"Practical Road Safety Engineering" online workshop

Module 4 – investigating blackspots

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Welcome back everyone

"Practical Road Safety Engineering" online workshop

MODULE 4 – INVESTIGATING BLACKSPOTS

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HOW TO INVESTIGATE BLACKSPOTS

(ELIMINATING HIGH CRASH LOCATIONS FROM YOUR ROADS AND HIGHWAYS)

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Objectives of this module:

- To introduce the *process* of investigating a hazardous location
- To emphasise good crash data
- To encourage you to be "detectives" or "doctors" in this important work
- To show some examples of recent blackspot investigations

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Eliminating hazardous road locations

- The *road* plays a role in road safety
- We can identify blackspots and black lengths – maybe not "perfectly"
- Police gather crash data
- We can investigate blackspots – carefully and thoughtfully – day and night
- Engineers can install logical, low cost countermeasures.
- Crashes can be reduced – Police and engineers working together
- And we must not build new blackspots! (Road safety audit)

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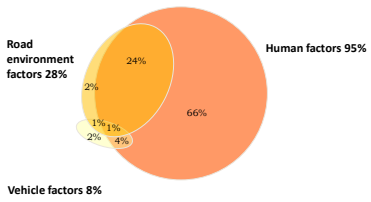
The factors involved with crashes



Based on British and American research

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- Road user error is the major contributing factor to road crashes.
- But it is easier for road users to make an error on a "bad" road (with poor alignment, inadequate signing, lacking traffic control).
- It is also easier for more serious injuries after an error on a road with unsafe roadsides (trees, poles, unsatisfactory barriers).
- Remedying such defects is an economical and effective way of reducing the cost of road trauma in your country.

YOU CAN SAVE LIVES

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WHAT IS A BLACKSPOT?

- A blackspot is any site with many casualty crashes
- Casualty crash means a fatal crash, or a crash in which at least one person is injured (serious or slight)
- Intersections, short lengths, or curves = blackspot
- Road length of 1km = black length

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What is a Blackspot ?

A blackspot is a location which has a high number of crashes – fatal, serious, minor. It may be an intersection, or it may be a length of road.

When the Victorian blackspot program started in 1980, a location needed 12 casualty crashes in 3 years to be a "blackspot".

Today it is 3 casualty crashes in 5 years.

There has been great success over 40 years (an 85% reduction in crashes according to our definition)

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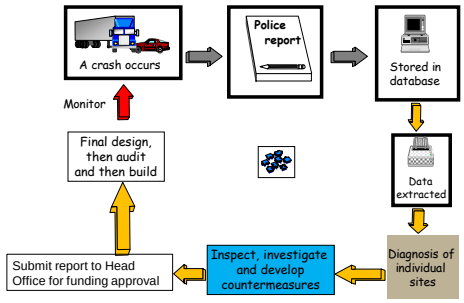

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Police gather.....

Date/time/location/directions
Names/addresses/ages/sex of all involved
Alcohol/drugs
Vehicle types/registration
Injury levels
Any other information needed to prosecute the offender
More

In countries with good road safety records, Police record the crashes, store it in a database and share it with government stakeholders

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Engineers need good crash data

Engineers do need to know:

- Where the crash happened (accurately)
- When it happened (day/night)
- The road users involved – from which direction
- Conditions at the time – rain, wind, fog, snow, sun

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Engineers need *good* crash data

Engineers do not need:

- Names, addresses of people involved
- Vehicle registration details
- Police prosecution information (alcohol, speed or drugs)

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Engineers look for patterns in the crashes

- Gain a "picture" of the crash history of the site.
- Work with Police – ask them for details of the crashes that may not be written in the reports.

