

EXAMPLES FOR THE APPLICATION
OF TRAFFIC CONFLICT TECHNIQUE
FOR THE ANALYSIS OF BLACK SPOTS

1. INTRODUCTION

In 1984 in the western part of Austria an extensive accident inquest was carried out with the aim to detect the specific risks of holiday traffic. 12 black spots were determined. Six of them rested untreated whereas on six other sites remedial measures were taken. In the sense of a before - after - design the efficiency of the taken measures should be analysed. The six untreated sites should show, whether there had been a change in accident - resp. traffic conflict occurrence by change of traffic conditions, or not.

The observed period comprised in the "before"-study the time space from June to September 1984 and in the "after"-study time space from June to September 1985. The "afterwards" inquest 1985 were carried out on the same week-days and within the same periods of the month of the summer-month June and July as the year before.

2. MEASURES AT THE BLACK SPOTS

The following variables were observed:

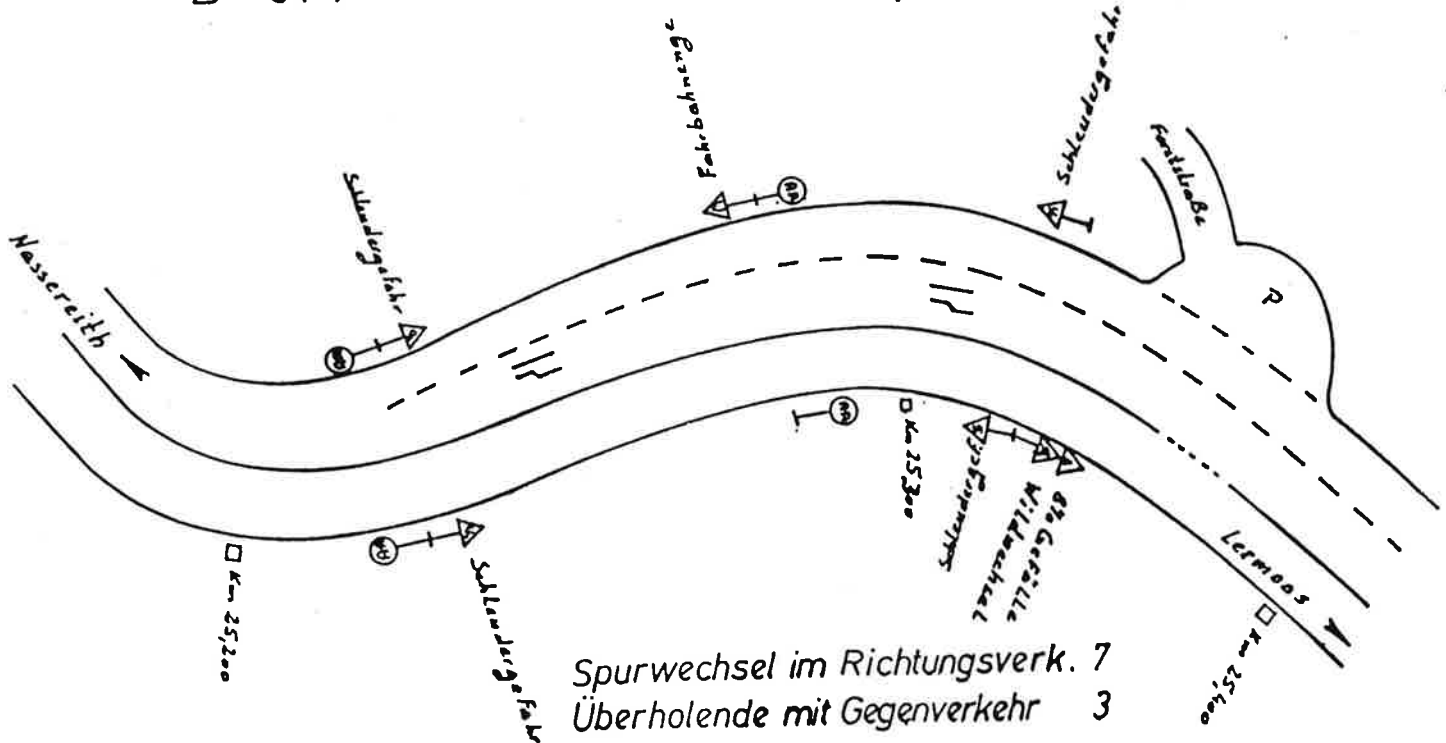
- the quantity of traffic conflicts
- the quantity of accidents with personal injury
- the quantity of vehicles per hour
- the mean of driven speeds.

2.1. Black spot on the Fernpaß - Federal Highway B 314 at Km 25,3

On this spot the Fernpaß - Federal Highway rises coming from Lehrmoos and going in the direction of Nassereith, whereat the lane narrows in a left curve. On the end of the narrowing there is a right curve.

Graph 1

B 314 km 25,350 Fernpaß 1984



On this spot the following improvements were strived for:

- reduction of severe lane changing conflicts and
- decrease of overtaking conflicts as most dangerous events on that spot.

