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EVALUATION OF ACCIDENT BLACK-SPOT REDEVELOPMENT INVESTIGATED AT A SAMPLE OF SITES

1 Introduction

In the Austrian technical guidelines [RVS 1.21, 1990] accident black-spots are defined as road locations (either sections of 250 m length or intersections), where

- 3 injury accidents occur per year, or
- 3 identical injury accidents occur per three years, or
- 5 accidents occur per three years (including damage-only accidents).

Based on this definition, approximately the half of all accidents in large urban areas take place at black-spots. In rural areas, including villages and small towns, about 25 % to 30 % of all road accidents happens at frequent accident locations [e.g. Amt der OÖ-Landesregierung, 1997].

Thus the redevelopment of accident black-spots is one of the most important methods of improving road safety, especially in large urban areas.

Since 1994, the Austrian road traffic regulations require the public road authorities to redevelop frequent accident locations. An often heard counter argument is that there are inadequate public funds available, i. e. it is too expensive to alter a hazardous intersection to meet a high safety standard. And indeed, the argument is understandable. The road authorities or the road maintainers have to pay for road safety measures, but the fruits of this labour accrue to other institutions (insurance companies, health authorities, ...).

However, road safety is a matter of public interest, and so it seems more appropriate to compare the costs of safety measures with savings accruing from the reduction of public accident and, especially, casualty costs.

In the comparisons presented in this paper mainly injury-accidents and casualty costs are considered. Cost figure are rounded to thousand Austrian Schillings (ATS). The Austrian casualty cost values for 1993 of [METELKA, CERWENKA, RIEBESMEIER, 1996] were used:

Per fatality	ATS	11 080 000	(~ECU 850 000)
Per serious casualty	ATS	596 000	(~ECU 46 000)
Per slight casualty	ATS	51 000	(~ECU 3 900)

The examples in the next chapter should give an overview, of how effectively accident black-spot redevelopment can benefit the public economy.

2 Examples of redeveloped accident black-spots in Austria

2.1 Stampfergasse - Wientalstrasse (Vienna)

On reaching Vienna, the eastbound lanes of motorway A1 (*Westautobahn*) turn into the *Wientalstrasse*, a four lane road reducing to three then two lanes. The speed-limit is 70 km/h. The first crossroads is at the traffic-signal controlled *Stampfergasse/Brauhausbrücke* intersection (Figs. 1 and 2); here a third left-turn lane has been added to the *Wientalstrasse*.

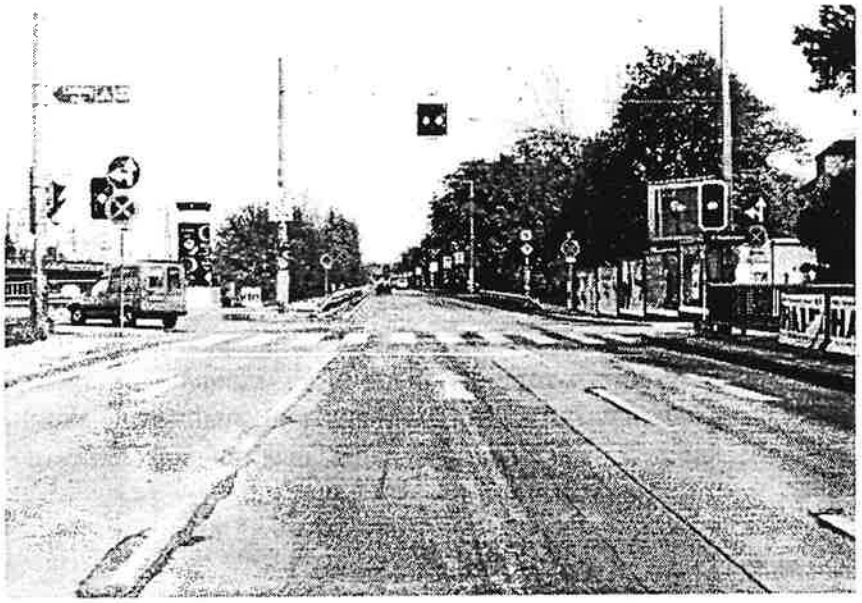

Fig. 1: *Wientalstrasse* when approaching the intersection

Accidents investigated: Right-angled accidents between vehicles in the *Wientalstrasse* and vehicles crossing out of the *Stampfergasse*.

Typical accident circumstances: Vehicles in the *Wientalstrasse* enter the intersection shortly after the beginning of their red phase and collide with vehicles starting out of the *Stampfergasse* on green.

Presumed main accident causes: Drivers in the *Wientalstrasse*: make errors in estimating velocity and stopping distance, caused by poor velocity adaptation coming from the motorway; they miss or see too late the traffic lights changing from green via yellow to red. Drivers in the *Stampfergasse* have no possibility for a visual check before entering the *Wientalstrasse* on green and, therefore, no chance to avoid a collision if a vehicle enters the crossing from the *Wientalstrasse* incorrectly.