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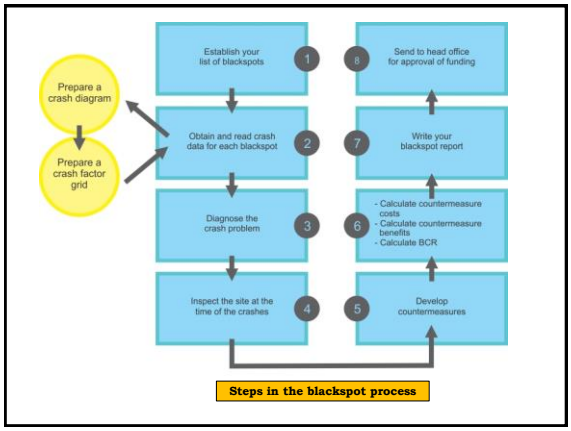

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1 Decide your list of blackspots How?

- National level, state or city level
- Locations with most fatalities?
- Locations with most crashes?
- A point system 10 for F, 5 for SI, 1 for PD.
- Always have more sites than you can fund as some will not be able to be changed.

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2 Draw a collision diagram

- Make a rough draft first
- For each vehicle – draw an arrow to show its direction
- Show pedestrians, cars, trucks, buses differently
- Show the point of impact accurately

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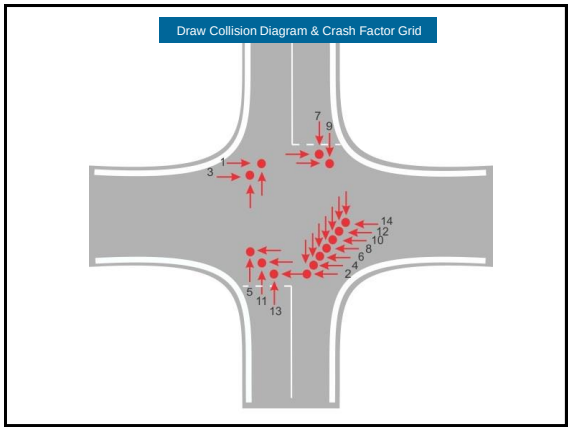

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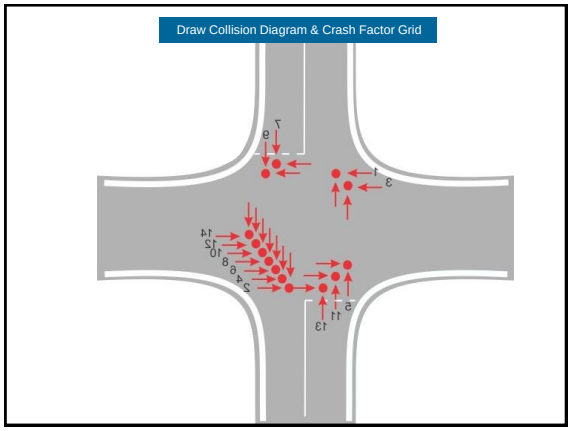

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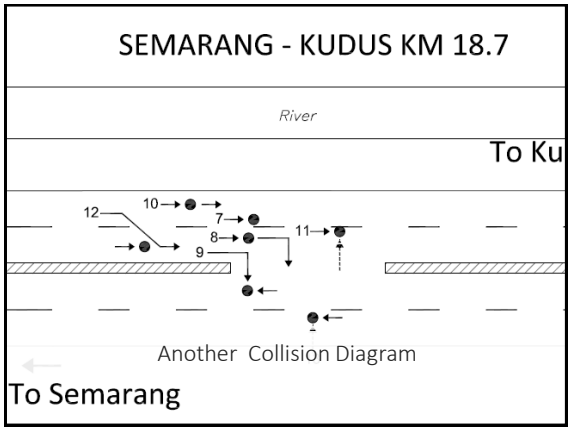

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2 Draw a crash factor grid (Matrix)

- Microsoft Excel or similar.
- Pen and paper is also OK.
- For each crash – summarise the details in one column.
- Add rows if extra information is known from the Police reports.