By these measures should be achieved, that the drivers attention should be called earlier as yet and supplied by pavement paintings to the lane narrowing. It should be proved, whether the quantity of rear and conflicts outside of the directly observed area rised.

The following measures were suggested to the authority and were in fact realized:

- o Announcement of the lane narrowing in the direction "Fernpaß" by the traffic sign "lane narrowing" on both sides.
- o Change of the prohibition line in the area of lane narrowing (improve perception resp. adaptation of the line trace)
- o The traffic sign "prohibition of overtaking" in the driving direction of "Fernpaß" was set approximately 100m earlier.

Observed change in the traffic conditions:

In the observation period there were registered 8 lane changing conflicts, two overtaking conflicts and two rear end conflicts. In the before period 1984 45 lane changing conflicts, 26 overtaking conflicts and 13 rear end conflicts were observed. Severe conflicts and near-accidents ceased entirely. According to the observers estimate the traffic flow was better in the observed area as well as outside. Rear end problems were conspicuous. The expectation of a reduction of severe lane changing and overtaking conflicts had been fulfilled although the traffic frequency increased by a third compared with the previous year.

Table 1: Conflict occurrence 1984/1985 on Fernpaß at Km 25.3

type of conflicts	1984		1985	
	A	S	A	S
right turn conflicts	3	0	0	0
lane changing conflicts	45	7	8*	0*
overtaking conflicts	26	3	2*	0*
rear end conflicts	13	0	2*	0
all conflicts together	87	10	12*	0*

Within the table the letter "A" stands for "all conflicts" and "S" stands for "severe conflicts". The figures marked with asterisc (*) stand for significant changes compaired with the preceeding investigation represented in confidence intervals on the basis of a Poisson-distribution (Alpha is smaller or equal 5%).

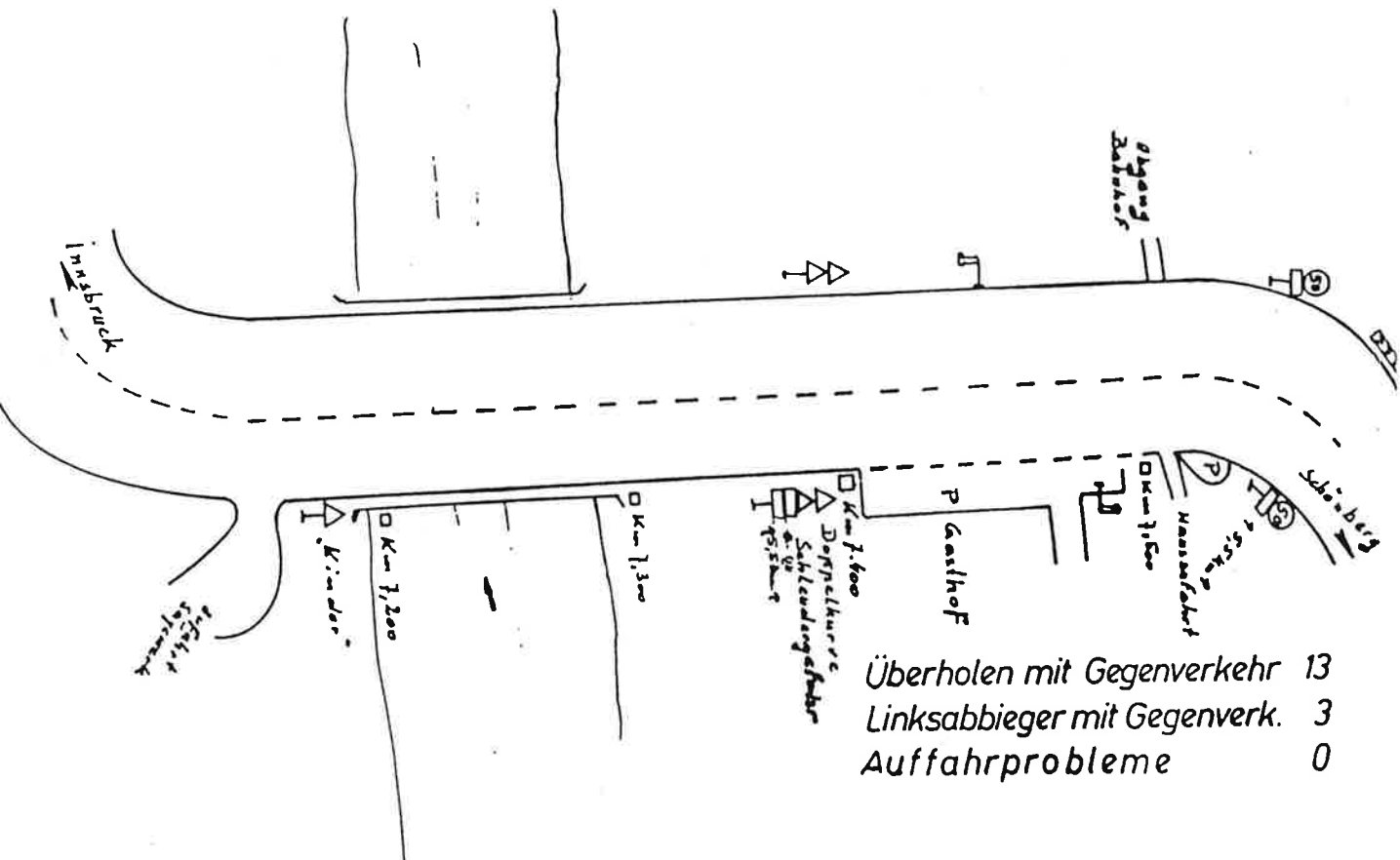
On the observed spot on the Fernpaß the mean speed in 1985 was 59 km/h opposite to 64 km/h the year before. Considering the already low mean speed that is a considerable decline which could be attributed to the changed optical design of the road space. But there was no variation of the 85%-speed, which was 68 km/h in 1984 and 69 km/h in 1985. It seems, that drivers choosing consciously high speed are less influenced in their speeding behaviour by the measures as taken at this place.