Measure implemented (06.1992): One additional second between the end of the green phase in the *Wientalstrasse* and the beginning of green in the *Stampfergasse* (6 seconds instead of 5; the end of yellow in the *Wientalstrasse* and the beginning of combined red/yellow in the *Stampfergasse* now coincide). The measure does not alter the drivers' conditions in the *Wientalstrasse*, but reduces the danger of a typical right-angled accident (Fig. 3).

Cost of measure: ATS 95 000 (8 different traffic signal programs altered).

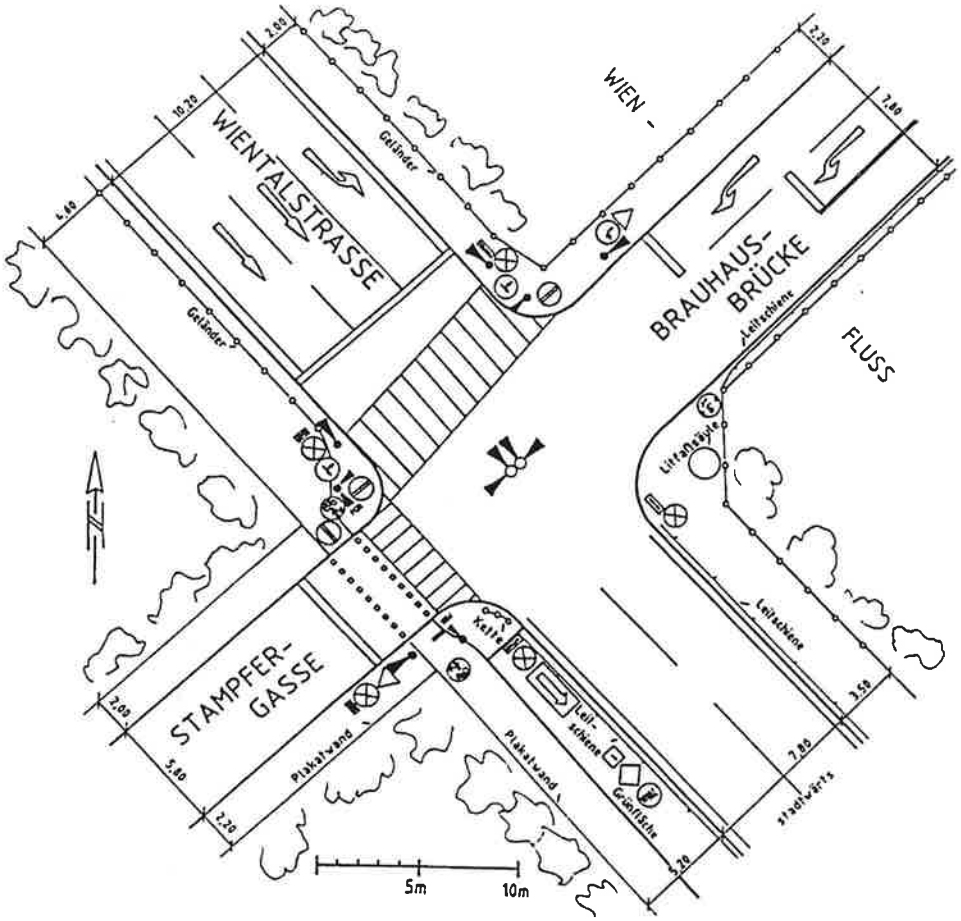

Fig. 2: Intersection *Wientalstrasse - Stampfergasse*; site-sketch

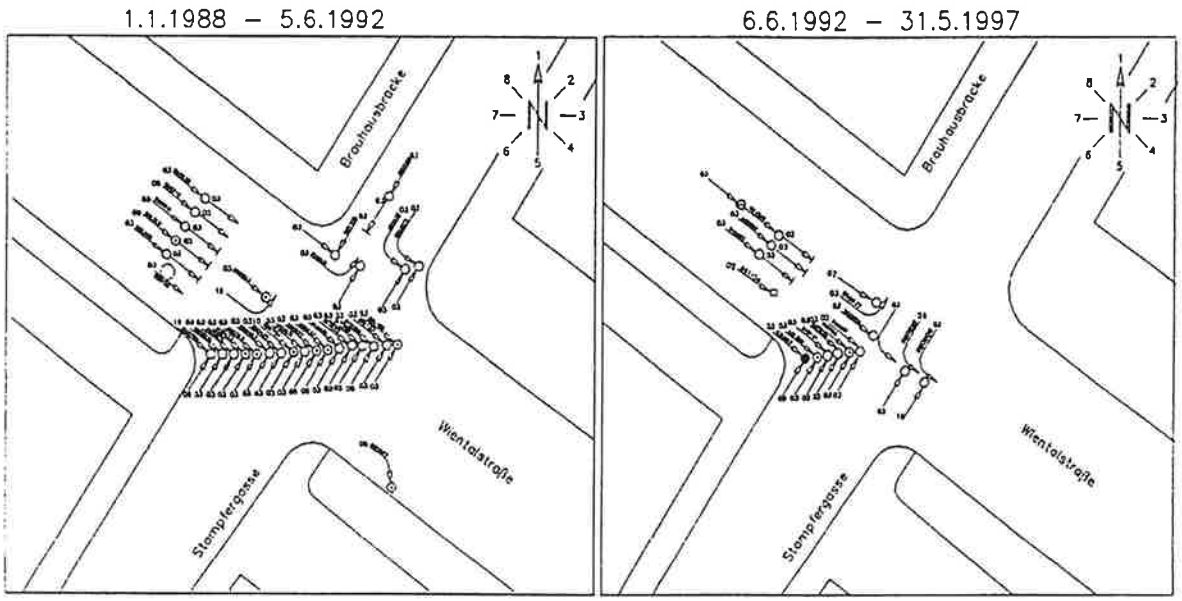

Fig. 3: Investigated collisions in the previous and subsequent period

Table 1: Statistics, only typical right-angled accidents, *Wientalstrasse - Stampfergasse*

