Conflict studies on urban roads

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Conflicts as a surrogate to accidents

- There is a strong need for a systematic evaluation/assessment of ”everything that is done or planned to be done”
- Without this we end up with safety problems that we should have detected long ago. Compare the Swedish “zebra crossing case”….
- …. And sub optimise our common resources

The Swedish “zebra crossing case” (2)

Driver behaviour at zebra crossings, **before** making yielding for pedestians mandatory 1st of May 2001

- Few drivers yield for pedestrians
- Injury accidents have **increased**

Conclusion

- There is a need to force drivers to yield for pedestrians
- A new law is the solution!?
- Introduced 1st of May 2001

What about other measures?

- What about retro-reflective poles?
- (Effect on injury accidents: -7% (-22 -- +12))
- And what about all IT-solutions, like Electronic Stability Control…
- (Effect on ESC-related injury accidents: Around minus 50%)
- (Effect on pedestrian and bicycle accidents: +4% (-12;+22)
- …and the new Driver Fatigue early warning system….
- ????
- ….and ISA (Intelligent Speed Adaptation)
- (Rather popular, ineffective)
- (Effect on
- ….and Speed Limiter in cars
- (Not very popular. Effective)

What happens???

A lady on her bike gets almost killed – peacefully on her way to go shopping…….

(VIDEO)

What happens here???

What **actually** happened?
Why did it happen?
What about speed adaptation?
Any behavioural mistakes?
Any perceptional mistakes?
How can we avoid a similar situation?
How can we test?

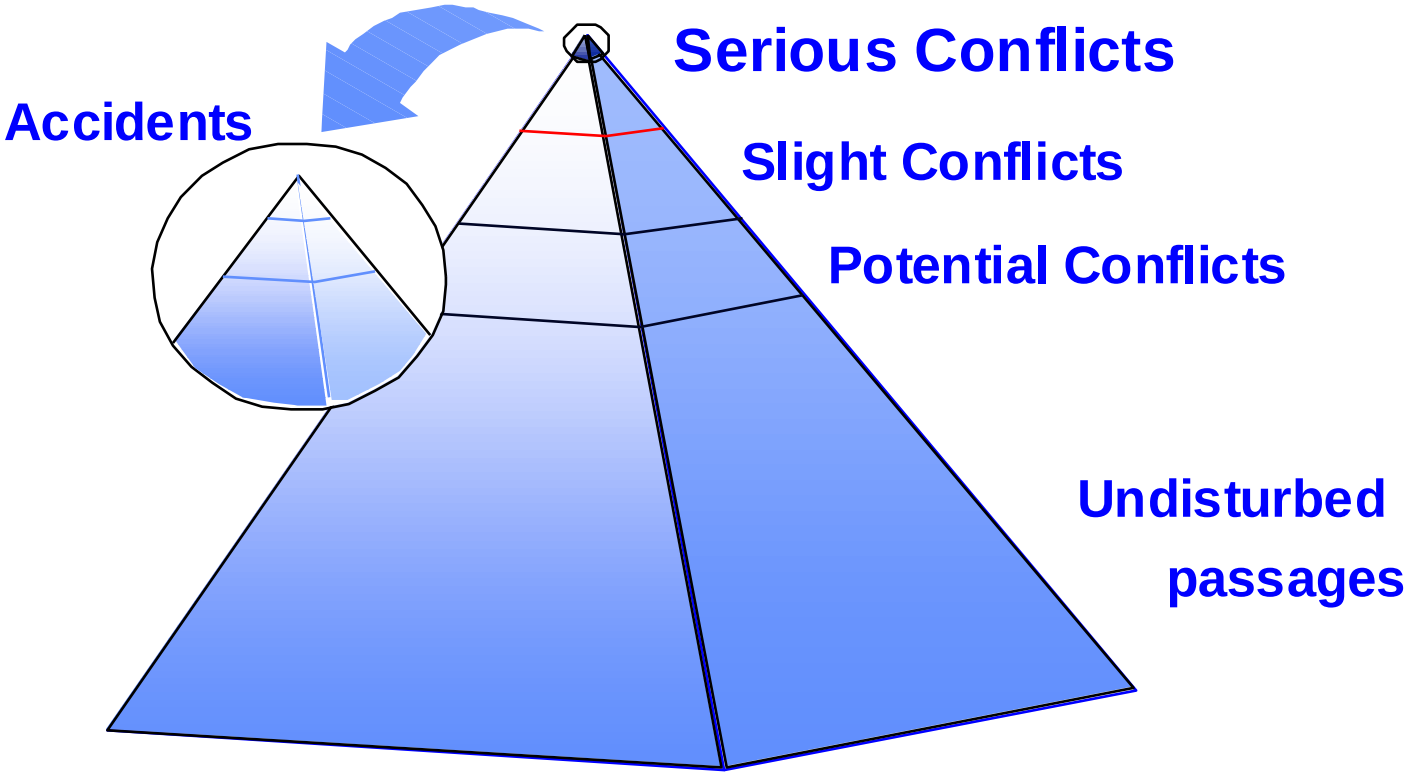
Why do we need surrogates to accidents?

- Accidents are rare events and are therefore associated with random variation
- Not all accidents are reported and the level of reporting is unevenly distributed
- The behavioural or situational aspects of the events are not covered by police accident data
- Accident analysis is a desk tool, **not** a field tool
- We need links between accidents and behaviours

Lots of convincing arguments. Still…

- Standardised use of conflicts or near accidents is very rare
- It is only recently that the topic became interesting
- And much thanks to the IT-(r)evolution
- The big thing in Automotive research is Naturalistic Driving.
- Millions of data from car driving – but what should it be used for??
- And how??

We need a link between accident and behaviour/interaction



Hydén, 1987

Relation between different kinds of elementary events

- Very few very serious events
- Very many events with low severity

Traffic Conflict Techniques in general

- In theory there are very many ways of defining conflicts
- In practise there are very few
- In real life there are almost none
- Reliability and validity studies are missing
- One (partly) exception is the Swedish Traffic Conflcits technique

Definition of a conflict

A situation where two road users approach each other in time and space to such an extent that a collision is imminent if their movements remain unchanged.

- There are always only two road users **primarily** involved

This definition is universal

It is valid in all situations where two road users meet in a way that it satisfies the basic criterion of collision course

ICTCT

Past:

- International Committee on Traffic Conflict Techniques

Now:

- International Cooperation on Theories and Concepts in Traffic Safety

http://www.ictct.org

The Swedish Technique

Two basic concepts

–Time to Accident (TA)

–Conflicting Speed (CS)

TA = Time to Accident

The time that remains from one of the road user have started an evasive action, until a collision **would have ocurred** if the road users had continued with unchanged speeds and directions.

TA is calculated based on **D** and **CS**.

D= Distance to the collision point

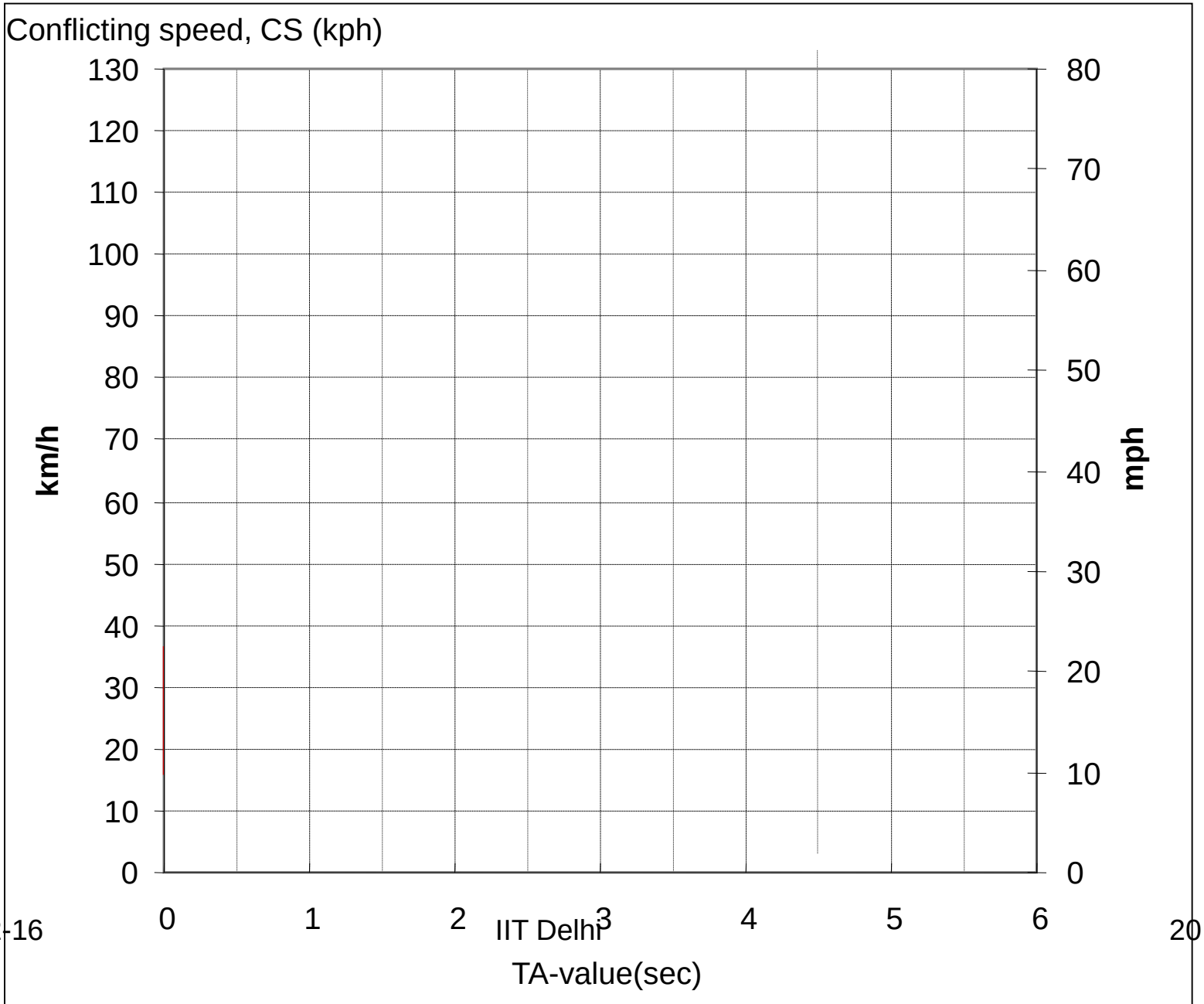
CS= Conflicting Speed

Conflicting speed (CS)

The speed (km/h or m/s) of the **relevant** road user just **prior** to the evasive maneouvre