1.2. The "Brenner"-Federal Highway B 182 at km 7.4 near Mutters "Stefansbrücke"

Coming on from Innsbruck the "Brenner"-Federal Highway rises in the direction of "Brenner"-pass. After a sharp left curve the Federal Highway crosses over a bridge the Sill-river. A guest-house with parking place is situated on the right handside. After the guest-house follows a sharp right curve.

Graph 2

1984 B 182 km 7,40 Mutters Stephansbrücke



The main goal in the Stefansbrücke-area was to reduce the amount of severe overtaking problems especially for overtaking manoeuvres in the curves. That should be achieved by better optical design of the road space.

The following measures were selected in order to solve the problem:

- painting the prohibition-lines in both curves
- fixing leading planks on the outside curve in the uphill going right curve.

Change in the traffic conditions:

On this spot overtaking- and lane-changing-conflicts represented the main problems 1984. Both kinds of conflicts have diminished considerably 1985 compared with the previous year.

Nevertheless now as before there occurred severe overtaking conflicts although the amount dropped to about one third compared with the previous year. The goal to eliminate entirely the critical driving manoeuvres could not be achieved, but an improvement of the situation could be noticed. The high amount of near accidents caused by carrying out left-turn manoeuvres to the guest house parking place was nearly constant. They were not influenced by the measures taken.

Table 2: Conflict events 1984/1985 at Stefansbrücke (B 182) at
Km 7.4

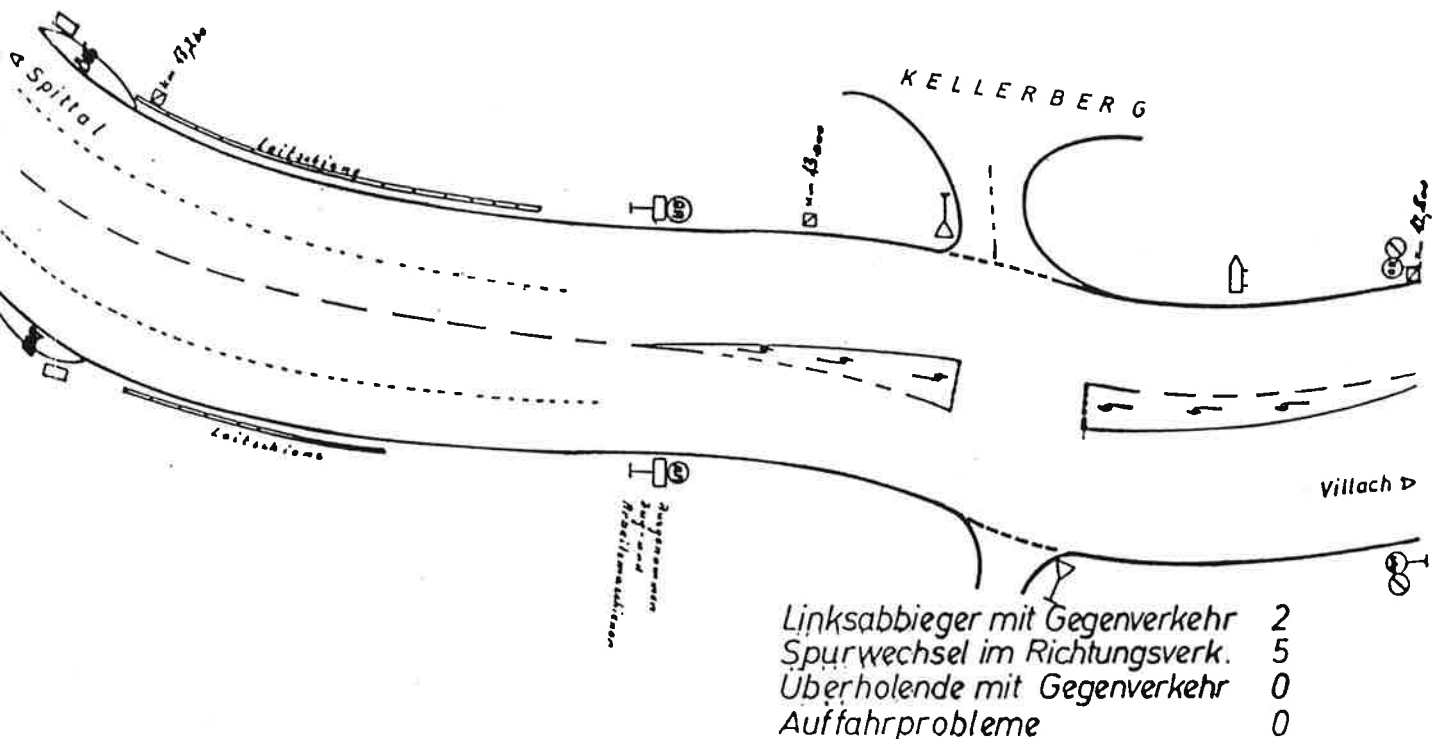
kind of conflict	1984		1985	
	A	S	A	S
right turn conflicts	6	0	0*	0
left turn conflicts	3	3	4	2
lane changing conflicts	27	0	4*	0
overtaking conflicts	30	13	4*	4*
rear end conflicts	3	0	3	2
all conflicts together	69	16	15	8