		PREVIOUS PERIOD 01.1988 - 05.1992 (53 months)			SUBSEQUENT PERIOD 06.1992 - 05.1997 (60 months)		
total	injury acc.	**17**			**6**		
	casualties	**0** fatal	**8** serious	**19** slight	**1** fatal	**4** serious	**4** slight
	casualty costs	ATS **5 737 000**			ATS **13 668 000**		
per year	injury acc.	**3.8**			**1.2**		
	casualties	**6.1**			**1.8**		
	casualty costs	ATS **1 299 000**			ATS **2 734 000**		

Result: Table 1 shows that the average accident rate as well as the casualties after implementing the measure decreased to one third. The surprising doubling of casualty costs is caused by the one fatality in the subsequent period.

Often it is pure chance, whether a road accident ends with a fatality or a serious casualty. Had the one fatality been a "serious casualty", the subsequent period casualty costs would have decreased from ATS 13 668 000 to ATS 3 184 000 or to ATS 637 000 from ATS 2 734 000 per year. This would be roughly the half of the previous period costs.

The money saved in one single year would be seven times the costs of the measure implemented.

2.2 Beheimgasse - Bergsteiggasse (Vienna)

Both *Beheimgasse* and *Bergsteiggasse* are one-way streets with one lane and with cars parked on both sides (Fig 4). The intersection is located in a typical old Viennese residential area. Traffic in *Bergsteiggasse* takes precedence over traffic in *Beheimgasse* (stop sign).

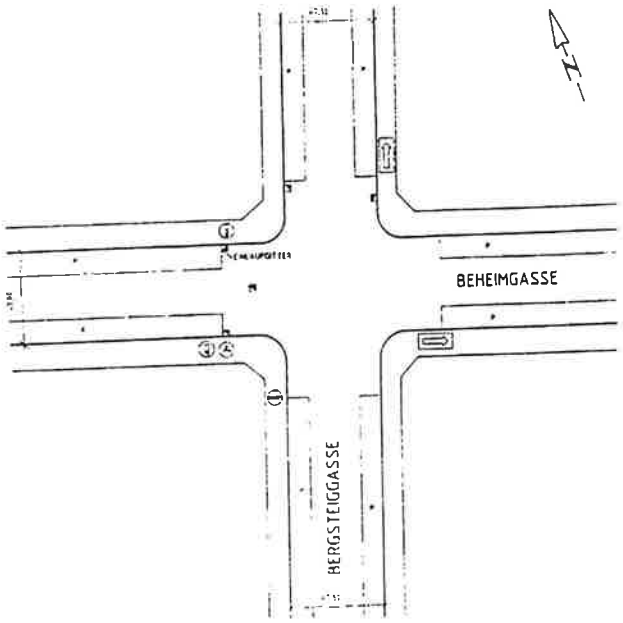

Fig. 4: Intersection *Beheimgasse - Bergsteiggasse*; site-sketch (original situation)

Accidents investigated: Right-angled accidents only.

Typical accident circumstances: Vehicles out of *Beheimgasse* enter the intersection too late ahead of cars approaching in *Bergsteiggasse*.

Presumed main accident causes: Drivers in the *Beheimgasse* may even obey the stop sign and stop but, because of the bad sight conditions, they do not see or see too late cars approaching in the Bergsteiggasse.

Measure implemented (07.1993): The pavement was extended in the important corner of the intersection to improve the sight conditions. The measure does not alter the legal parking conditions, but illegal parking at the junction corner is obviated (Fig. 5).