2/ Comparison of conflicts and accidents regarding their TA and CS values

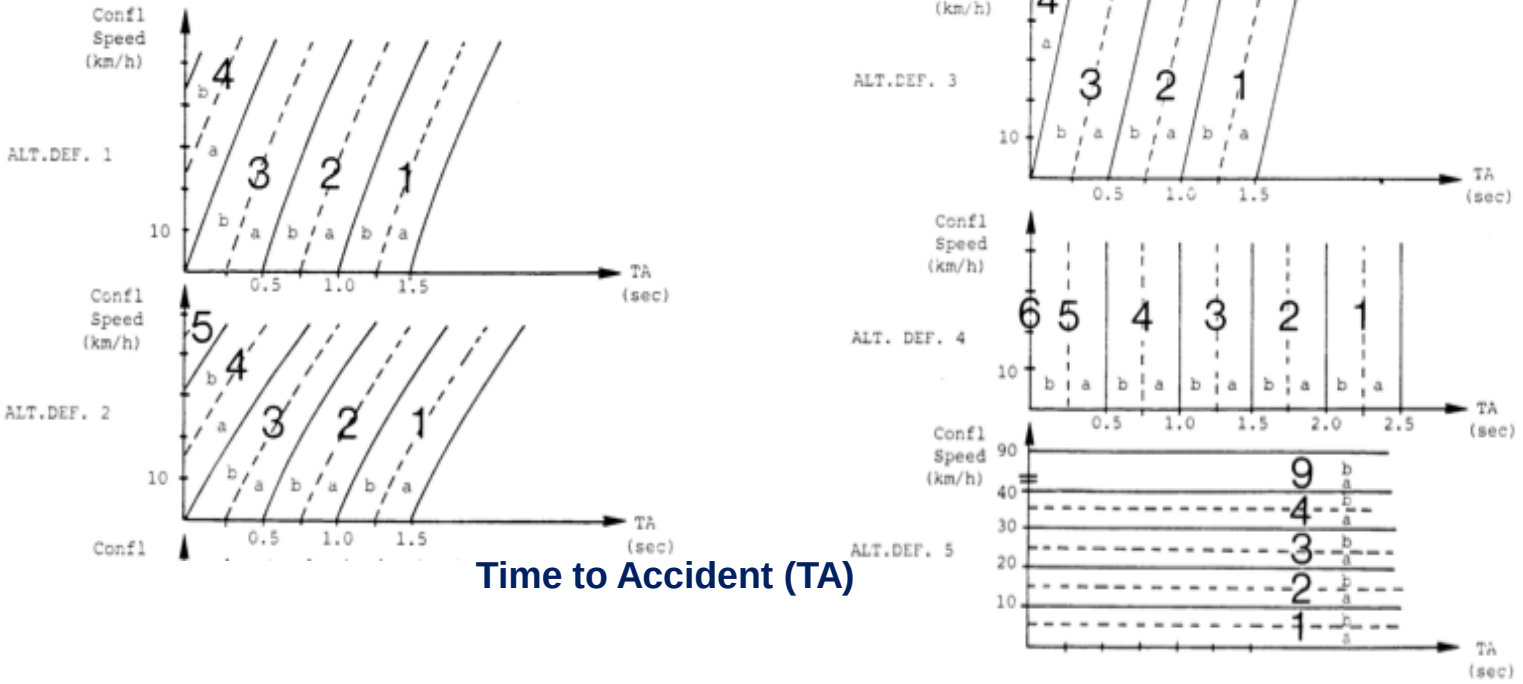
Conflict diagram



Definition of alternative severities and severity zones for testing-

5 zone alternatives

Conflicting Speed (CS)



Time to Accident (TA)

From: Hydén 1987

Definition of alternative severities and severity zones for testing –

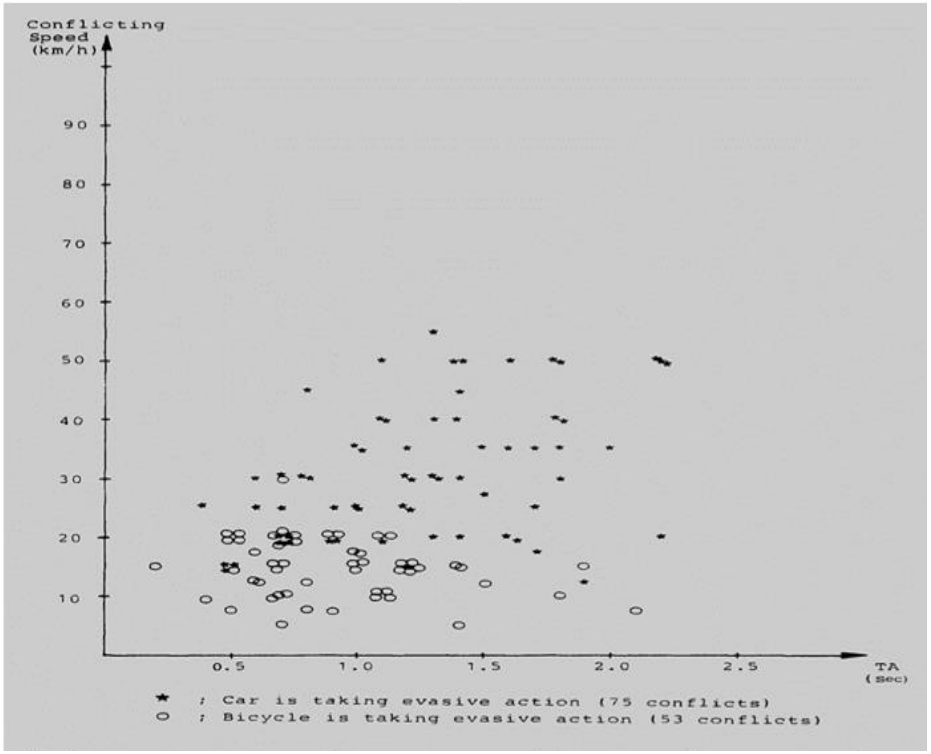
Main criteria

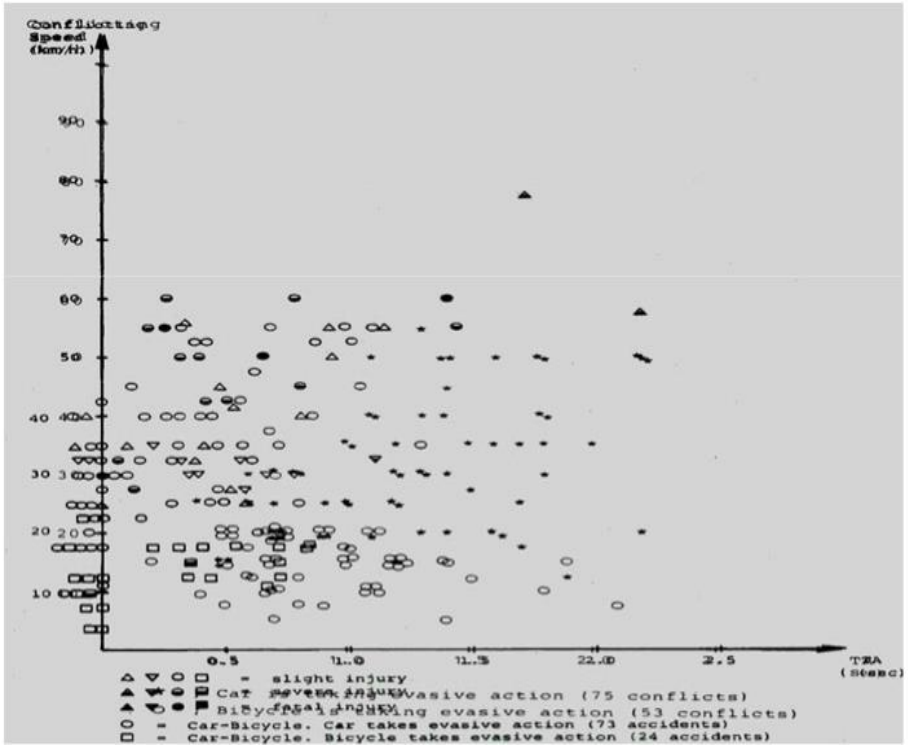
1/ The risk in terms of accident to conflict ratio should increase continuously from the ”lowest” class.

2/ Accident severity, i.e. number of fatal and serious injuries in relation to the total number of injuries should increase with class.

