction is easier to cross the street; the cyclists experience the largest change.

A majority of the car drivers (60 %) thinks however that it has become less comfortable and less convenient to drive along Hamngatan. A fourth thinks that it has become more comfortable and more convenient.

### **Attraction**

For the unprotected road users the situation on Hamngatan has generally become more attractive. A big majority thinks that the new situation generally is advantageous and that it is more pleasurable to stay along at Hamngatan after the reconstruction; a smaller part of the respondents thinks that there are disadvantages with the reconstruction or that the situation at Hamngatan has become worse. The people that live in the area are also satisfied with the reconstruction and about 40 % thinks that it has become more attractive to live in the area; about 4 % thinks the other way around.

The car drivers do not see as many advantages with the reconstruction as the unprotected road users do. About a third of the car drivers think that the reconstruction has advantages and about the same number of people state that they don't see any disadvantages. A majority however, don't see any advantages with the reconstruction and about 50 % of the respondents state that the new layout of the street has disadvantages. On the other hand a bit more than 50 % state that it have become more attractive to drive along Hamngatan.

### **Aesthetics**

For the experts (politicians, municipality employed, architects etc.) improvements of the aesthetics were one of the goals with the reconstruction and in their opinion this goal is fulfilled.

All categories of road users agree that the aesthetics have become much better after the reconstruction; also the car drivers agree quite unanimous about this. Even the people with impaired vision mentioned aesthetics as something very positive in their statements.

All together it can be established that the aesthetics is the aspect, among the ones examined, that shows the greatest improvement.

### **Air pollution**

Since the time consumption for the car drivers in general has increased there was a suspicion that the exhaustion and energy consumption would increase as well. Studies of these parameters through simulation have therefore been carried out. The result shows that if the decrease in traffic volume is taken into account it is only the CO<sub>2</sub> that have increased; the other exhaustions are about the same as before. These effects are at a local level.

## Summary

An attempt was made to summarise the results in marks, see table 2; +++ means very good, ++ good, + good enough, - not so good, -- bad and 0 unchanged. An empty square means that the aspect could not sufficiently good be judged by the collected data. The marks for the different road users reflect our (read the authors) interpretation of the statements. The total estimation shows how we think the situation ought to be estimated from the society/public authority point of view.

*Table 2: "Marking" of the aspects for different groups of road users and the society.*

	Car drivers	Cyclists	Pedestrians	Elderly people	Disabled people	Residents	Total
Traffic safety	+	++	++	++	++	++	++
Subjective safety		+++	++	++	+	+++	++
Pass ability	--	++	++	++	++	+	+
Accessibility	-	+++	+++	+++	++	+++	++
Comfort	-	++	+++	++	+	++	+
Attraction	+	+++	+++	+++	+++	+++	+++
Aesthetics	+++	+++	+++	+++	+++	+++	+++
Air pollution	-	-	-	-	-	-	-

## DISCUSSION

The main purpose with the reconstruction of Hamngatan in Eskilstuna was connecting important parts of the town (town centre with shops, restaurants, residents, etc.) with its most attractive parts around the river. Implicit this improvement would increase the attraction of the whole town, and increase the quality of life in Eskilstuna. In practice this goal is met – and it is met without major disadvantages in other aspects.

All groups of road users agree that the attraction of the area in generally has increased; especially the aesthetic qualities, that have increased a lot. At the same time the traffic safety has increased (a lot). The accidents will according to our predictions decrease strongly, especially accidents involving unprotected road users. Furthermore will the accidents that occurs be less severe, with fewer severe injured or killed; the risk of severe injures and deaths will most likely be reduced very much. Even if increasing the traffic safety was not a major goal with the project, this is very positive results.

Further has the non motorists pass ability strongly increased, at the same time has however the motorist pass ability decreased. This is a classic problem when dealing with traffic calming measurements. The deterioration is not drastic, in average less than a minuet when driving the whole stretch.

All the advantages with the reconstruction are “paid” with this deterioration of the car drivers pass ability (and perhaps a slight increase in emissions, but the regional and the long term effects are very hard to estimate). But non motorists are more often injured or killed. It is true that there are many single accidents were pedestrians and cyclists are injured, but really severe injuries occur most often when cars are involved. A logic consequence of this is that the physical danger that the cars constitute have to be reduced. The main method to do this is to decrease the speed of the motor traffic. In the case at Hamngatan this is done by infrastructural measurements.

Car drivers or persons representing car drivers can look positively of this (and some do) – by accepting changes like the ones at Hamngatan they can make a considerable contribution to improving the traffic safety, and at the same time contribute to increase the attraction of the town and the quality of life in Eskilstuna.

## REFERENCES

Ekman, L., 2001, Short manual for CDBasew.exe

ULR:<http://www.tft.lth.se/research/cdbasew.htm> (2002-11-18)

Hammarström, U. & Karlsson, B., 1987, Veto- ett datorprogram för beräkning av transportkostnader som funktion av vägstandard. VTI meddelande 501, 1987 Linköping, Sweden.

Hammarström, U., 1999, Mätning och simulering av bilavgaser körning med och utan husvagn i laboratorium och på väg. VTI meddelande 856, 1999. Linköping, Sweden.

Hydén, C., 1987, The development of a method for traffic safety evaluation: The Swedish Traffic Conflicts Technique. LTH Bulletin 70. Lund, Sweden.

Nilsson, G., 1984, Speeds, accident rates and personal injury consequence for different road types. VTI Report 277, 1984. Linköping Sweden.

## APPENDIX I

In pictures i-iv some before/after pictures from Hamngatan are shown.



Figure i: The major intersection at Hamngatan before reconstruction.



Figure ii: The major intersection at Hamngatan after reconstruction.



Figure iii: The second major intersection at Hamngatan before reconstruction.



Figure iv: The second major intersection after reconstruction. (Please note that the pictures are taken in opposite directions.)

The following pictures (figure v-ix) some details from the new layout are shown.



*Figure v: A scene from the major intersection.*



*Figure vi: Example of the pedestrian and bike paths.*



*Figure vii and viii: Pictures from the new park.*



*Figure ix: The marina inspired stroll area.*