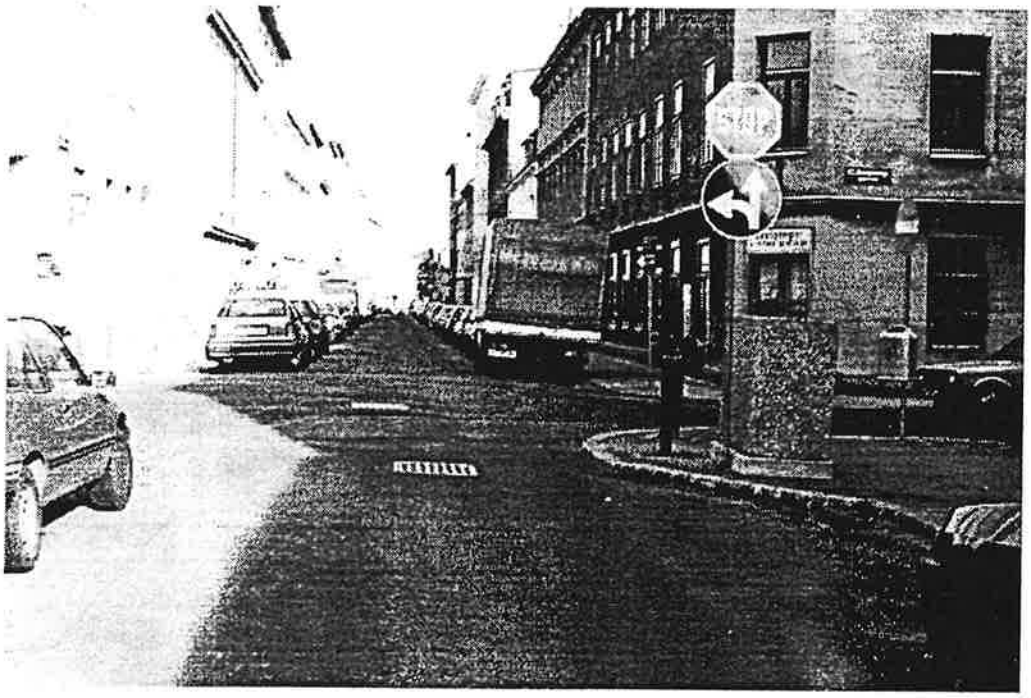

Fig. 5: Intersection *Bergsteiggasse - Beheimgasse* with extended pavement

Cost of measure: ATS 80 000

Table 2: Statistics, right-angled accidents, *Bergsteiggasse - Beheimgasse*

		PREVIOUS PERIOD 01.1990 - 06.1993 (42 months)			**SUBSEQUENT PERIOD** 08.1993 - 04.1997 (45 months)		
total	injury acc.	**4**			**2**		
	casualties	**0** fatal	**1** serious	**7** slight	**0** fatal	**0** serious	**2** slight
	casualty costs	ATS **953 000**			ATS **102 000**		
per year	injury acc.	**1.1**			**0.5**		
	casualties	**2.3**			**0.5**		
	casualty costs	ATS **272 000**			ATS **27 000**		

Result: Though the accident rate at this intersection was not very high before implementing the measure, it reduced during the subsequent period to half and casualties to less than a quarter (Table 2). The average yearly casualty costs now are only 10 % from the costs in the previous period.

cost of implementing the corrective measure (ATS 80 000) would have been amortised within a year. This example shows, that even the rather expensive safety redevelopment of such a small intersection effectively saves public money.

2.3 Schubertring - Fichtegasse (Vienna)

The *Schubertring* is part of the Vienna's famous *Ringstrasse*, a road encompassing 270° of the inner city. It is a one-way street with three lanes. Tram tracks flank the three lanes, with the anticlockwise tram track having a direction counter to the traffic flow. There are service roads on one or both sides.

At the junction of interest, a two-way cycle track is situated between the *Schubertring* and its inner service road (Fig. 6).

The *Fichtegasse* is a side street and crosses the *Schubertring*. Crossing cyclists take precedence over traffic in *Fichtegasse*.

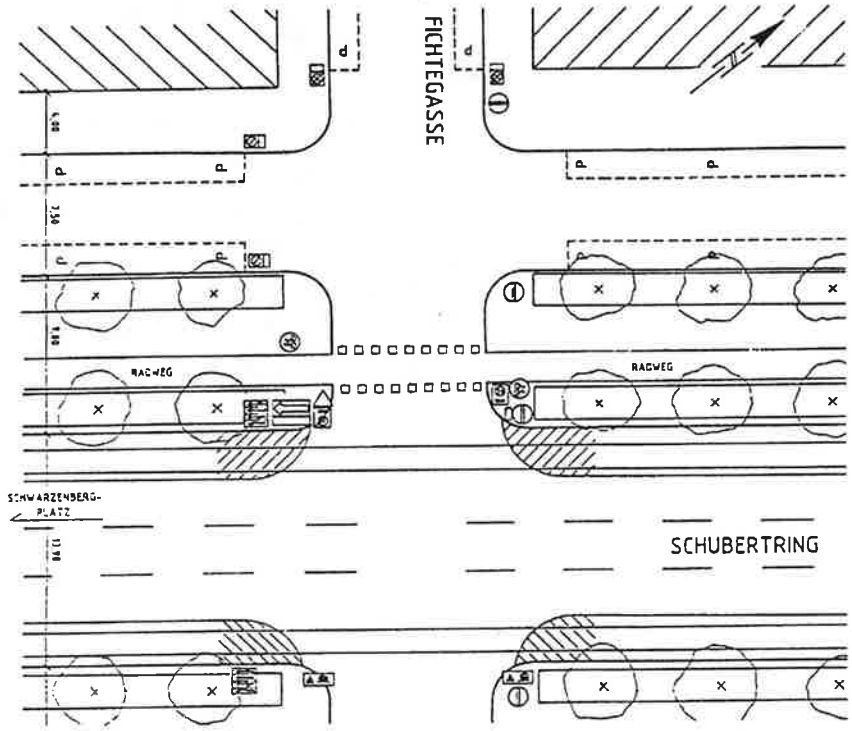

Fig. 6: Intersection *Schubertring - Fichtegasse*; site-sketch (original situation)

Accidents Investigated: Accidents between vehicles in the *Fichtegasse* or vehicles turning from the *Schubertring* into the *Fichtegasse* and cyclists on the cycle track crossing the *Fichtegasse (Fig. 7)*.