Car – Bicycle

TA and CS





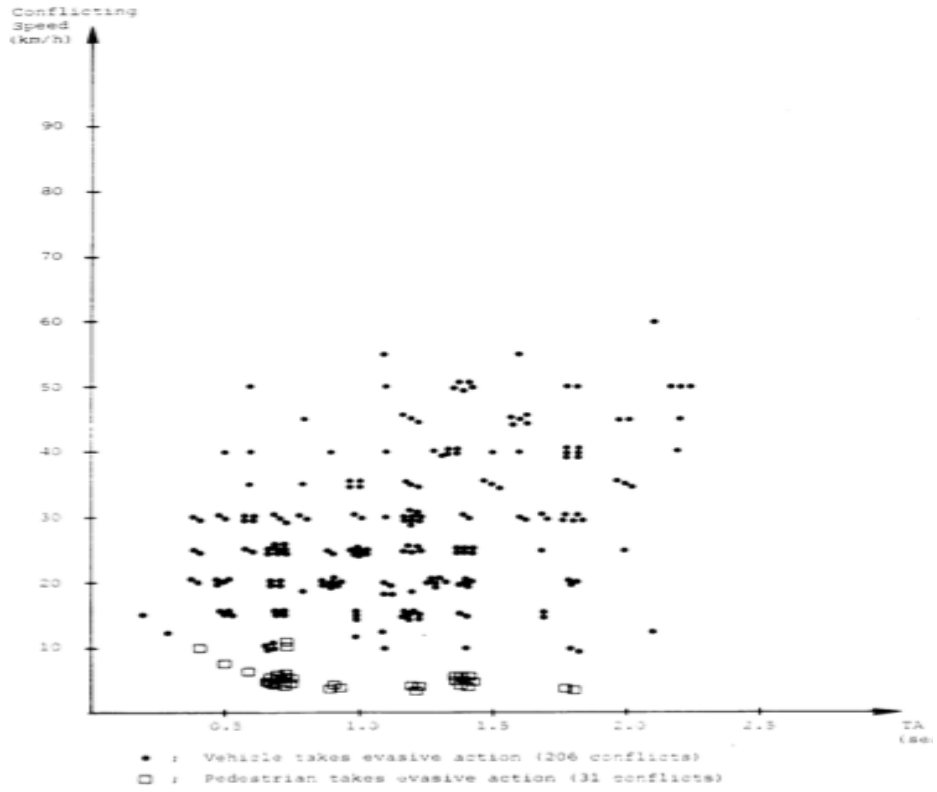
conflicts

accidents

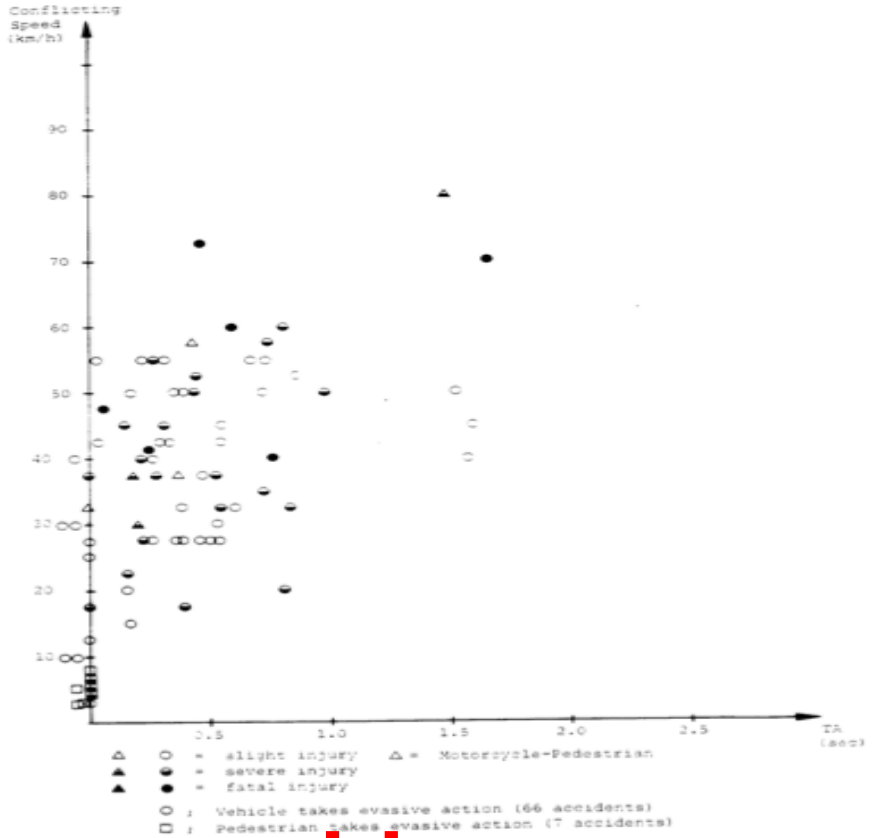
From: Hydén 1987

Car – Pedestrian

TA and CS



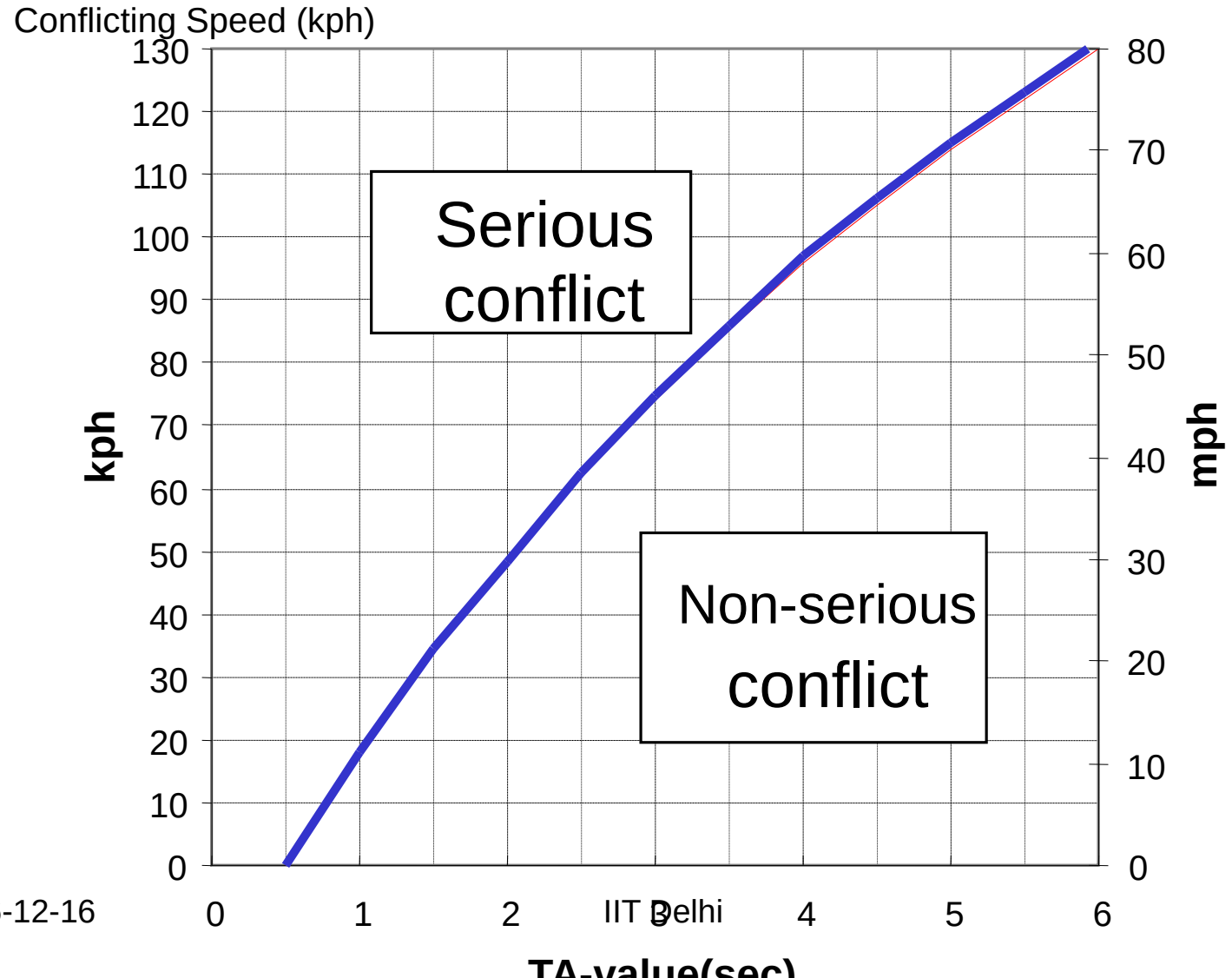
conflicts



accidents

From: Hydén 1987

ALT.DEF 2 fulfilled the criteria best
For definition of a serious conflicts
0,5 seconds margin was added



Severity of conflicts

…. is defined by its position in the TA-CS- graph

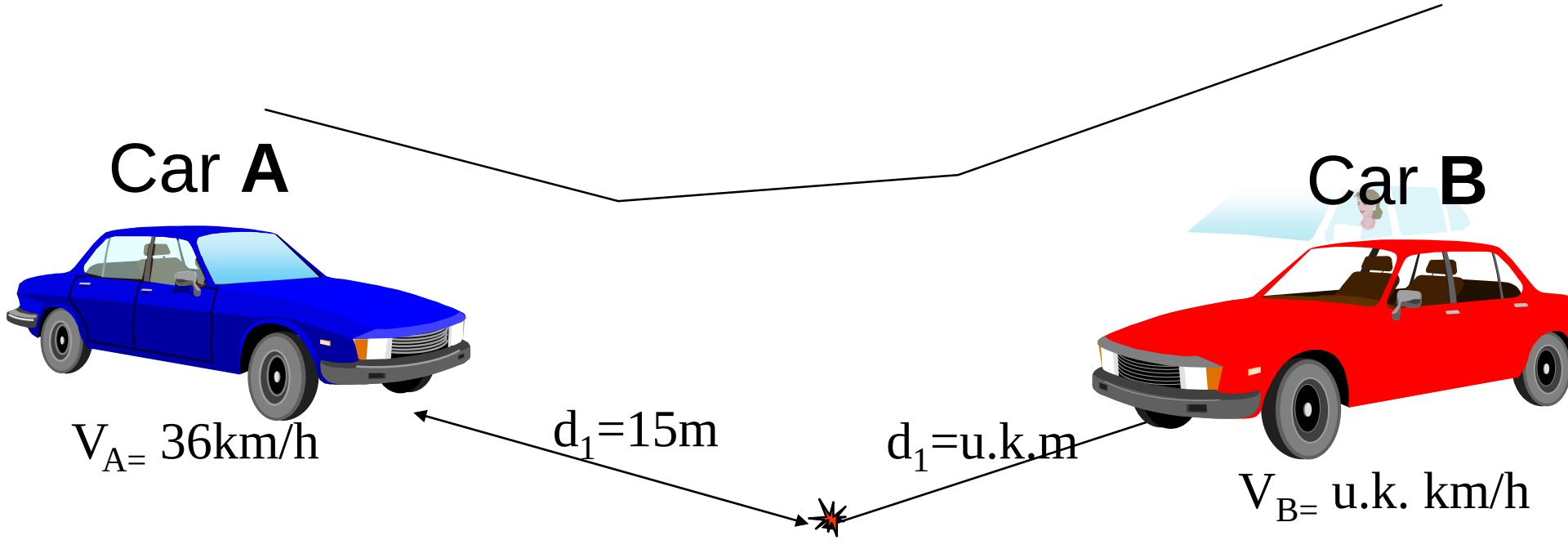
A serious conflict

…. is a conflict that ends up to the left of the border line in the “TA-CS”-graph

Definition of a Serious Conflict in practise

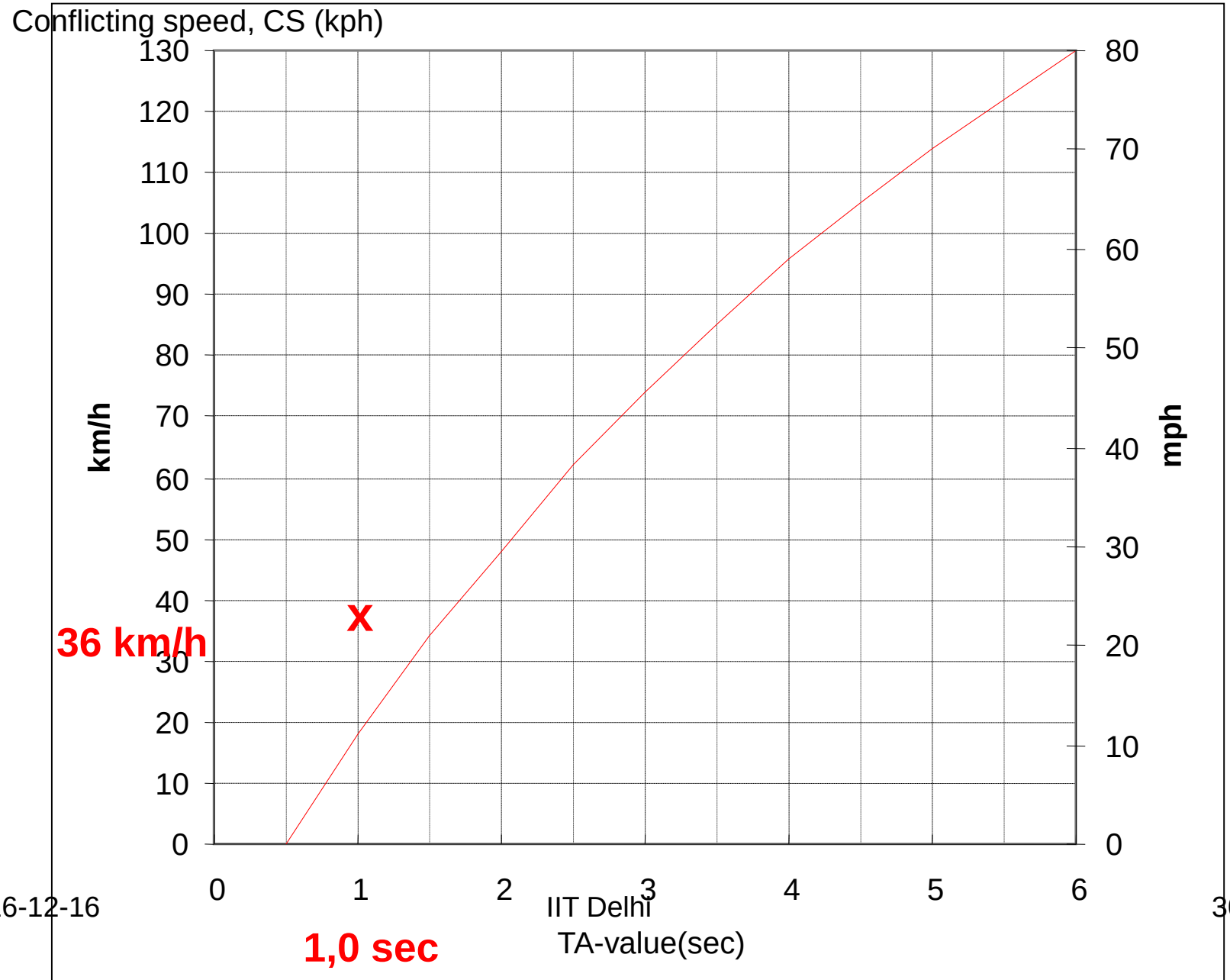
The TA-Value can be calculated based on estimates of distance and conflicting speed

d= Distance to potential point of collision



Car A brakes; would have collided with Car B if no braking

Conflict diagram



The character of a serious conflict

- Characterised by suddeness and harshness in action of at least one of the involved
- Even possible to build training on those aspects
- Road users say that ”they would never like to be involved in such a situation”

Primary road user

Those two directly involved in the conflict

(always only two; no matter how many who are colliding)

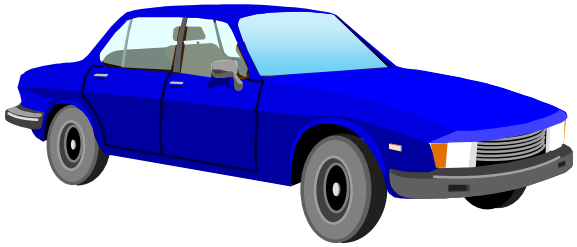
Secondary road user

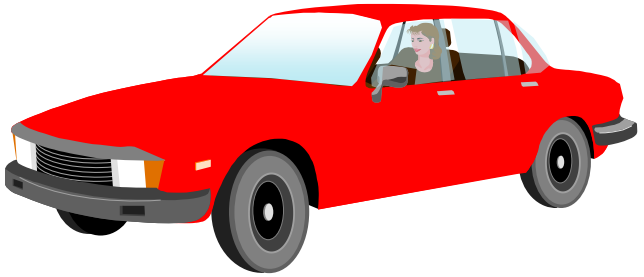
A road user who indirectly have had importance for causing the conflict

Relevant road user..