Unexpected was the occurrence of severe rear end conflicts after the setting of the measures and that one time in connection with an unexpected right turn manoeuvre and another time in connection with an overtaking manoeuvre that had to be stopped. The amount of near-accidents could be halved by setting the measures. The mean speed did not change compared with the previous year (62 km/h in both years). The 85% speed dropped from 97 km/h in the year 1984 to 69 km/h in the year 1985, what could well be a consequence of the taken measures.

1.3. "Drautal"-Federal Highway B 100 at km 13.0 in the area "Kellerberg"

The "Drautal"-Federal Highway was on that spot coming from Spittal and leading in the direction Villach supplied with four lanes and narrowed in the Kellerberg area from four to two lanes. In the middle between the two lanes a special line up-lane for left turning manoeuvres was established.

Graph 3 B 100 km 13,00 Kellerberg 1984



The following effects should be achieved on this crossing between the B 100 and the entrance to the village of Kellerberg:

- decrease of the amount of severe lane changing conflicts directly in the crossing area
- absence of severe left turning conflicts
- reduction of overtaking conflicts

Analogous to the proceedings on the Fernpaß it should be achieved thereby to call the driver attention to the lane narrowing resp. to the crossing area.

The taken measures:

- o Additional pavement painting of three arrows directing to the right (in the direction "Villach").
- o Setting up of three traffic sign "lane narrowing" on the left road side (in the direction "Villach") as supplement to the pavement paintings between the right directing arrows.
- o Setting up of additional traffic signs "lane narrowing" with symbolic representation of the "zip"-principle and the inscription "Let traffic from the other lane get into your lane".
- o Pavement painting of a prohibition area of 100 m length in the middle of the street to mark clearly the lane narrowing from two to one lane in the direction "Villach" (km 13.1 to km 13.0). By that measure the line-up lane for left turning manoeuvres should be made safer.

Changes in the traffic conditions:

On that spot an impressing reduction of the number of traffic conflicts could be achieved. Only two kinds of traffic conflicts could be observed after the implementation of the measures, namely overtaking and rear end conflicts.

Table 3: Conflict occurrence 1984/1985 on the B 100 highway in Kellerberg at km 13.0

Type of conflict	1984		1985	
	A	S	A	S
right angle conflicts	19	0	0*	0
left turner conflicts	2	2	0	0
right turner conflicts	4	0	0	0
lane changing conflicts	62	5	0*	0*
overtaking conflicts	19	0	2*	1
rear end conflicts	46	0	2*	1
all conflicts together	152	7	4*	2

The result is not as satisfactory as it may seem at the first sight: The amount of severe conflicts indeed was reduced to a quarter. However for the first time a severe overtaking conflict with four vehicles involved occurred. That might have the reason in the fact that an announcement referring to the chance of overtaking might have been misunderstood by some drivers. The announcement was set up shortly before the Kellerberg crossing in the direction to Villach. So the crossing has been regarded by these drivers as chance for overtaking. Therefore the table has been transferred to another place after our analyses in 1985.