Presumed main accident causes: Drivers in the *Fichtegasse* who want to enter *Schubertring*, when approaching, pay attention to traffic on *Schubertring*, which comes from the left, and do not see cyclists coming from the right.

In addition, drivers turning from the *Schubertring* into the *Fichtegasse* often overlook that they have to give way to the cyclists. There is also poor visibility of cyclists, especially, if there are other cars waiting in the *Fichtegasse*.

Cyclists try to cross *Fichtegasse* in front of or between cars waiting to enter *Schubertring*.

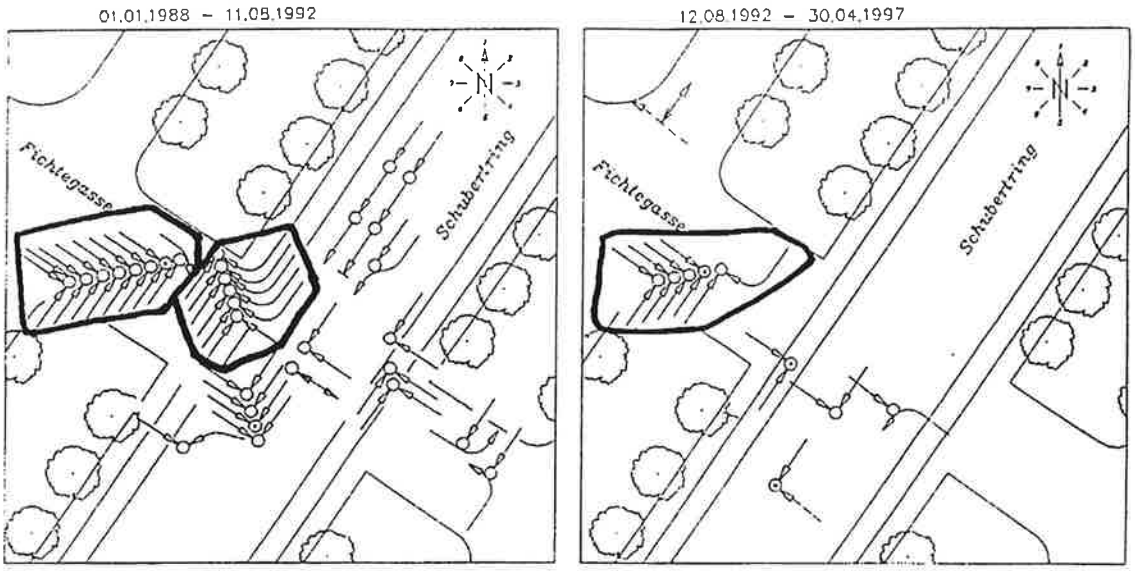

Fig. 7: Accidents with cyclists in the previous and subsequent period

Measure implemented (08.1992): The cycle track was raised (10 cm) and now crosses the *Fichtegasse* on a hump that also incorporates a new pedestrian crossing (Fig. 8). Cars now cross the cycle track at low velocity, and car drivers pay much more attention to cyclists (and pedestrians) than before.