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An example of a Crash Factor Matrix

Accident Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: day: month	1307	0409	1912	0806	0307	0711	3012	2702	0305	2407	1804	2105	1406	2008
Date: year	15	15	15	16	16	16	16	17	17	17	17	17	17	17
Day of week	Sat	Wed	Thu	Sun	Thu	Fri	Tue	Fri	Sun	Fri	Sun	Fri	Mon	Fri
Time of day	1700	1855	1530	1900	1345	2145	1900	1220	1800	2000	1845	1610	1735	1855
Severity	3	3	2	3	2	4	3	3	4	2	3	2	2	3
Light conditions														
Road Conditions	W	W	D	D	D	D	D	D	D	D	D	D	W	D
DCA Code	101	101	101	101	101	101	101	101	101	101	101	101	101	101
Object 1	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Van	Car
Object 2	Car	Car	Truck	Car	Car	Car	Car	Truck	Car	Car	Car	Car	Car	Car
Object 3					Car			Car			Car			
Direction 1	N	S	N	S	N	S	S	S	S	S	N	S	N	S
Direction 2 (& 3)	E	W	E	W	W,E	W	E	W,N	E	W	W,E	W	W	W
Other														

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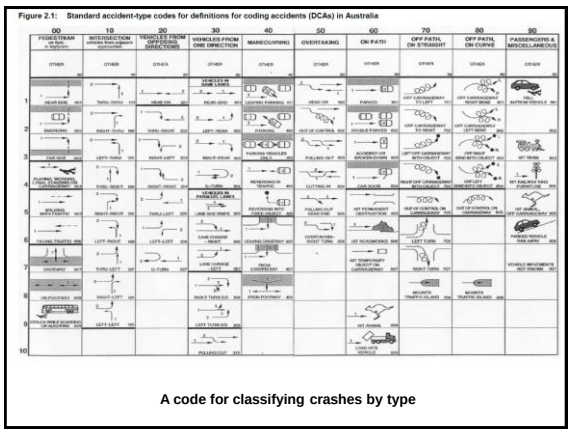

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3 Diagnose the crash problem

- A patient visits a doctor and tells the doctor about his illness.
- The doctor does not just guess about his illness – he does not want to treat the patient for a sore arm when he has a heart problem.
- You are like a doctor – diagnosing a "sick" part of your road (a blackspot).
- The blackspot cannot speak – you must look, listen, read crash data, speak with Police, ask locals.
- This takes time, skill, and logic

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3 Diagnose the problem

Examine the Collision Diagram and the Crash Factor Matrix

Look for *patterns*?

- Day time vs night time?
- Wet vs dry?
- Type of crash - head on, or run-off-road, pedestrian etc
- Type of road user?
- Direction of travel?

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4 Inspect the site – at the time the pattern of crashes happened!

If crashes happened at night, inspect at night!

Put yourself in the shoes of those involved.

Ask yourself ….. why did they have their crash?

….. why did they have their crash?

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- Inspect the site day and night. Assess likely causes for the patterns.
- You are a doctor – diagnose your patient to prescribe the best medicine!
- You may NOT get it right immediately. Keep trying!

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Be logical .....

Recommend only countermeasures that will reduce the crashes

(For example, if crashes happened mainly during daytime, do not install street lighting as a countermeasure.

And do not replace the nearby barrier simply because it is old and rusty, unless it was involved in crashes)

$ are always limited – so look first for low cost options.

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When you are on-site……

- Get a good "feel" for the location – the topography, the type of traffic, its speed, its volume
- Keep asking – why do a few people have crashes here each year, but thousands do not?
- What is missing? What is misleading? Be logical!

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5 Develop countermeasures – discuss them with colleagues

Keep your ideas simple

Use low-cost options wherever possible

Persevere – some sites are difficult but most locations will be open to low cost countermeasures

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Your list of low cost countermeasures

- Signs – warning, regulatory, direction
- Line marking
- Delineation
- Shoulder sealing
- Roadside hazard removal (or shielding)
- Geometric changes
- Opening sight lines (benching, cut vegetation)
- Speed limits
- Traffic signals
- Roundabouts
- Lighting

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A few tips for your site inspection (NOTE: some crashes have nothing to do with the road!!)