The road user that is relevant for the defining of TA and CS values

Example 2





55 km/h

27 km/h

15 m

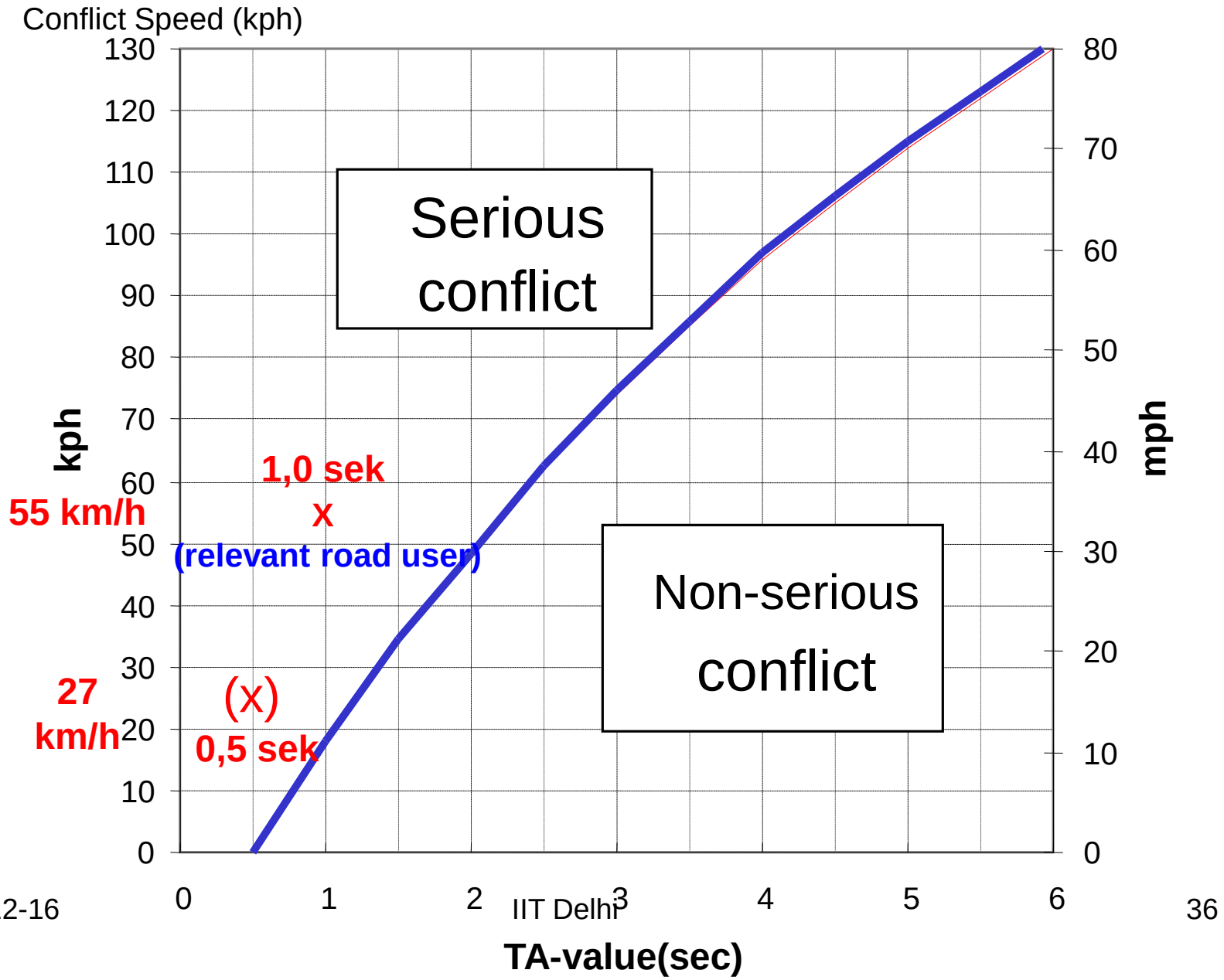
4 m

Relevant road user is ”decided” either by...

...the road user who takes evasive action if only one does

...if both take evasive action then the one of the two primarily involved road users whose combination of TA and CS produce the value with **lowest** risk

Example 2


Conflict Speed (kph)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
kph
80
70
60
50
40
30
20
10
0
mph
Serious conflict
Non-serious conflict
1,0 sek
x
(relevant road user)
55 km/h
(x)
0,5 sek
27 km/h
0
1
2
3
4
5
6
TA-value(sec)

First try…..

- You will see some conflicts on video
- You shall estimate the distance to the potential collision point **from** the moment one of the road users take evasive action (braking, swerving, acceleration)
- You shall estimate the speed of the road user who take evasive action
- You use the Speed-Distance graph to find out the Time to Accident
- You use the TA-Speed graph to decide whether a conflict is serious or not
- Fill in your data on a blank piece of paper and compare with the ”true value”

Personal scorings. Name:

Personal scorings				True values			
Conflict no.	Confl speed	Distance to Coll. P.	TA	Conflict no.	Confl speed	Distance to Coll. P.	TA

Speed-Distance-TA-value

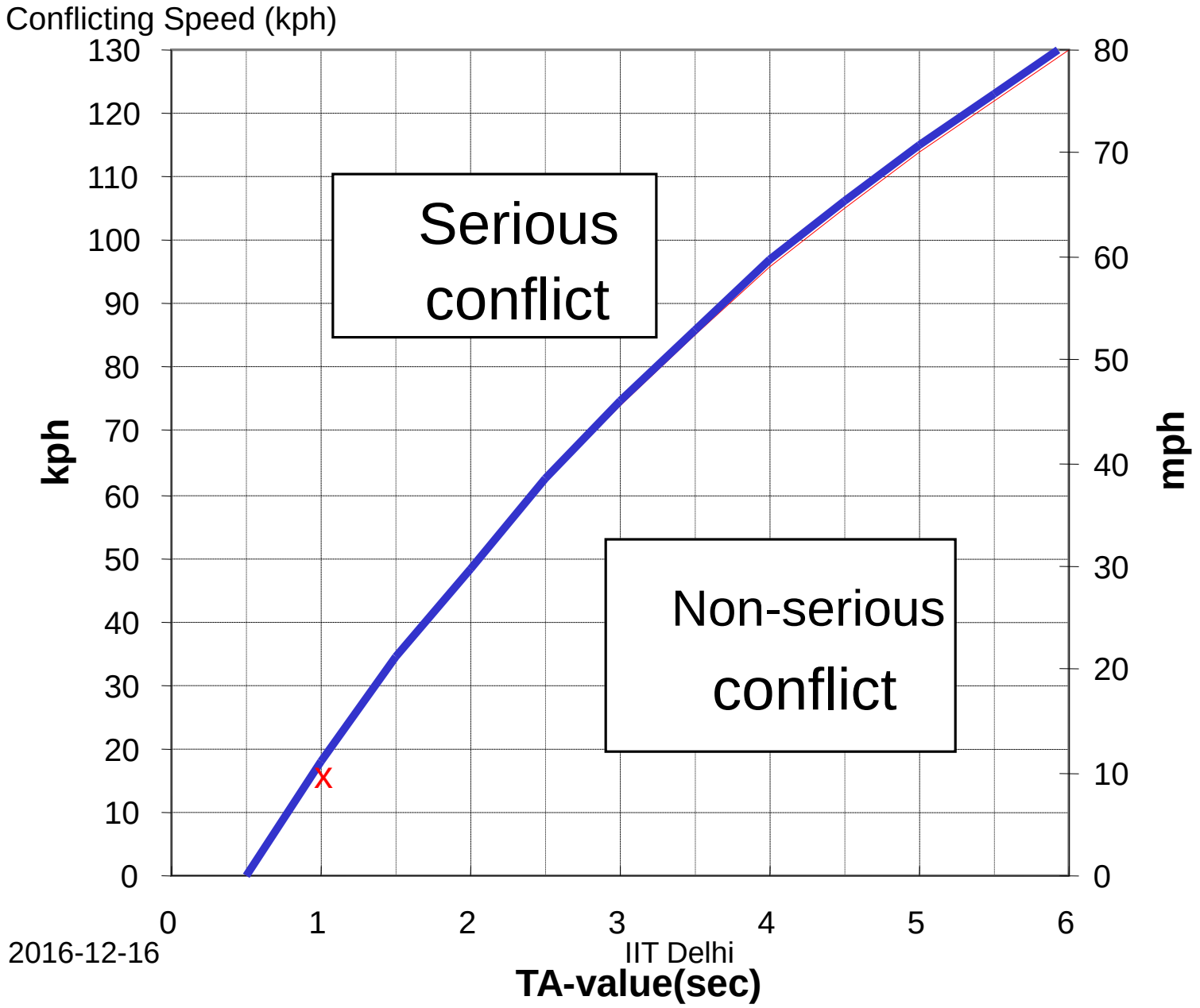
TA-value																
Speed		Distance														
km/h	m/s	0.5	1	2	3	4	5	6	7	8	9	10	15	20	25	30
5	1.4	0.4	0.7	1.4	2.2	2.9	3.6	4.3	5.0	5.8	6.5	7.2	10.8	14.4	18.0	21.6
10	2.8	0.2	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.2	3.6	5.4	7.2	9.0	10.8
15	4.2	0.1	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4	3.6	4.8	6.0	7.2
20	5.6	0.1	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.6	1.8	2.7	3.6	4.5	5.4
25	6.9	0.1	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.4	2.2	2.9	3.6	4.3
30	8.3		0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.8	2.4	3.0	3.6
35	9.7		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.5	2.1	2.6	3.1
40	11.1		0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.4	1.8	2.3	2.7
45	12.5		0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	1.2	1.6	2.0	2.4
50	13.9		0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	1.1	1.4	1.8	2.2
55	15.3		0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	1.0	1.3	1.6	2.0
60	16.7		0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.9	1.2	1.5	1.8
65	18.1		0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.8	1.1	1.4	1.7
70	19.4		0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.8	1.0	1.3	1.5
75	20.8		0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.7	1.0	1.2	1.4
80	22.2		0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.7	0.9	1.1	1.4
85	23.6		0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.6	0.8	1.1	1.3
90	25.0		0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.6	0.8	1.0	1.2
95	26.4		0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.6	0.8	0.9	1.1
100	27.8		0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.5	0.7	0.9	1.1

Video conflicts - facit

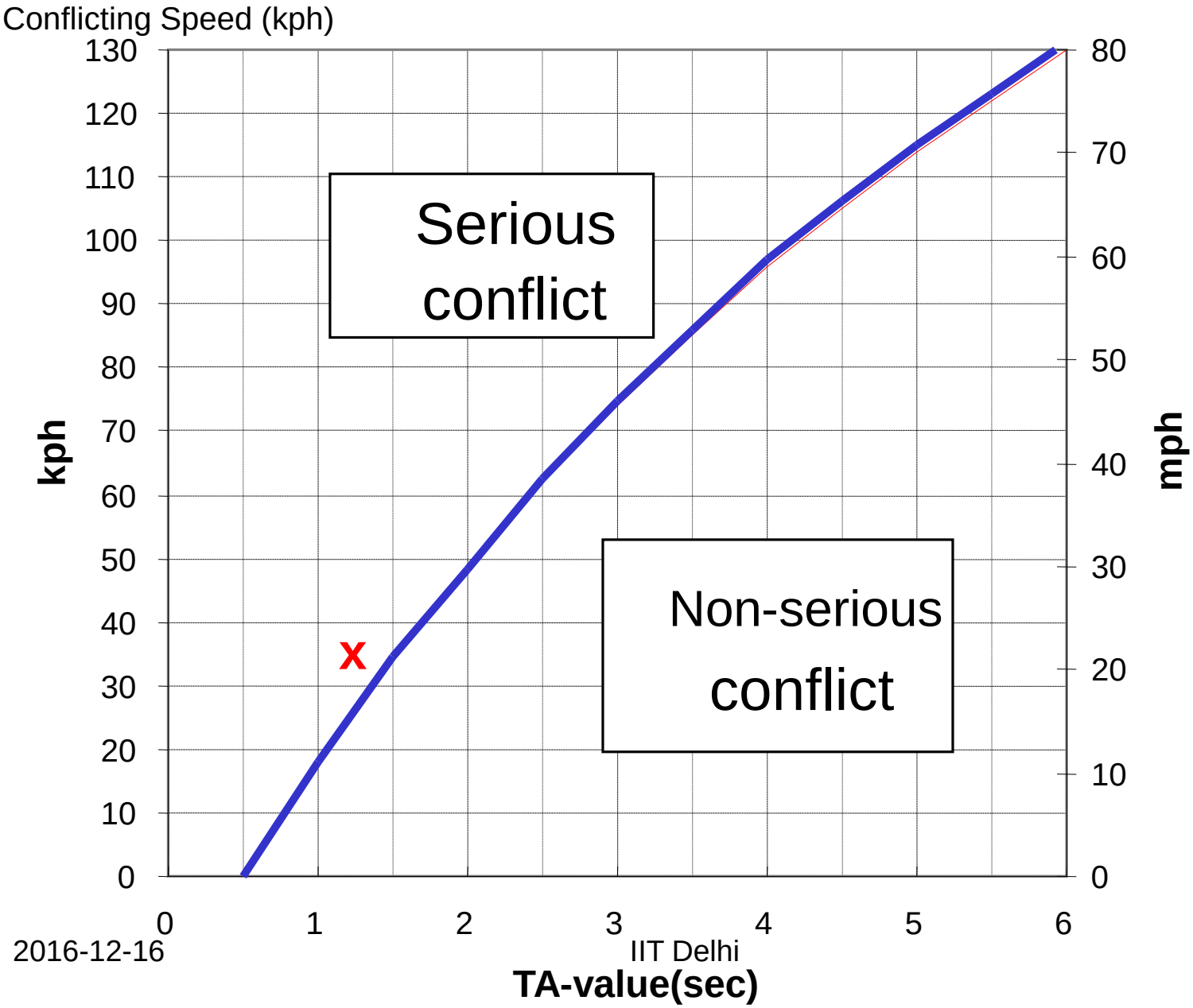
Conflict	Speed (km/h)	Distance (m)	Speed (m/s)	Time to Accident (s) (m/m//s
1	15	4	4.2	1.0
2	35	12	9.7	1.2
3	20	2	5.6	0.4
4	55	12	15.3	0.8
5	20	3	5.6	0.5
6	15	2	4.2	0.5
7	20	3	5.6	0.5
8	45	25	12.5	2.0