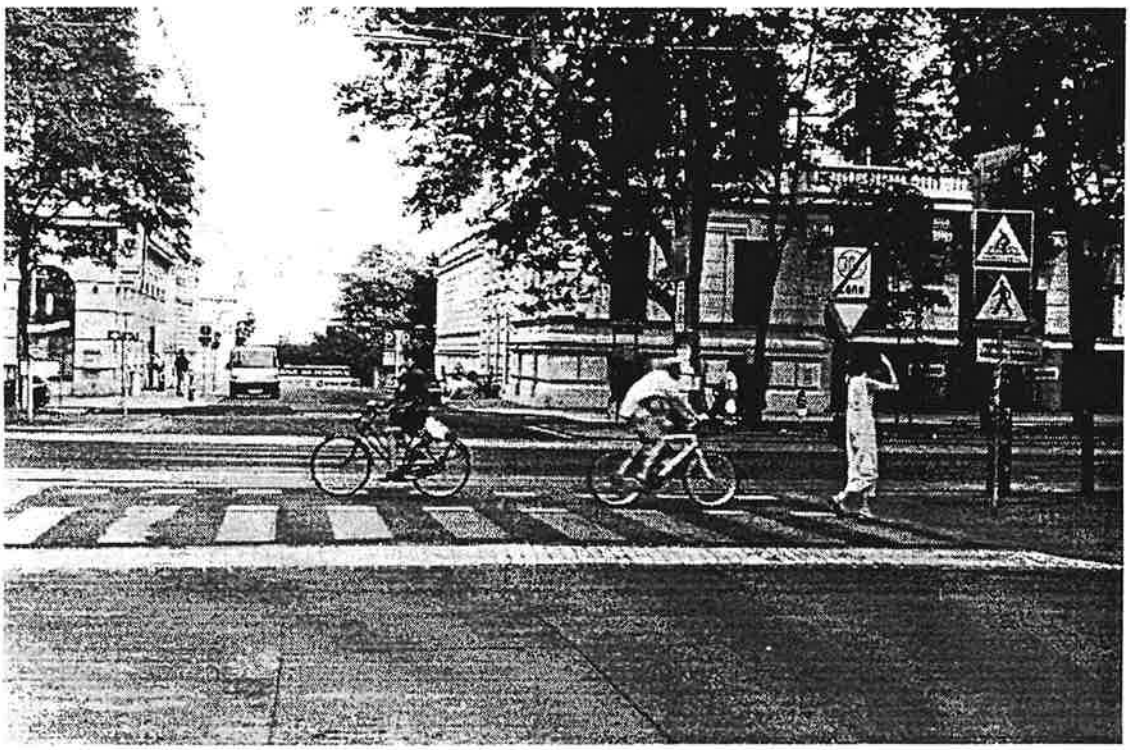

Fig. 8: View from the *Fichtegasse* to *Schubertring*, cyclists and pedestrians crossing on the raised surface

Cost of measure: ATS 150 000

Table 3: Statistics, only accidents with cyclists involved, *Schubertring - Fichtegasse*

		PREVIOUS PERIOD 01.1988 - 07.1992 (55 months)			SUBSEQUENT PERIOD 08.1992 - 04.1997 (57 months)		
total	injury acc.	**14**			**5**		
	casualties	**0** fatal	**2** serious	**12** slight	**0** fatal	**1** serious	**4** slight
	casualty costs	ATS **1 804 000**			ATS **800 000**		
per year	injury acc.	**3.1**			**1.1**		
	casualties	**3.1**			**1.1**		
	casualty costs	ATS **394 000**			ATS **168 000**		

Result: In the subsequent period, as Table 3 shows, the total number of injury accidents and casualties are only about 35 % of those in the previous period. The yearly accident rate as well as the casualty rate and the average yearly casualty costs decreased by about 60 %; the average yearly casualty costs saved are ATS 226 000. Again the costs of the measure were paid of within a year.

2.4 Josefstrasse - Landsbergerstrasse (St.Pölten)

Both *Josefstrasse* and *Landsbergerstrasse* are two-way roads in a residential area near the centre of *St.Pölten* (the capital of Lower Austria, with a population of about 50 000). The crossroads was a large junction with traffic islands and separate lanes for the right-turning traffic. The whole situation was very confusing for drivers crossing (Fig. 9). Traffic in *Josefstrasse* took precedence over traffic in *Landsbergerstrasse* (give-way signs).

Fig. 9: View from the *Landsbergerstrasse* showing bad sight conditions (original situation)

Accidents investigated: All injury accidents at the intersection.

Typical accident circumstances: Mainly right-angled accidents between motor-vehicles, all during daylight.

Presumed main accident causes: Drivers in the *Landsbergerstrasse* did not recognize that they have to give way to traffic in *Josefstrasse*, and entered the intersection without slowing down. Other drivers observed the traffic in the *Josefstrasse*, but missed or saw too late the approaching vehicles.

Measure implemented (06.1994): The intersection was rebuilt as a roundabout (Fig 10).