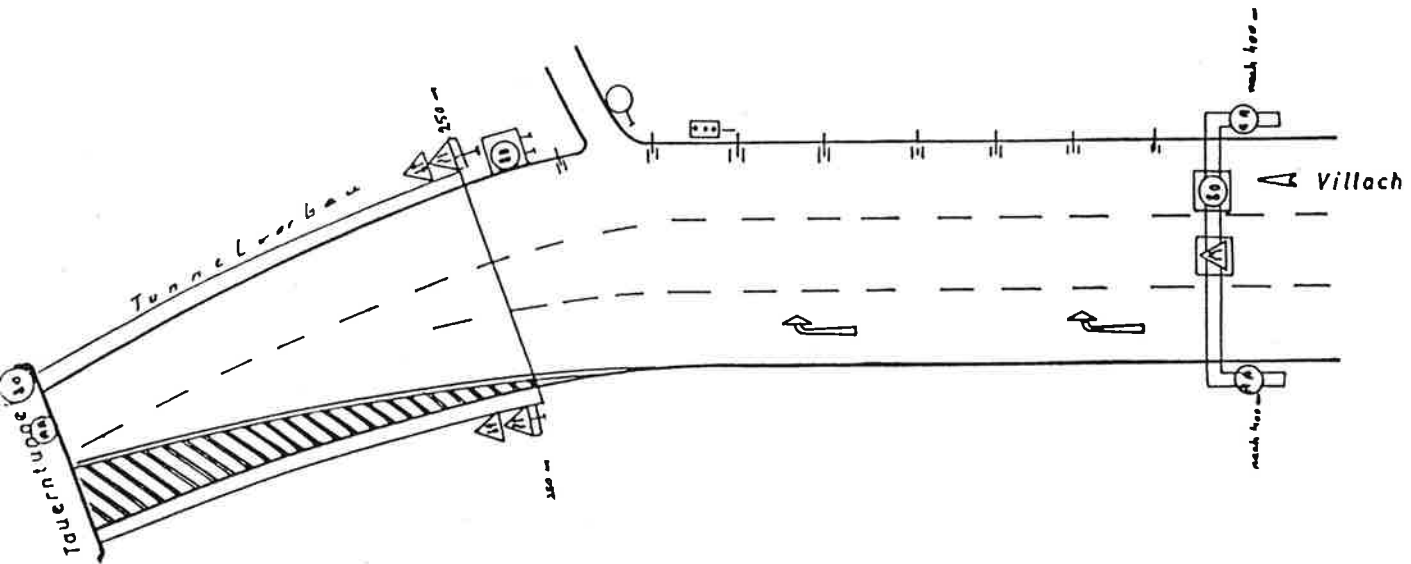
On that spot a considerable increase of traffic frequency had to be handled: The density of traffic rose from 650 vehicles per hour in 1984 to 901 vehicles in 1985. This increase gives evidence that the results have to be judged quite positive. To the mean speed of 78 km/h in 1984 stands opposite a mean speed of 76 km/h in 1985. The 85% speed declined from 91 km/h in 1984 to 88 km/h in 1985. The speeding behaviour could obviously not be influenced by the reorganisation of the Kellerberg crossing. The main effect for the reduction of the number of traffic conflicts was indeed due to the better orientation and the announcement of a critical situation.

1.4. "Tauernautobahn" (Tauern freeway) A 10 at km 80.6, area before the tunnel entrance

Coming from Salzburg the "Tauernautobahn" ascends in the direction of the entrance of the "Tauern-tunnel". On the uphill going section there are three lanes in that direction which are narrowing before the tunnel to one lane.

Graph 4

A 10 km 80,600 Flachau 1984



Spurwechsel im Richtungsverk. 10

The main danger on that spot were the severe lane changing conflicts on the narrowing from three to one lane. The mixing section of the middle and the right lane were overlapping. Additional lane changing manoeuvres were often set in the last moment before the entrance of the tunnel. Therefore the pavement painting should be changed in that sense, that the both merging areas should be separated, so that lane changing manoeuvres should take place earlier and step by step.

The implemented measures:

- o Begin for the narrowing of the three lane at km 80.5 (before: 80.7)
- o Application of four oblique right showing pavement painted arrows on the third (left) lane over a stretch of 210 m, to divert the drivers from the third lane to the second lane in time.
- o The first and the second lane were separated by a prohibition line from km 80.5 to km 80.8, so that the two traffic flows could not merge earlier than in the area immediately before the tunnel.
- o The traffic signs "lane narrowing on the left side" and "oncoming traffic" with the additional table "250 m" were transferred from the begin of the tunnel front building 54 m

- into the front building and were set up in an inside illuminated design.
- o Over the two lanes in the direction "South" an announcement table was put with a symbolic representation of the "zip"-principle and the inscription "Let them get into the lane" and additionally the speed limit "80 km/h" was announced by an inside illuminated traffic sign.
- o At km 81.0 on both sides the traffic sign "Overtaking prohibited" was put, which was beamed on by a light emitter.
- o From km 81.0 to 81.1 at the beginning of the one lane traffic through the "Tauern-tunnel" in the direction "South" three reflecting guard rails were set up.

Changes in the traffic conditions:

If one takes as a measure for the achievement of the goals the decrease of the total amount of traffic conflicts from 1984 to 1985 the changes in the design of the road space were efficient. The number of near-accidents declined considerably compared to the previous year.