Conflicts on the conflict video. From 5:08

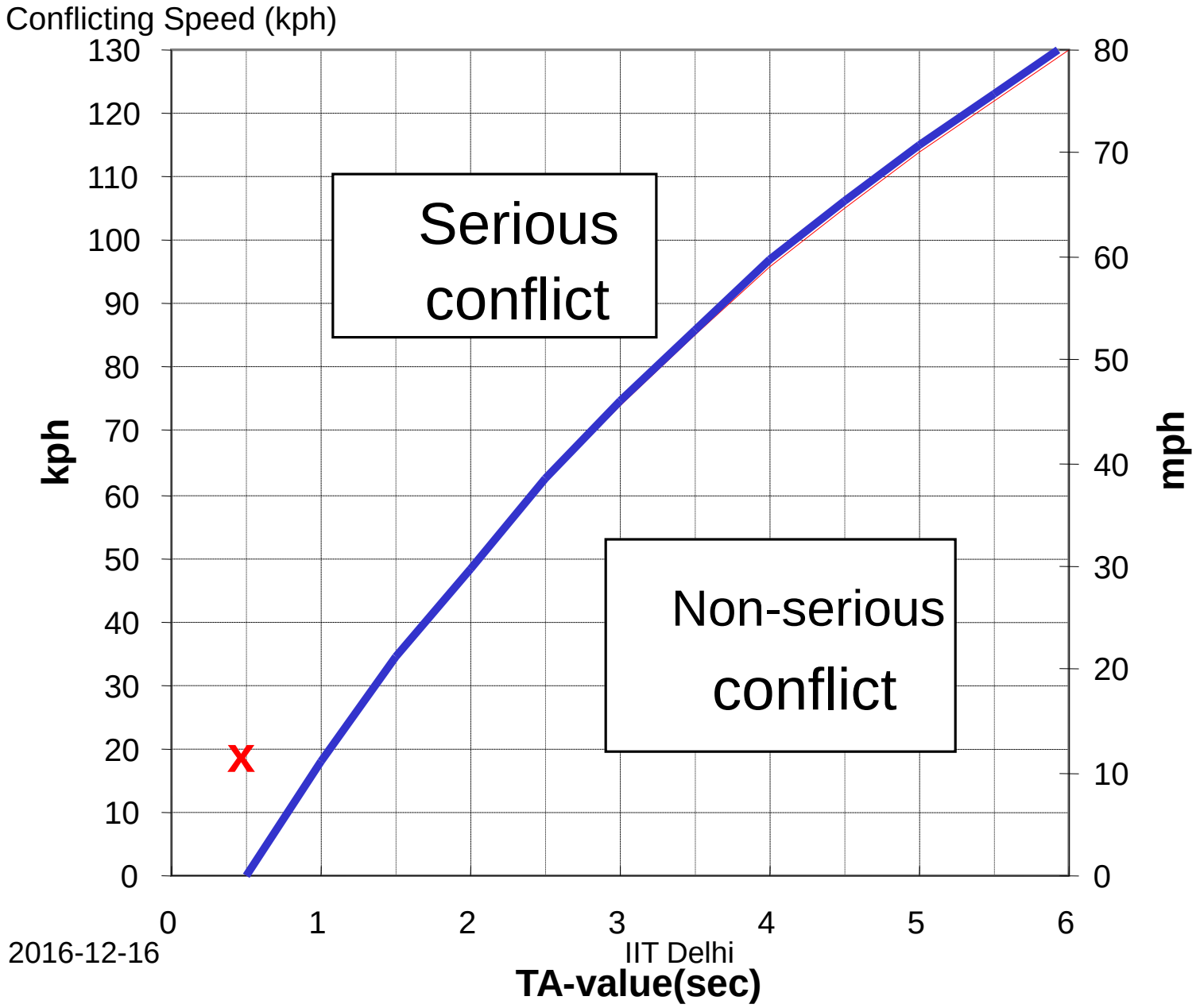
Conflict no. 1 – 15km/h, 4 meter, TA=1.0 sec



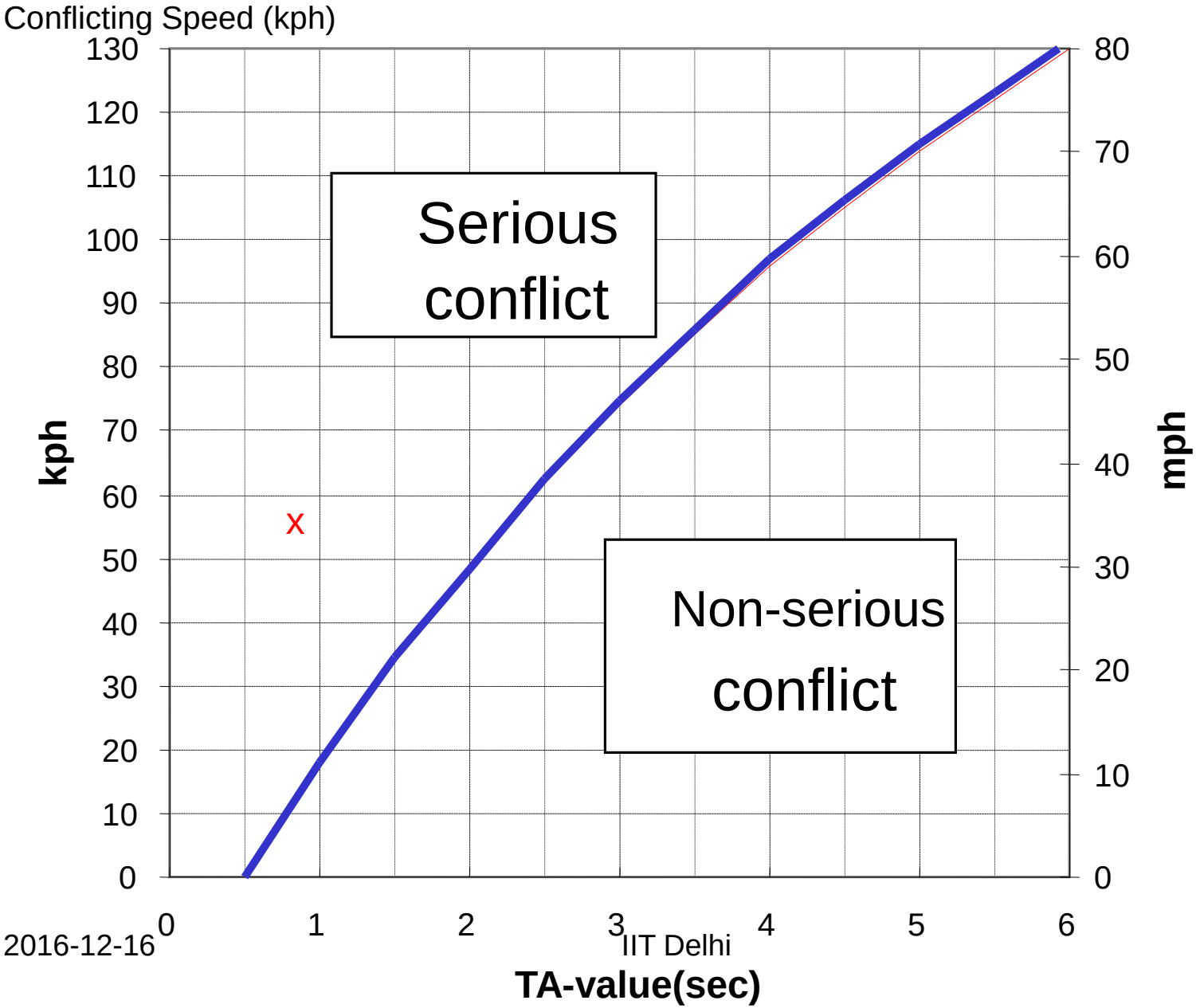
Conflict no. 2 – 35km/h, 12 meter, 1.2 sec



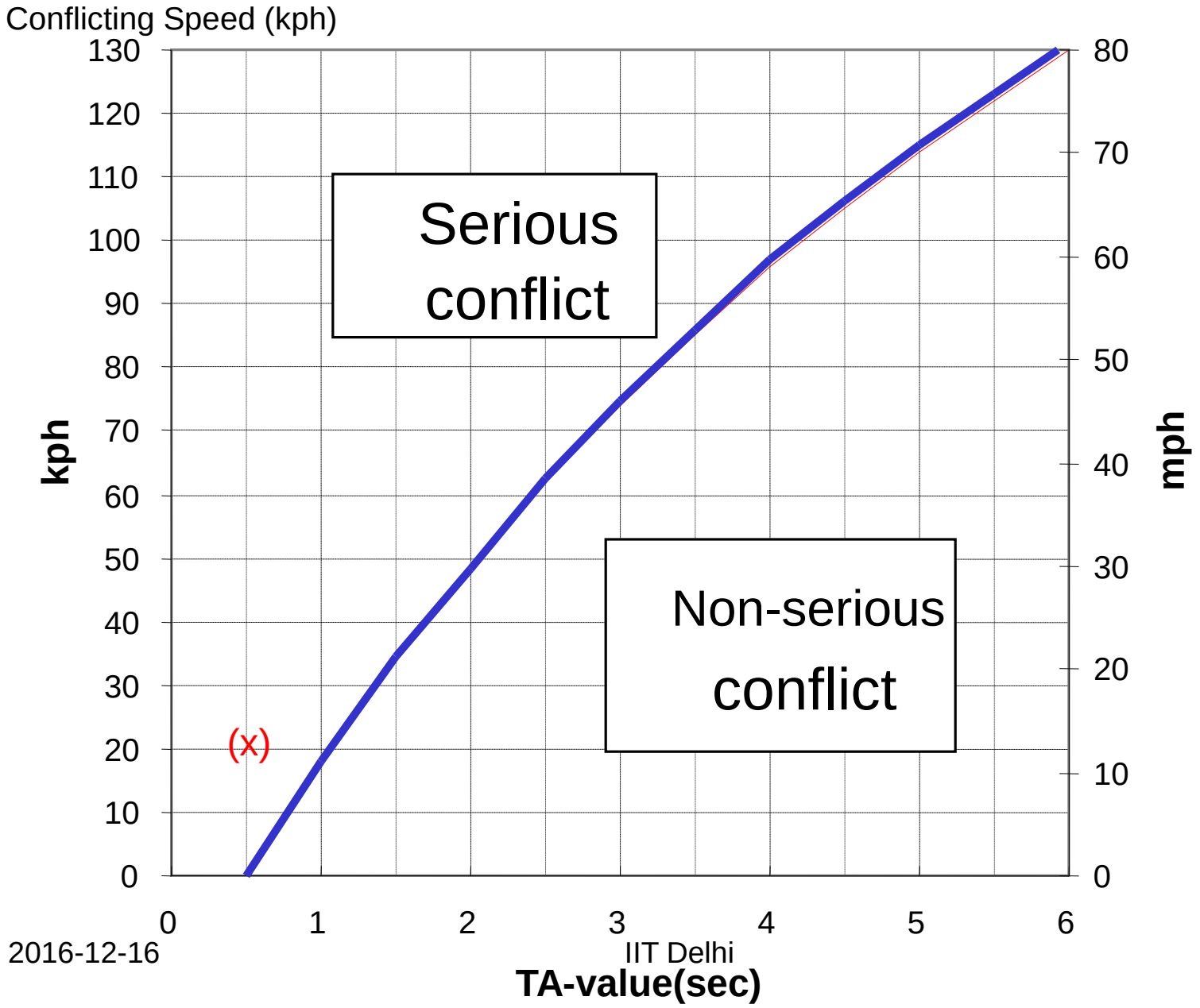
Conflict no. 3 – 20km/h, 2 meter, TA=0.4 sec