Cost of measure: ATS 1 885 000

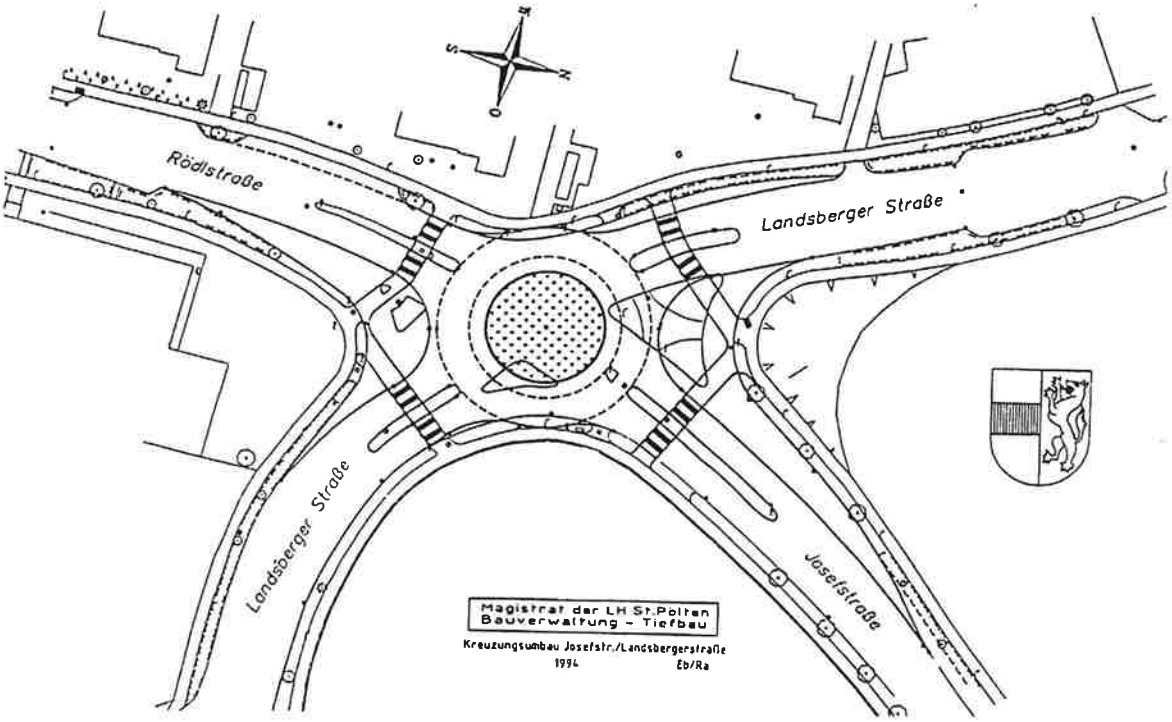

Fig. 10: *Josefstrasse - Landsbegerstrasse*: a roundabout (35 m dia.) built instead of the complex intersection

Table 4: Statistics, all injury accidents, *Josefstrasse - Landsbergerstrasse*

		PREVIOUS PERIOD 01.1992 - 05.1994 (29 months)			**SUBSEQUENT PERIOD** 07.1994 - 12.1996 (30 months)		
total	injury acc.	**8**			**0**		
	casualties	**0** fatal	**2** serious	**6** slight	**0** fatal	**0** serious	**0** slight
	casualty costs	ATS **1 498 000**			**0**		
per year	injury acc.	**3.3**			**0**		
	casualties	**3.3**			**0**		
	casualty costs	ATS **620 000**			**0**		

Result: Even at an intersection with a "medium" accident rate, the construction of a roundabout amortises after approximately 3 years.

2.5 S4 - B50 (Burgenland)

The *S4* is a "Schnellstrasse" (express road, two lanes in each direction with no turning across the oncoming traffic, without a hard-shoulder). It is approximately 20 kilometres long and leads from Lower Austria to Burgenland. For its last several hundred metres it turns into a broad two-way road and leads at right angles (with stop signs) into the federal highway *B50*, also a two-way road.

Accidents investigated: All accidents (including the accidents with damage only).

Typical accident circumstances: Two thirds of the accidents involved cars from the *S4* crossing the *B50* and leaving the road straight ahead at the junction (70 % when the road surface was wet); most others were right-angled impact accidents [SCHANTL 1995].

Presumed main accident causes: Driving along the express road, drivers had problems in realising, that it ended in a T-junction, and noticed too late, that they had to stop at the junction. Drivers coming from the *S4* are affected by velocity adaptation problems: the speed seems lower to them than it really is and, therefore, they fail in estimating the braking distances. In general, drivers tend to approach the junction at too high a velocity.

Measures implemented (07.1992): A give-way sign above the approach lane equipped with solar-energy powered blinking lights was placed 350 m before the junction (Fig. 11).

The surface was milled several times (each slot 2 cm deep, 50 m long, 100 m apart) for some hundreds of metres ahead of the junction to cause a "rumble effect" to alert drivers in time. Near the junction, the entire road was milled to increase the grip of the coarsely textured surface.