Table 4: Conflict occurrence 1984/1985 on the A 10 freeway at Flachau at km 80.6

Type of conflict	1984		1985	
	A	S	A	S
lane changing conflicts	97	10	10*	2
rear end conflicts	14	0	6*	0
all conflicts together	111	10	16*	2*

It is nevertheless important to point out that a reduction of traffic quantity of 33% from 600 vehicles per hour in 1984 to 451 vehicles per hour in 1985 happened. Despite the decline of traffic quantity the mean speed on that observation spot decreased from 74 km/h in 1984 to 69 km/h in 1985. The 85% speed did not change, however. It was 87 km/h in 1984 and 86 km/h in 1985.

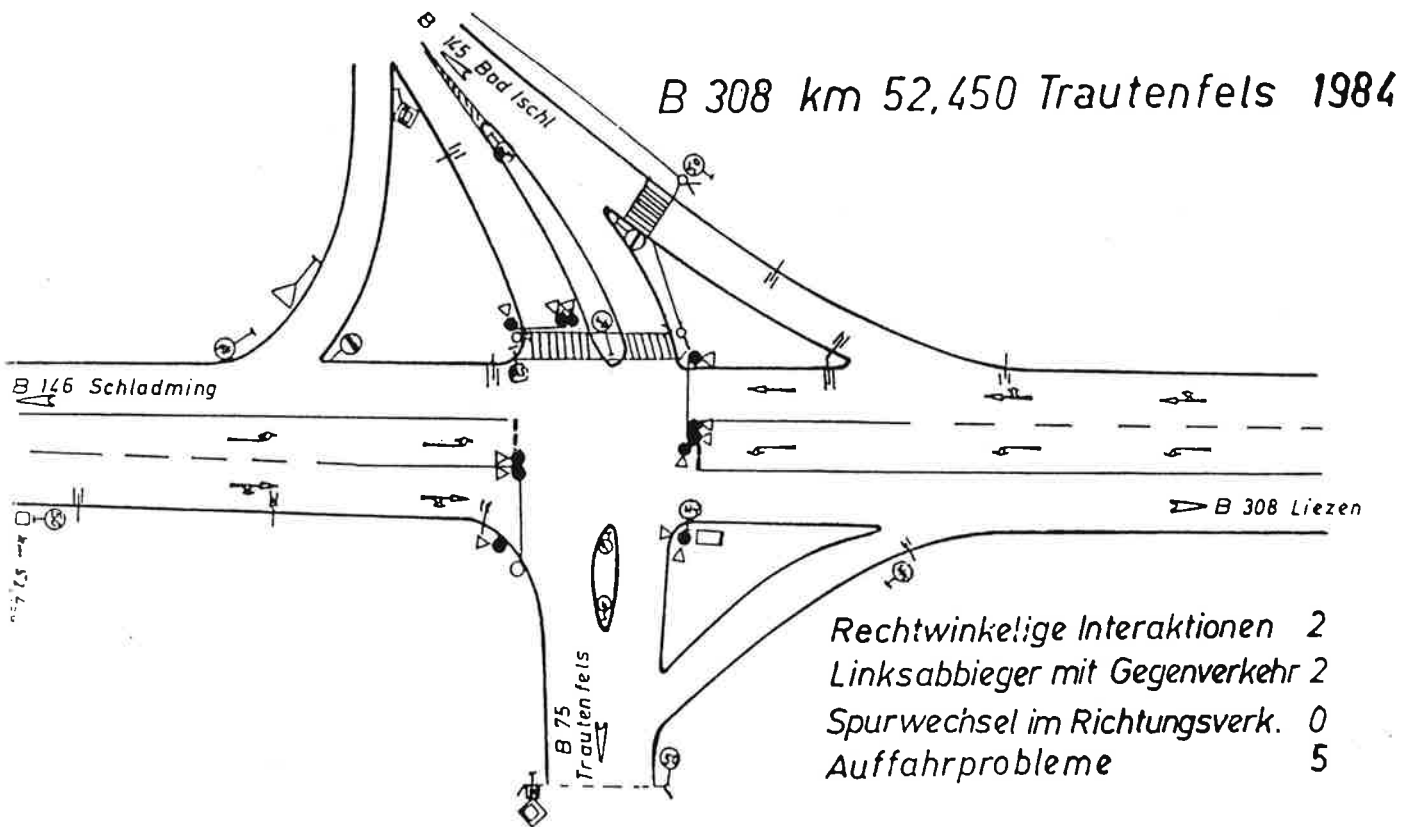
The reduction of the traffic quantity apparently did not effect the driven speed. Obviously that result is partly attributable to the implemented measures.

1.5. Ennstal-Federal Highway B 308 at km 53.6 close to the village of Trautenfels

The "Ennstal"-Federal Highway B 308 crosses coming from the town Schladming and going in the direction of the town Liezen close to the village of Trautenfels the "Salzkammergut"-Federal Highway B 145, which is going from Trautenfels north to the town Bad Ischl. On the opposite side of the crossing a local road is going south to the village Irdning. This crossing is protected by a speed

limit of 50 km/h as well as by a traffic light. The Ennstal-Federal Highway is widened to three lanes in that area. Exits and entrances to the main road are arranged fan-shaped.