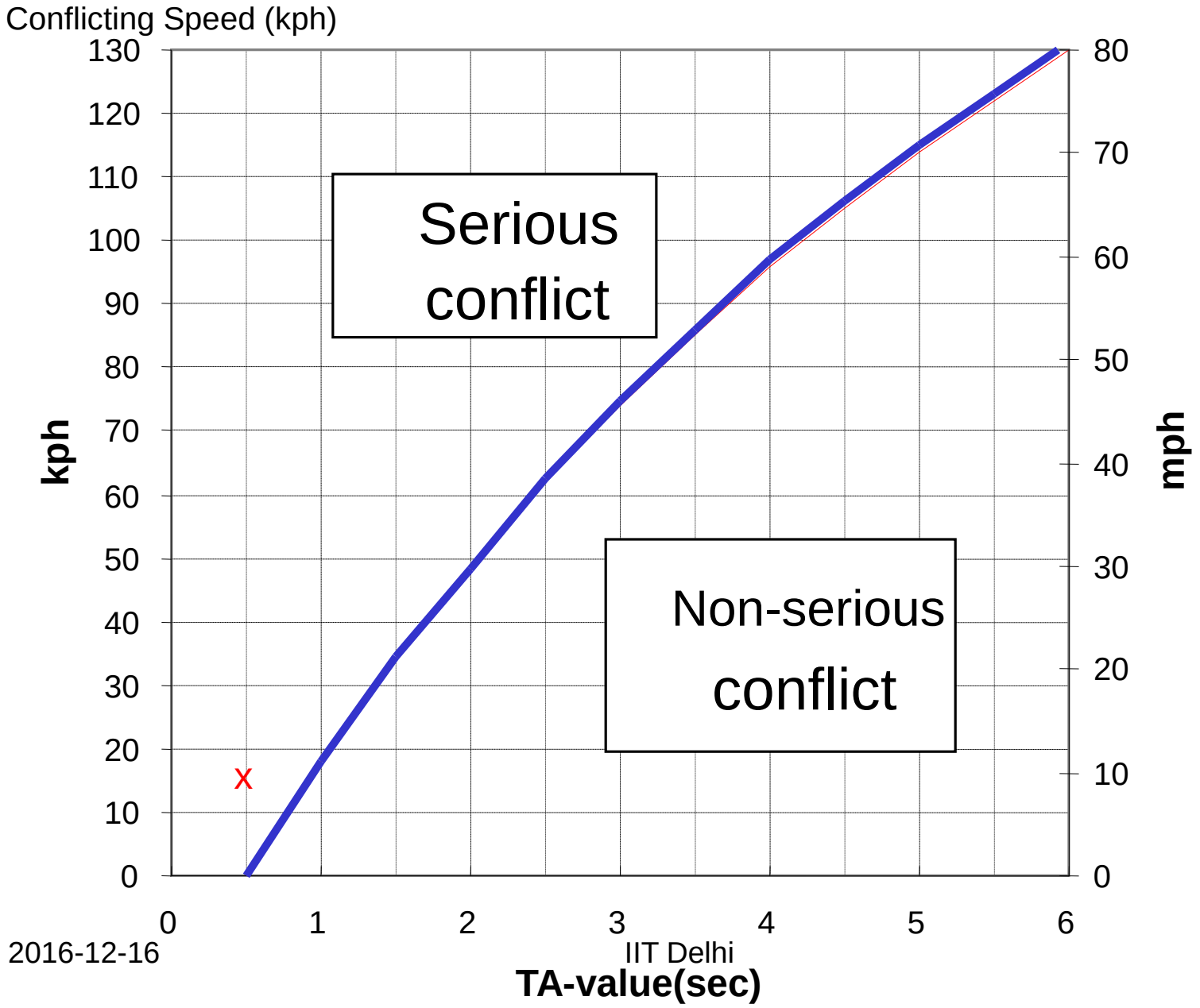
Conflict no. 4 – 55km/h, 12 meter, TA=0.8 sec



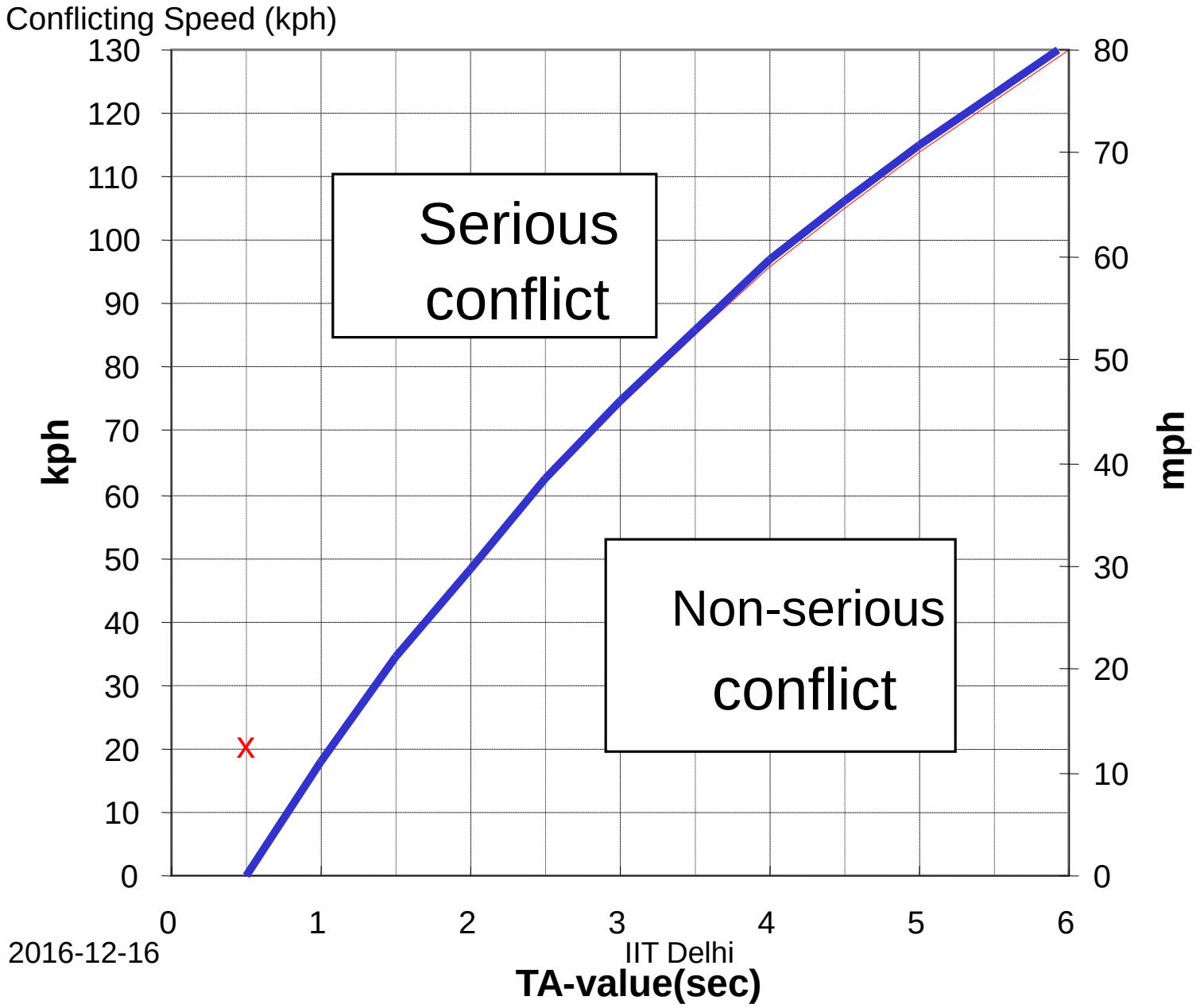
Conflict no. 5 – 20km/h, 3 meter, TA=0.5 sec



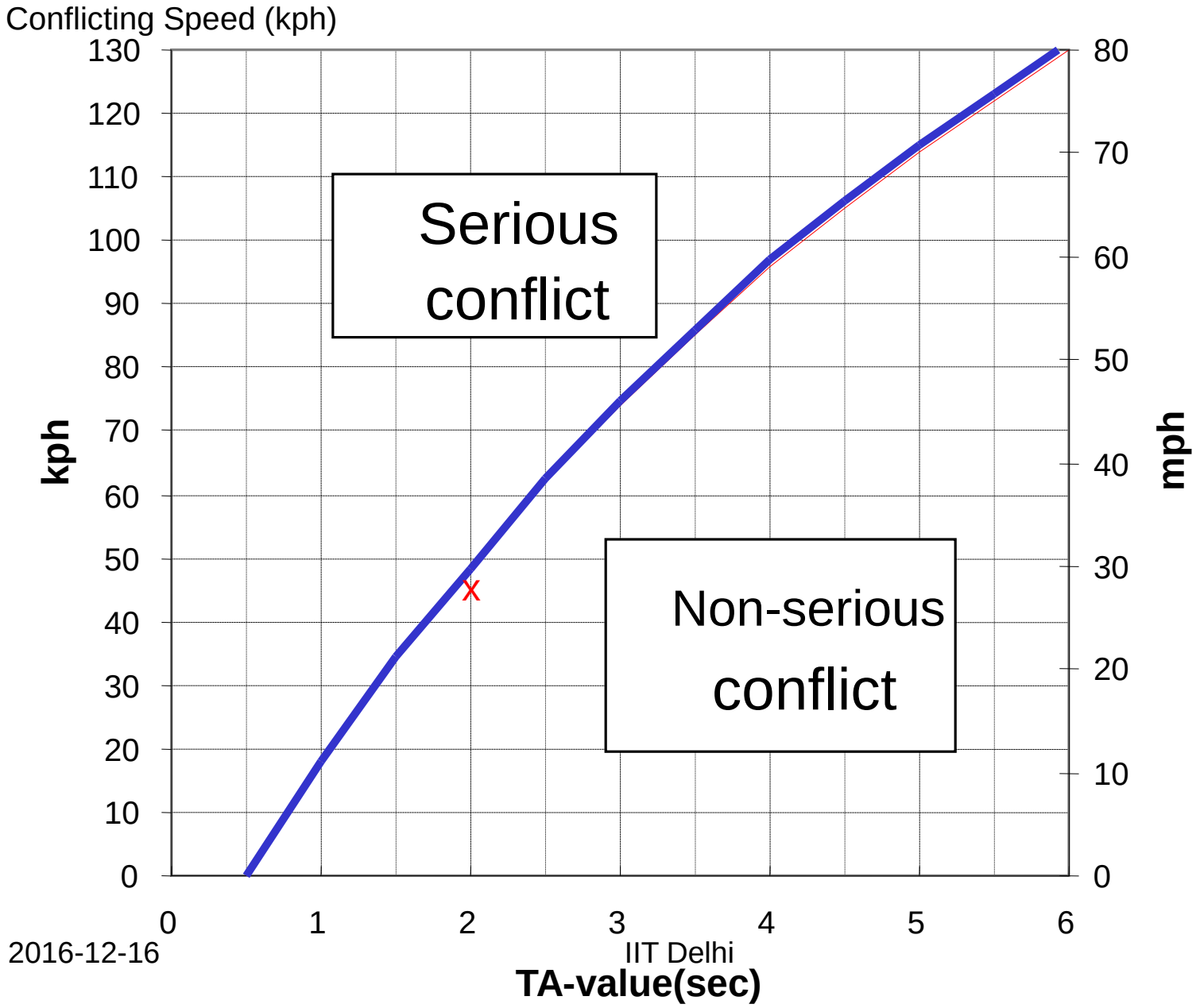
Conflict no. 6 – 15km/h, 2 meter, TA=0.5 sec