Look for "visual deceit"

- Not all drivers/riders see the road the same way.
- Try to look at the road as others "might"

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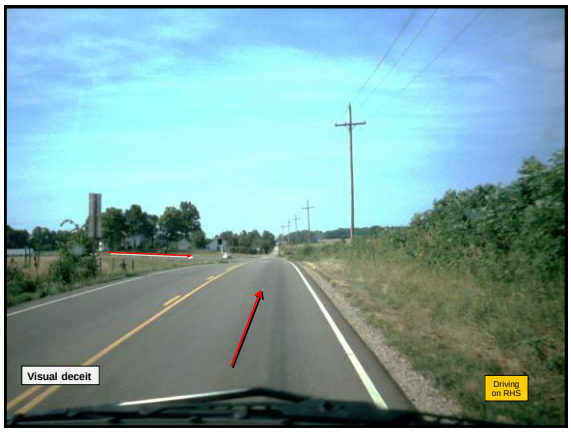

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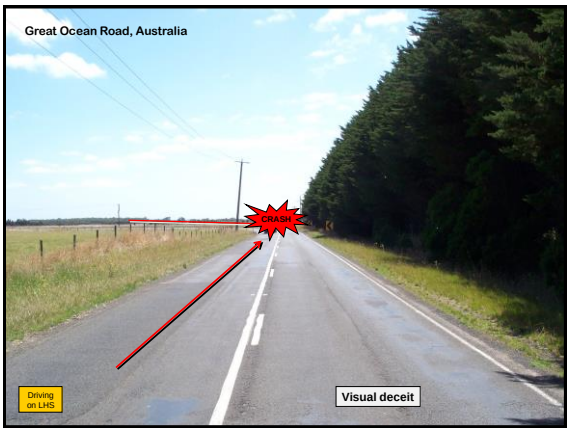

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A FEW TIPS FOR YOUR SITE INSPECTION

(SOME CRASHES HAVE NOTHING TO DO WITH THE ROAD!!)

With intersection right angle crashes – you need to decide if the crash is an overshoot or a re-start

Why?
Because your countermeasure(s) may be quite different

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The truck failed to give way. But why? Overshoot, or re-start?

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Overshoot **– the driver did not know the intersection was there**

- Improve Approach Sight Distance
- Make intersection more conspicuous
- Advance warning signs
- Advance direction signs
- Duplicate GW or Stops
- Lighting (if crashes are at night)
- Roundabout or signals

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Re-start **– knew intersection was there, slowed, maybe stopped, but selected a "wrong" gap**

- Improve Safe Intersection Sight Distance
- Maximise sight lines
- Reduce speeds
- Alter the traffic control
- Geometric changes
- Cut trees/grass
- Reduce speed limits
- Roundabouts or signals

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WHY?

6 Finalise a preliminary design, and then calculate a benefit/cost ratio for your recommendations

In the future there will be competition for funding within the national blackspot program. Then you will have to rank sites so that funds are spent on those sites that will return the "best value" to your country

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How will *you* determine benefits and costs?

1 You need to know the benefits to be gained from your countermeasures (in $)
2 You need to know the cost of the countermeasures (in $)
3 You then calculate the benefit/ cost ratio

BCR

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To determine benefits and costs

Costs are easy!

But how do we calculate the benefits to be gained (in $)

How many crashes do we expect to save, and how much would each one cost your country?

A TOUGH QUESTION!

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Who has heard of crash reduction factors?

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Treatments	Crash Reduction Factors	Treatment Life
INTERSECTION		
New roundabout	85%	20
Modify roundabout (approach deflection)	55%	20
New traffic signals	45%	20
Convert intersection signals to roundabout	30%	20
Staggered T low volume (<2000 AADT of through road)	70%	20
Removal of Y-intersection	85%	20
Splitter islands/median, urban	20%	20
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Line marking to improve intersection definition	10%	5
Improve sight distance (remove/relocate obstruction)	50%	20
Improve signage	30%	15
Rumble strips on approaches	30%	5
Install Stop signs	30%	15
Install signs	30%	15
Change to Stop signs	5%	15

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How will *you* determine benefits and costs?