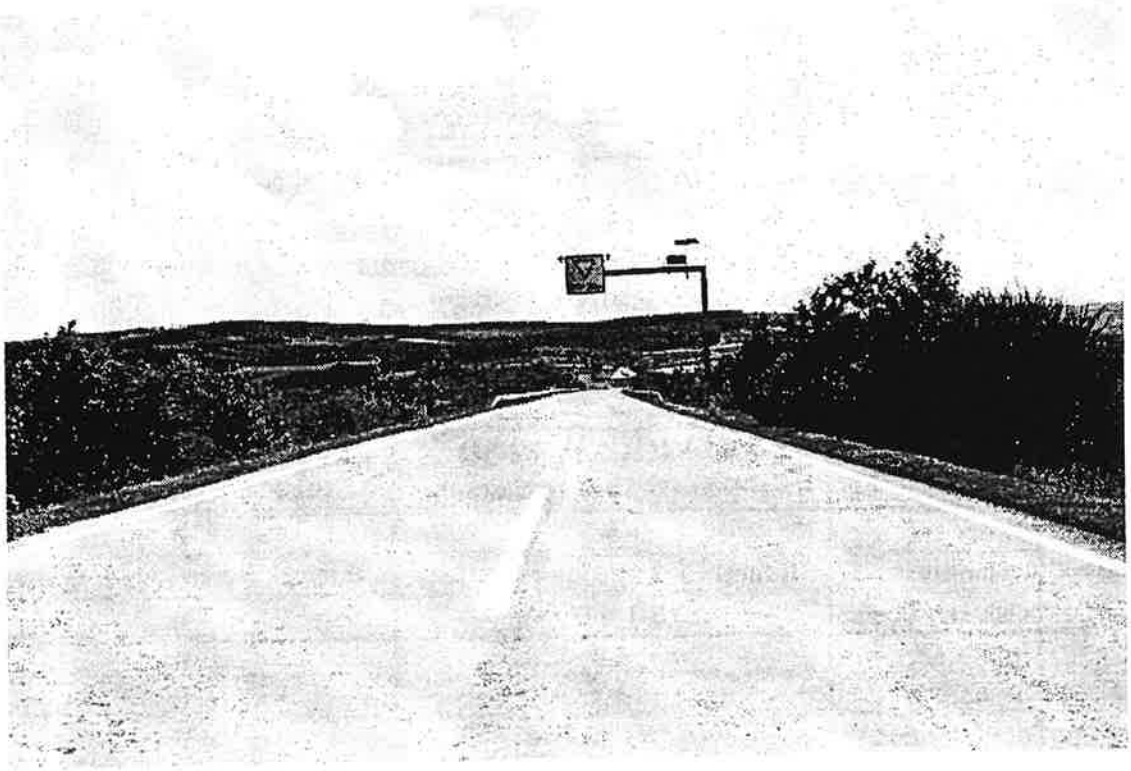

Fig. 11: Measures implemented on the *S4* when approaching the T-junction with the B50: give-way sign equipped with solar-energy powered blinking lights; milled slots at road surface

Cost of measures: ATS 220 000

Table 5: Statistics, all accidents (including the accidents with damage only), *S4 - B50*

		PREVIOUS PERIOD 01.1987 - 06.1992 (66 months)			SUBSEQUENT PERIOD 07.1992 - 06.1995 (36 months)		
total	damage acc.	29 (!)			2		
	injury acc.	2			0		
	casualties	0 fatal	1 serious	6 slight	0 fatal	0 serious	0 slight
	casualty costs	ATS 902 000			0		
per year	damage acc.	5.3			0.7		
	injury acc.	0.4			0		
	casualties	1.3			0		
	casualty costs	ATS 164 000			0		

Result: Of interest is the large number of damage-only accidents and, especially, the extreme reduction after implementing the measures by nearly 90 % (Table 5, Fig. 12). The measure costs were totally amortised within the subsequent 18 month (and that despite car damage costs and the costs of some dozen destroyed road signs are not considered).

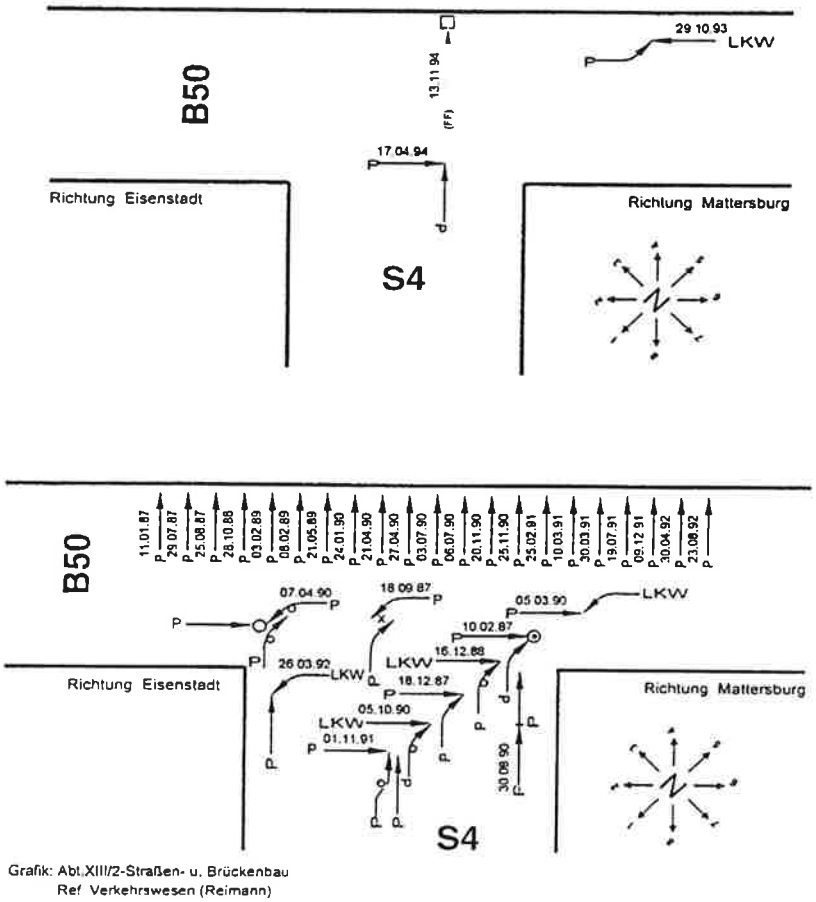

Fig. 12: Investigated collisions in the previous and subsequent period

3 Conclusions

Over the past years, many Austrian accident black-spots have been redeveloped. Because most resulted in positive effects, there was little difficulty in selecting examples.

Accident black-spot redevelopment is a very effective measure to lower the peak of the "road accident mountain". It decreases both accident rates and casualties. And, as shown, it benefits national economy, because the public money saved as a result of the reduction in casualties is normally several times the costs of the corrective measures taken.

Sources:

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