Conflict no. 7 – 20km/h, 3 meter, TA=0.5 sec



Conflict no. 8 – 45km/h, 25 meter, TA=2.0 sec



Old video conflicts for training - facit

Time/nu. (sec/#)	Speed (km/h)	Distance (meter)	TA Sec.		Time (sec	Speed (km/h)	Distance (meter)	TA Sec.
4:24/18	25	6	0.9 (ALLV)		13:52/35	25	8	1.2 (ALLV)
4:55/19	15	2	0.5 (ALLV)		13:59/35	35	14	1.4 (bra)
5:29/31	25	5	0.7 (ALLV)		14:55/46	10	1.5	0.6
6:56/22	35	8	0.8 (ALLV)+		15:30/49	45	8	0.6 (bäst)
9:13/9	25	8	1.8 ---		16:36/24	15	3	0.7
9:46/10	45	13	1.0 (ALLV)		18:55/39	30	10	1.2
11:00/28	40	12	1.1 (ALLV)		21:14/11	15	3	0.7 (bra)
11:22 /44	45	10	0.8 (ALLV) +		1:58 (ny del)			
11:53 //48	5	0,5	0.4 (intress.)		3:30 (paus)			
13:28/27	15	3	0.7 (ALLV) +					

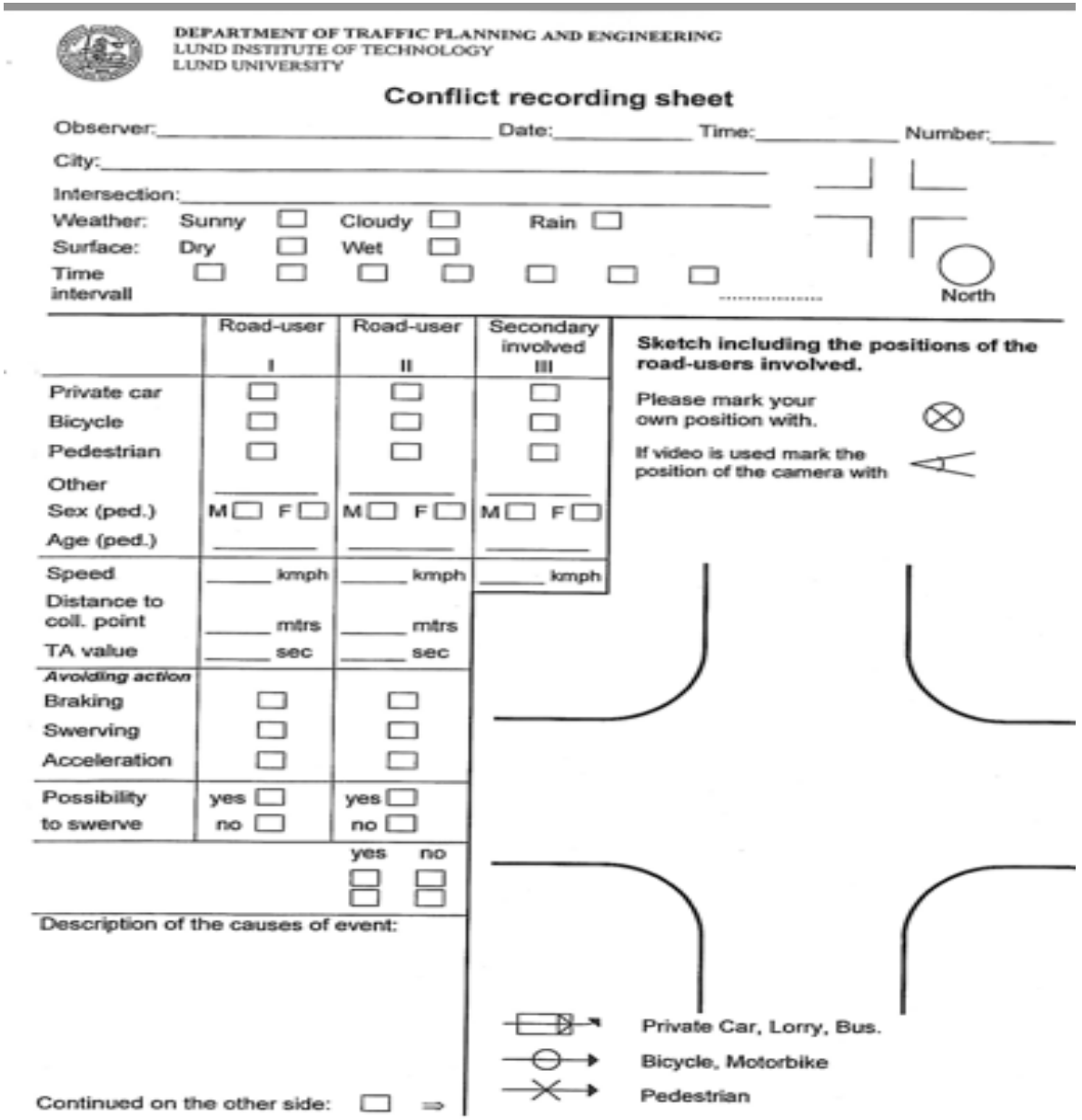
Konflikter på konfliktfilmen. Från 5:08

Practical use of the conflict technique (1)

- Conflicts are recorded using trained observers.
- Basic training normally takes one week
- Each conflict is recorded on a separate **recording data sheet**
- It is only **serious conflicts** that are used for the prediction of the expected number of accidents. However, the recording should include some more conflicts (to be on the safe side)
- Video is normally used as a complement and for behavioural studies, counts, etc

Practical use of the conflict technique (2)

- Behaviour that seems to be interesting based on the conflict studies can be followed up systematically by specially designed behavioural studies



DEPARTMENT OF TRAFFIC PLANNING AND ENGINEERING
LUND INSTITUTE OF TECHNOLOGY
LUND UNIVERSITY

Conflict recording sheet

Observer:_____ Date:_____ Time:_____ Number:_____

City:_____

Intersection:_____

Weather: Sunny ☐ Cloudy ☐ Rain ☐

Surface: Dry ☐ Wet ☐

Time intervall ☐ ☐ ☐ ☐ ☐ ☐ ☐ .....

North

	Road-user I	Road-user II	Secondary involved III
Private car	☐	☐	☐
Bicycle	☐	☐	☐
Pedestrian	☐	☐	☐
Other	_____	_____	_____
Sex (ped.)	M☐ F☐	M☐ F☐	M☐ F☐
Age (ped.)	_____	_____	_____
Speed	_____ kmph	_____ kmph	_____ kmph
Distance to coll. point	_____ mtrs	_____ mtrs	
TA value	_____ sec	_____ sec	
Avoiding action			
Braking	☐	☐	
Swerving	☐	☐	
Acceleration	☐	☐	
Possibility to swerve	yes ☐ no ☐	yes ☐ no ☐	

yes ☐ ☐ no ☐ ☐

Description of the causes of event:

Continued on the other side: ☐ ⇒

Sketch including the positions of the road-users involved.

Please mark your own position with. ⊗

If video is used mark the position of the camera with

Private Car, Lorry, Bus.

Bicycle, Motorbike

Pedestrian

Practical use of the conflict technique (3)

- The most important task for the observer is to estimate TA, with the help of CS and distance,
- .....and to fill in the sheet correctly
- .....and always describe the events preceeding the conflict ”as complete as possible”
- .....and never lose attention...

Practical use of the conflict technique (4)

- Normally one observer; more if the intersection is big or it is heavy traffic
- Select times of the day/year when problems seem to appear (e.g. Problems in darkness...)
- Still; normally studies are made 3 times 2 hours a day, morning, lunch and afternoon
- Normally 3 to 5 days of observations
- ”Extreme weather” should be avoided

The **reliability** and **validity** of the Swedish Technique has been carefully studied

Reliability and validity

1/ Comparison of different observers ability to score correctly

2/ Comparison of the evasive maneouvre in conflicts and accidents

3/ Comparison of conflicts and accidents regarding there TA and CS values

Observer reliability

- The ”hit rate” is normally around 80%
- The average size of the difference in absolute values was in a comparative study 0,28 seconds
- In almost half of these conflicts the difference was less than ± 0,2 seconds
- In 82% the difference was less than ± 0,4 seconds

1/ Comparison of different observers ability to score correctly

TABLE 4.1 SUMMARY OF THE FIRST RELIABILITY TEST

Observer	A	E	H	J	M	Total
Number of serious conflicts to be scored	8	8	8	8	8	40
Number of serious conflicts actually scored as serious	7	7	8	8	6	36 (90%)
Number of non-serious conflicts actually scored as serious	0	2	0	0	0	2

From: Hydén 1987

Product validity

- Three different samples of accidents and serious conflicts from different intersections in two cities produced quite similar “conflict to accident” ratios
- The average annual expected number of police reported injury accidents was often shown to be better predicted by conflicts than by accidents at single locations

Conversion factors – serious conflicts to accidents

	Car-car	Car-car	Car-pedestrian Car-bicycle
p=	$2.8\ 10^{-5}$	$11.9\ 10^{-5}$	$33.9\ 10^{-5}$

Process validity

1/Comparison of the evasive maneouvre in conflicts and accidents

2/ Comparison of conflicts and accidents regarding there TA and CS values

1/ Type of evasive action in conflicts and accidents

Motor vehicles vs motor vehicles

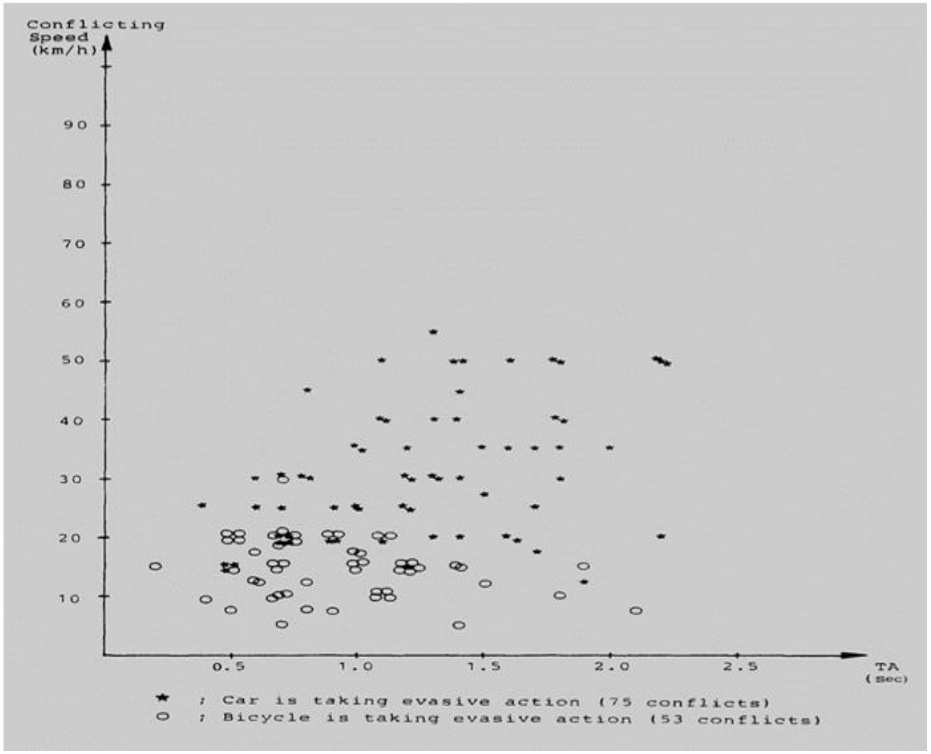
	braking	braking +swerving	swerving	acceleration
Conflicts	**77%**	**16%**	**5%**	**3%**
Accidents	**73%**	**15%**	**10%**	**2%**