1. Establish your countermeasures
2. Get the Crash Reduction Factor
3. This is the *highest CRF* of those that apply to your treatments
4. Agree on a crash cost ($) for your country
5. Calculate the benefits of the countermeasures ($)
6. CRF x number of crashes saved x $ value for each crash

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How will *you* determine benefits and costs?

7. Calculate the cost of the works ($)
8. Calculate the benefit/ cost ratio
9. Include this BCR in your report
10. Head Office will approve funding to the highest BCR's first – working down the list until the annual budget is committed.

NOTE: Funding is approved on the basis of BCR's – not the cost.

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EXAMPLE OF CALCULATING THE BENEFIT COST RATIO

To work out the BCR we need to know the benefits (in $) of the countermeasures, and the cost (in $) of the countermeasures.

- An intersection blackspot with many right-angle crashes
- Some day, some night
- You believe it is a re-start (gap acceptance) problem
- You check traffic counts and recommend a roundabout – CRF's indicate it will save 85% of crashes for next 20 years
- The roundabout will cost $1,200,000 USD

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Benefits – look at a table that shows the Crash Reduction Factor for each countermeasure

What percentage of crashes at the blackspot will be reduced if we construct a roundabout as the treatment for an intersection crash problem?

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Crash reduction factors based on real experience from the Victorian (Australia) blackspot program since 1980

PAVEMENT WORKS	%	YEARS
Road reconstruction	25%	20
Duplication short length	30%	20
Install raised median	30%	20
Add median strip	20%	20
Widen pavement	10%	20
Construct overtaking lane	25%	20
Add lane	10%	20
Widen road for Right Turn lane	50%	20
Widen road for Left Turn lane	15%	20
Lane widening - 0.3m	5%	20
Lane widening - 0.6m	12%	20
Widen shoulder not seal - 0.3m	3%	20
Widen shoulder not seal - 0.6m	7%	20
Widen shoulder not seal - 1m	10%	20
Widen shoulder and seal - 0.3m	4%	20
Widen shoulder and seal - 0.6m	8%	20
Widen shoulder and seal - 1m	12%	20

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Crash reduction factors based on real experience from the Victorian (Australia) blackspot program since 1980

DELINEATION		
Reflectorised guide posts	30%	20
Advance Curve Warning signs - static	20%	15
Advance Curve Warning signs - vehicle activated	75%	15
Install chevron signs (CAMS) - normal	35%	15
Install chevron signs (CAMS) - electronic	50%	15
Painted centrelines	30%	5
Tactile centrelines	40%	5
Painted edge lines	25%	5
Tactile edge lines	35%	5
Barrier lines	30%	5
Raised reflectorised pavement markers (RRPM)	20%	5

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ROADSIDE HAZARD MANAGEMENT		
Wire Rope Safety Barrier (WRSB)	45%	20
Guardrail	35%	20
Median barriers (any type including centreline WRSB)	20%	20
Guard rail at culvert	25%	20
Guardrail for bridge end post	20%	20
Crash Cushions	15%	20
PEDESTRIANS & CYCLISTS		
Refuges, Channelisation, Kerb extension	30%	20
Pedestrian signals	25%	15
Bicycle paths, threshold treatments	10%	20
Upgrade pedestrian signals	20%	15
Pedestrian overpass	10%	20
MOTORCYCLISTS		
New roundabouts	75%	20
Intersection signal remodel	50%	15
Fully Controlled Right Turn	55%	15
Shoulder sealing	50%	20
STREET LIGHTING		
Provision of street lighting general	25%	15
Improve lighting at intersections	25%	15
Improve lighting at roadway segment	25%	15
Improve lighting at PEDESTRIAN CROSSING	40%	15
Improve lighting at railway crossing	10%	15

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Benefits – you need a table that shows the Crash Reduction Factor for each countermeasure

- 20 reported crashes in 5 years
- A roundabout will reduce 85% (17) of these crashes
- 20 years = 4 x 17 = 68 fewer crashes
- Each crash in …… = $65,000 USD
- 68 x $65,000 = $4,420,000

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Benefit/ Cost Ratio

BCR

- Benefits = $4,420,000USD
- Costs = $1,200,000USD

BCR = almost 3.7

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7 & 8 WRITE AN ACCURATE REPORT AND SEND TO H/O SEEKING FUNDS

7 Write your blackspot report – use a template.

8 Send the report to Head Office for approval for funding

9 Once approved this site goes into the Annual Works Program. Ensure to implement the agreed countermeasures(s).

HEAD OFFICE WILL APPORTION FUNDS DOWN THE LIST ACCORDING TO BCR.