Graph 5



In that sector of the highway problems with left turners and rear end conflicts are frequent. Turning off vehicles as well as vehicles approaching the changing traffic light sometimes reduce their speed in the crossing area abruptly. Left turning vehicles take advantage of very short gaps in the oncoming traffic for turning left. Therefore the hypothesis was formulated that the problems occurring in that sector and being typical for crossings regulated by traffic lights would decrease, when the drivers would be prepared in time and sufficiently to the presence of the traffic light. By that preparation they would be able to adapt driven speed and attention to the situation.

Implemented measures:

- o Announcement of the control by traffic light already 300 m resp. 400 m before the crossing on both sides of the road in each driving direction by a traffic sign in the dimension of 250 cm height.
- o The announcement of the traffic light 300 m resp. 400 m before the crossing was equipped with an intermittent light in the yellow field of the symbolic represented traffic light.

- o Improvement of the traffic signaling by setting up bigger signposts on both sides of the road in each direction.
- o A speed limit of 70 km/h in each case 100 m before the crossing on both sides of the road and for each driving direction.

Changes in the traffic conditions:

The number of all conflicts observed on the Trautenfels crossing decreased only slightly in comparison with the previous year. The goal could not be reached concerning the left turn conflicts because their amount rose in comparison to the year before. 1985 there were more right angle conflicts too (six in comparison to four in the previous year). Lane changing problems decreased, but in 1985 for the first time two severe conflicts of this type were observed.

Table 5: Conflict occurrence 1984/1985 on the B 308 Federal Highway at km 53.6 close to Trautenfels .

Type of conflict	1984		1985	
	A	S	A	S
right angle conflicts	4	2	6	2
left turning conflicts	10	2	16	2
lane changing conflicts	7	0	2	2
rear end conflicts	9	5	2*	0*
all conflicts together	30	9	26	6

In comparison to the previous year indeed an increase of the traffic frequency from 217 to 268 vehicles per hour was noticed, but that fact cannot explain the unsatisfactory result. On the other observed spots an essential reduction of the number of traffic conflicts was observed in spite of an increase in traffic frequency.

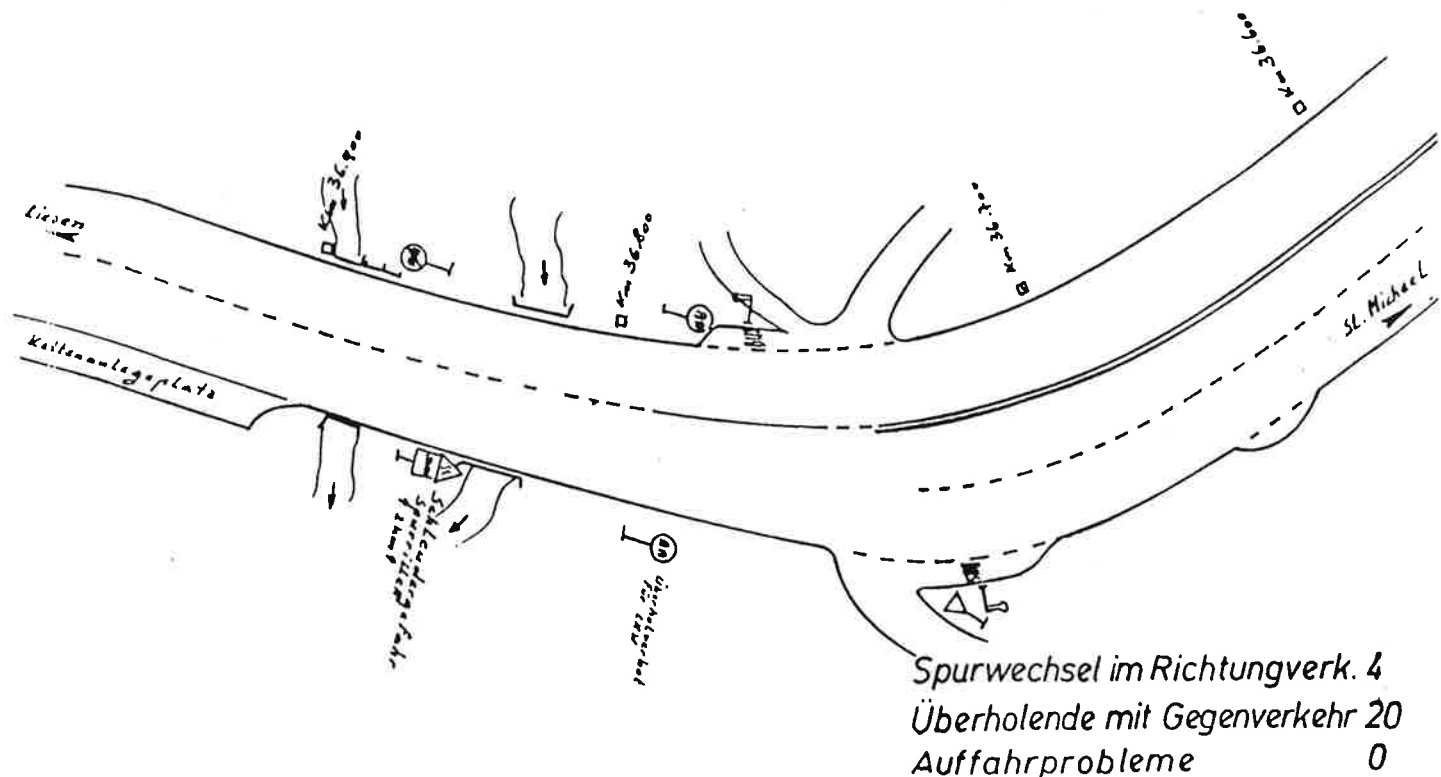
In the year 1984 a mean speed of 59 km/h was measured in Trautenfels (speed limit of 50 km/h). This mean speed rose in 1985 even to 60 km/h. The 85% speed was 1984 at 68 km/h and increased 1985 to 70 km/h.