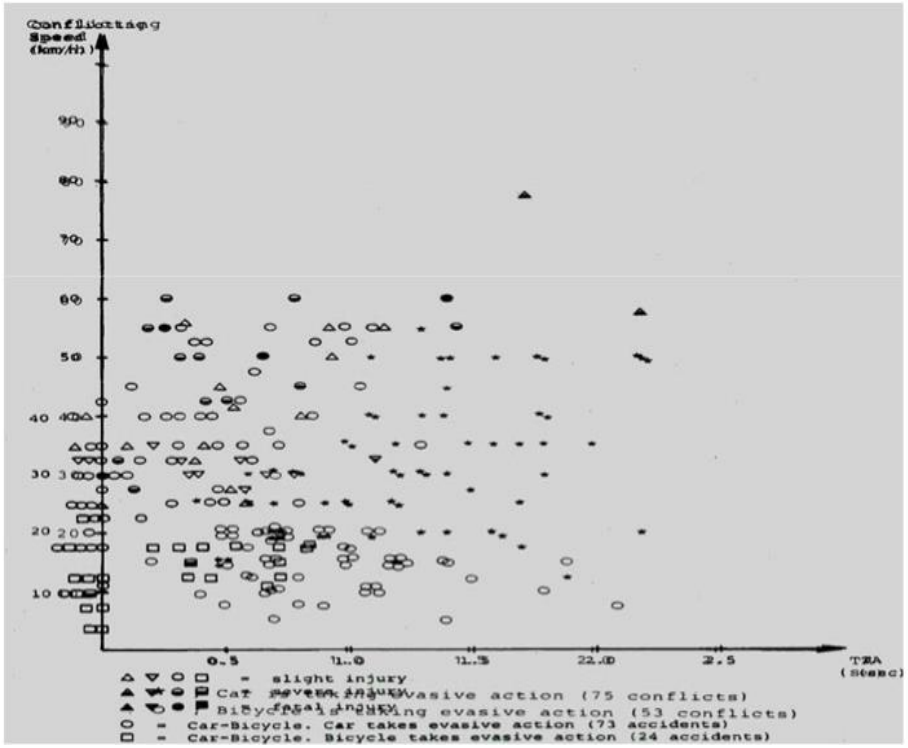
2/ TA and CS for conflicts and accidents

- Based on conflict studies
- Based on analysis of in-depth data from accidents – from the same locations

Car – Bicycle

TA and CS





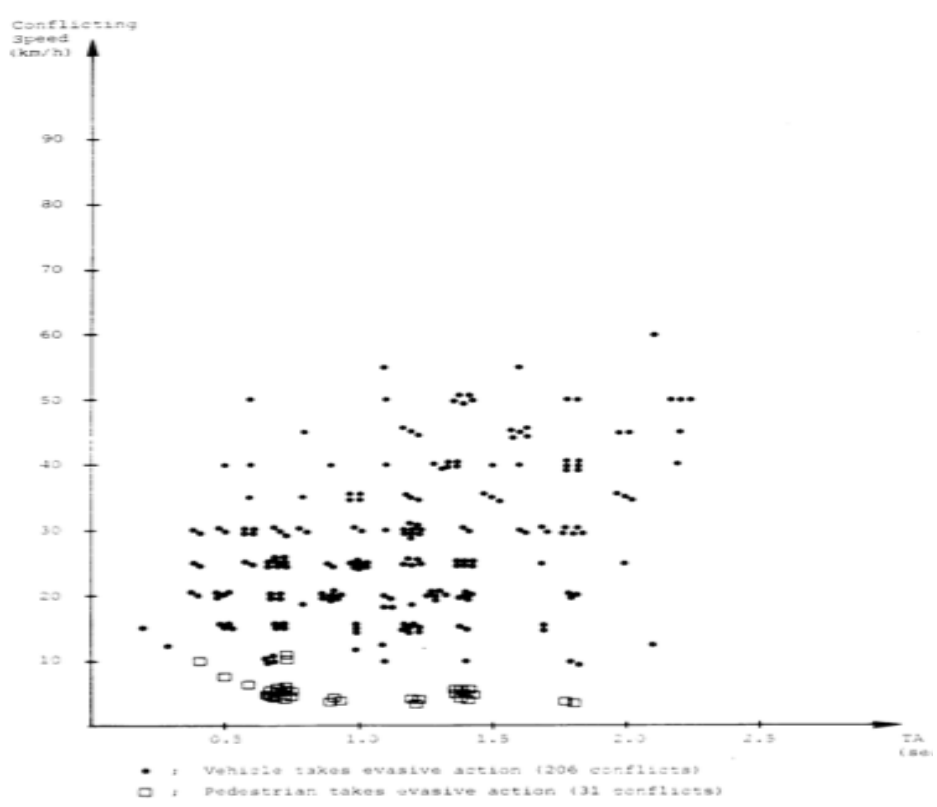
conflicts

accidents

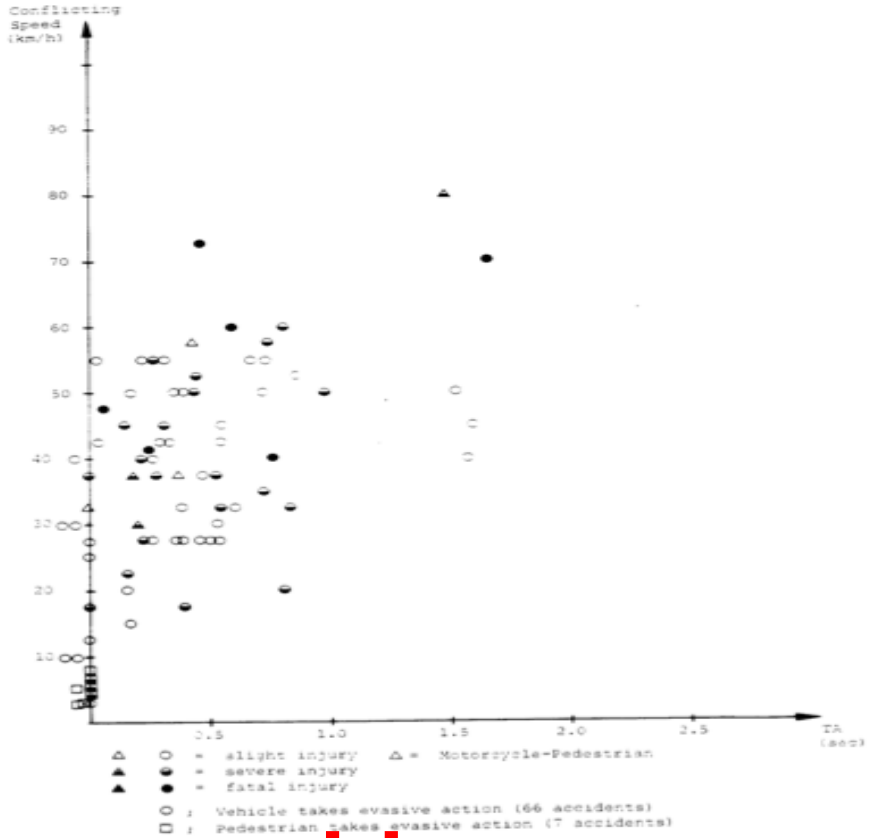
From: Hydén 1987

Car – Pedestrian

TA and CS



conflicts



accidents

From: Hydén 1987

Conflicts and accidents belong to the same process, just with different degree of seriousness (most often)

- Patterns are very alike
- Accidents have a TA-value that is approx 0,5 seconds smaller and a CS that is approx 10 km/h higher than serious conflicts
- Accidents represent a logical continuation of the serious conflicts on a severity scale

Main conclusion

Conflicts and accidents belong to the same process, just with different degree of seriousness

Analysis of conflict studies

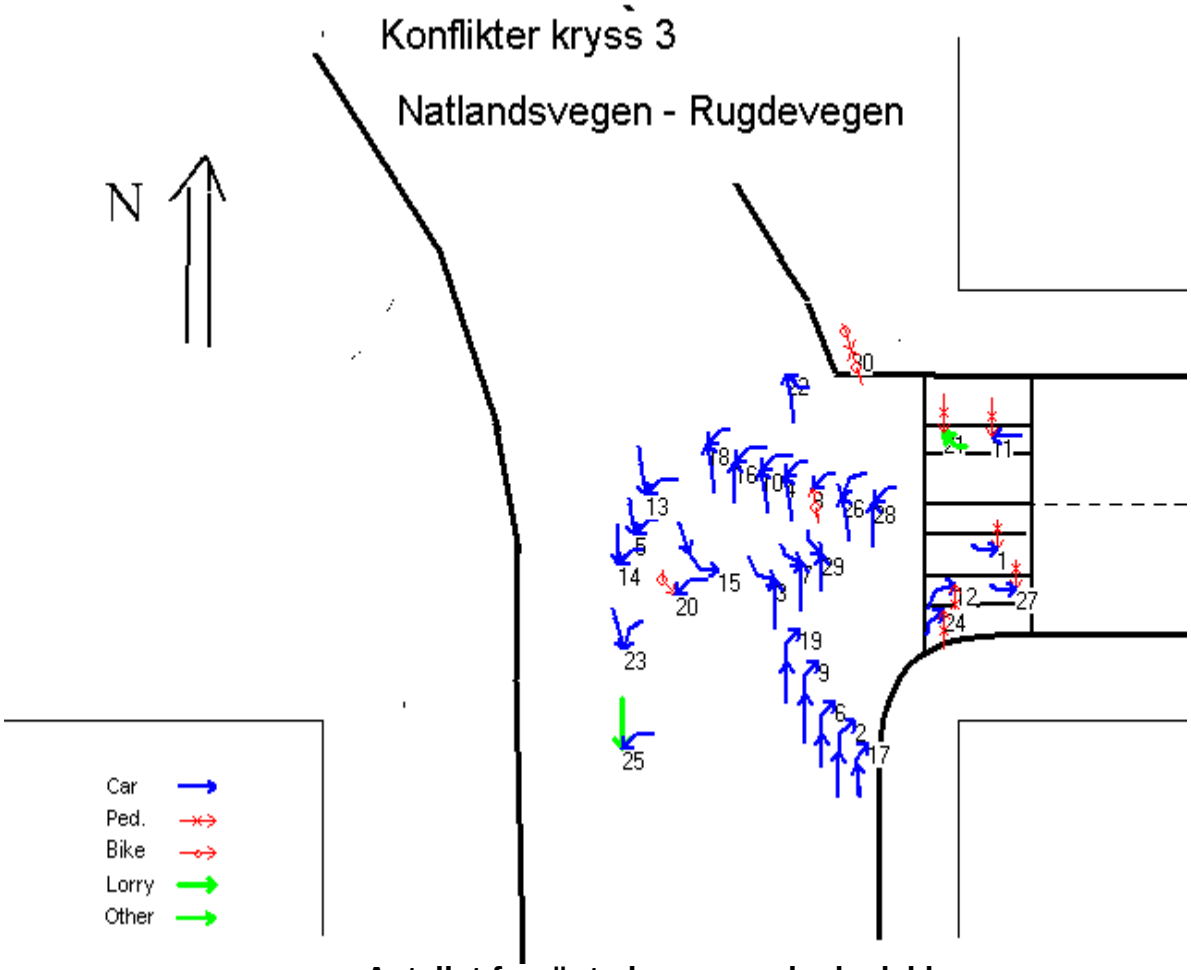
- There are between 3.000 och 40.000 conflicts on each police-reported injury accident (Swedish conditions)
- We use these **conversion factors** (π) between accidents and serious conflicts
- In principle the analysis is made as if it were accidents, with the adding that conflicts are also described in terms of **events**
- The Data Base **CDBase** can be used to automatise the analysis
- It produces predictions automatically as well as other statistics

Conversion factors (π) –

conflicts per day to police reported injury accidents per year

	Car-Car	Car-Car	Carl-Pedestrian Car-Cyclist
π=	$2.8\ 10^{-5}$	$11.9\ 10^{-5}$	$33.9\ 10^{-5}$

Example on an assessment of a conflict study



Antallet forventede personskadeulykker:

a/ Fra konfliktstudiet: Bil – Bil: 0,24 ul. per år. Bil – Myk trafikant: 0,35 ul. per år

b/ Fra ulykkesstatikken: Bil – Bil: 0,10 ul. per år. Bil – Myk trafikant: 0,50 ul. per år