THIS IS WHY IT IS VITAL TO AIM FOR LOW COST HIGH BENEFIT COUNTERMEASURES – TO GET A HIGH BCR AND THUS TO MAXIMISE FUNDING POSSIBILITIES

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Steps in the blackspot process

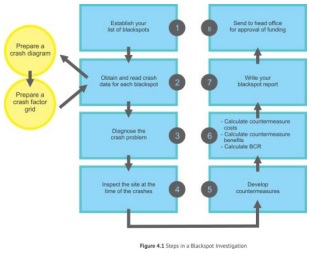

Figure 4.1 Steps in a Blackspot Investigation

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Some recent blackspots

1. A village on a newly improved highway
2. Airport Road
3. A rural Y junction
4. A suburban cross road intersection

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Recommendations

- Large gateway signs each end of village
- 40km/h speed limit
- Flat top road humps each 100m, with kerb extensions
- Zebra Crossings only on humps near mosques, schools

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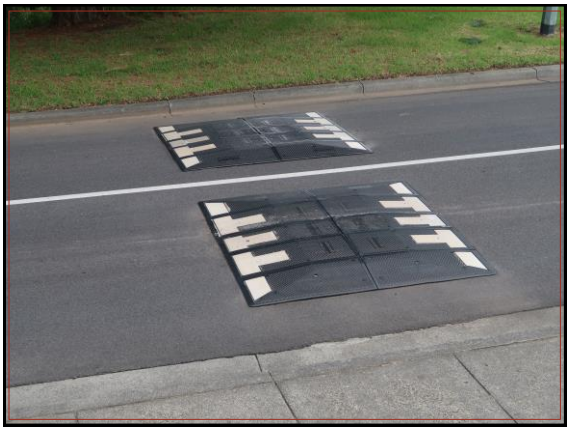

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Crash reduction factor 30% for 20 years

Crash savings = $2,675,000

The humps, sealing, signs and line marking will cost $225,000

Benefits = $2,675,000
Costs = $225,000

BCR = 11.9

This project will be compared with all other blackspots in the country – those with the highest BCR's will be treated first. The others will wait for next year.....

BCR

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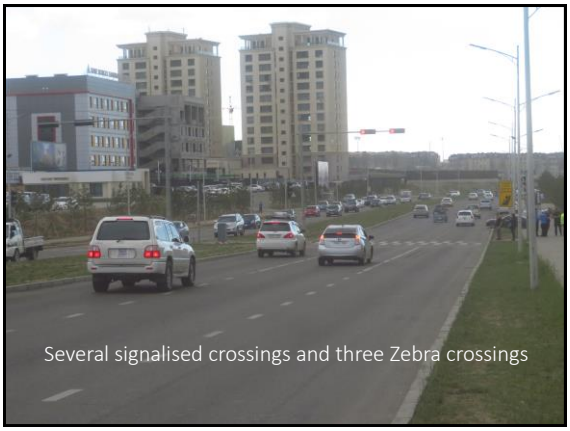

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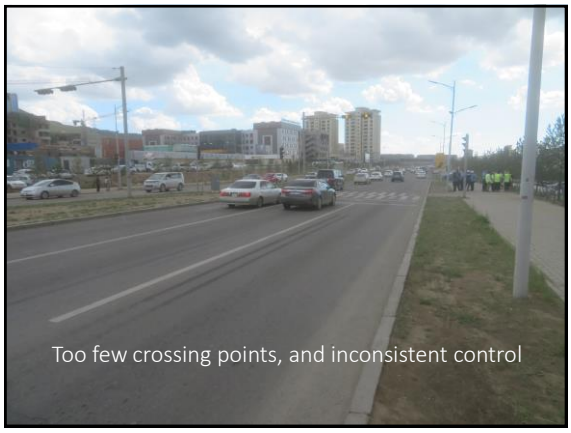