A satisfactory improvement of the situation could altogether not be achieved by the implemented measures. An essential improvement can only be expected by substantial reorganisation of the intersection.

1.6. Schoberpaß-Federal Highway B 113 at km 36.9 close to the village of Treglwang

The Schoberpaß-Federal Highway goes from Liezen in the direction St. Michael uphill and widens in the observed area from two to three lanes, because uphill an additional lane for slow going lorries is designed. The black spot is situated several hundred meters before the widening to three lanes. Coming from Liezen there is a wide right curve followed by a straight on part of the road for several hundred meters. Uphill a slight left curve links up within which the road is widening to three lanes.

Graph 6 B 113 km 36,90 Schoberpaß 1984



Characteristic for this spot are the many severe overtaking conflicts. Some severe lane changing conflicts were also recorded, but their importance is secondary in view of the outstanding problems with overtaking. Drivers going in the direction St. Michael often get problems, if they want to overtake between the km 36.9 and 36.8. More than half of the drivers involved in conflicts at that spot were involved in conflict exactly in that area. These conflicts are unnecessary because the highway several hundred meters later is equied with two lanes in that direction and an overtaking is then possible without danger. By that reason it was necessary to call the drivers attention to the chance of overtaking several hundred meters later to detain them from a premature and therefore dangerous overtaking manoeuvres.

Implemented measures:

- o For the direction St. Michael the coming chance for overtaking between km 36.9 and 35.1 was announced by a traffic sign. Thereby overtaking manoeuvres should be excluded in the dangerous area with two lanes before the overtaking chance.
- o Between km 36.7 and km 36.9 in addition to this a prohibition line was painted on the pavement to exclude overtaking manoeuvres in that area.

Changes in the traffic conditions:

Altogether a clear reduction of the number of traffic conflicts resulted in this area. The number of lane changing conflicts decreased distinctly. Nevertheless the same number of vehicles got into severe lane changing conflicts as in the previous year. Referred to the total number of traffic conflicts the diminution was more marked for overtaking conflicts accompanied by a remarkable decrease of near-accidents. The number of rear end conflicts decreased too, but in 1985 for the first time two severe conflicts of that type had to be registered. The achieved improvement on that spot was especially remarkable as the traffic frequency rose from 288 vehicles per hour in 1984 to 423 vehicles per hour in 1985.

The mean speed in the year 1984 was 78 km/h on that spot. It declined in 1985 to 73 km/h. The 85%-speed was 101 km/h in 1984 and sank in 1985 to 97 km/h. This slight reduction of the driven speed might be a side-effect of the implemented measures. On the other hand, the speed reduction might be attributed to the increased traffic frequency.

1.7. The accident developement on modified and non-modified spots

In 1984 12 black spots in the transit-road-network with increased accident occurrence were selected to study by traffic conflict observation the behaviour of the different nationalities traversing Austria. Six of these spots were selected to demonstrate the chance of improvement of traffic safety by simple measures.

Table 7: Accidents with personal injury on modified and
non-modified accident accumulation spots

modified spots	10 km before area	observed spot	area 10 km subsequent
1984	83	10	101
1985	76	7	89
non-modified spots			
1984	94	18	233
1985	106	18	207

The total observation time for the inquest of the accident occurrence was 732 days on modified spots just as on non-modified black spots.

Table 8: Observed traffic conflicts on modified and non-modified spots

Severity of conflicts	1984	1985
all conflicts	563	109
severe conflicts	76	32

The observation time was 3 1/2 days for modified spots just as on non-modified spots. The comparison of accident data with traffic conflict data demonstrates that the accident data on the observed spots show only a small amount and therefore only an insufficient efficiency control is possible (BAST 1989). The number of traffic conflicts responded quite more sensitive to the implemented measures: An accident recording time of 732 day stands against a traffic conflict observation time of 3 1/2 days. Traffic conflict observation by that fact is not only a more efficient research method but also saving time and costs.

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