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Think about all of your customers:

- senior citizens - 19% of pedestrian fatalities are over 65 years
- young - 20% of pedestrian fatalities are aged 4-12 years
- intoxicated - 43% of night time pedestrian fatalities ≥ 0.15% BAC
- .....plus the disabled

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Make all crossings signalised - consistency
Separate phases for each carriageway
Pedestrian push buttons
Increase flood lighting at each

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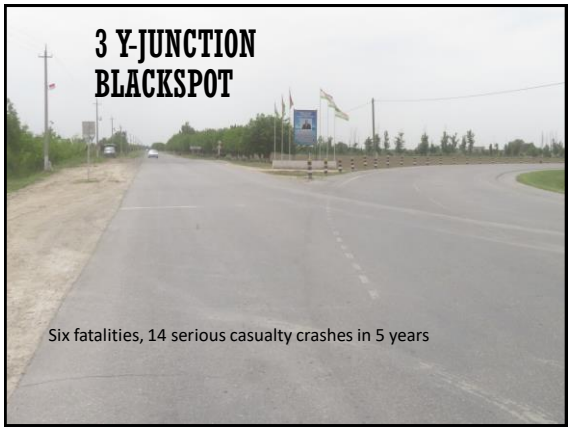

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3 Y-JUNCTION BLACKSPOT

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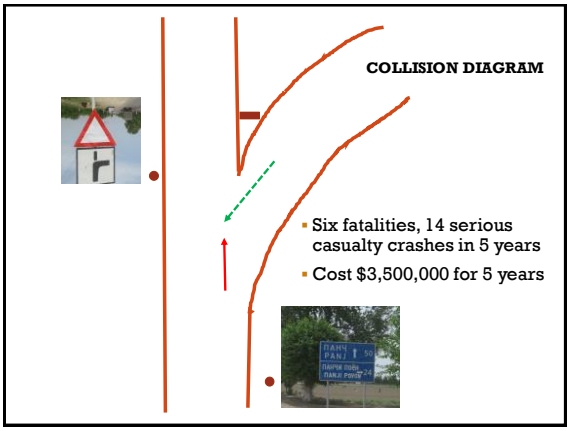

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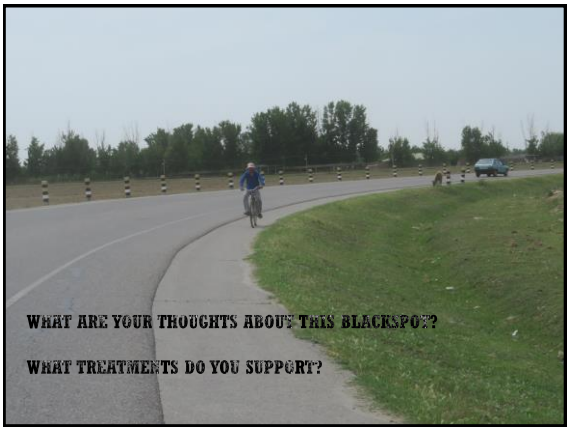

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Stage 1

- Install new diagrammatic advance direction signs on all three approaches informing road users of the destinations in each direction.
- Install oversized (900mm) "Intersection" warning signs on both approaches of the NH.
- Install a tactile centre line and edge lines on national highway.
- Install duplicate Give Way signs and line marking facing minor road traffic.
- Install an advance warning sign "Give Way Ahead" on the minor road.
- Pave all shoulders through the intersection at least 1.5m wide for at least 200m each side of the intersection.

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Stage 2

- Square up the minor road to intersect with the NH at a T-junction.
- Widen the NH and construct channelisation on it to give physical separation of NH traffic though the junction, including a sheltered left turn lane for traffic turning from the NH to the minor road. (See typical layout).
- Install lighting at the intersection.

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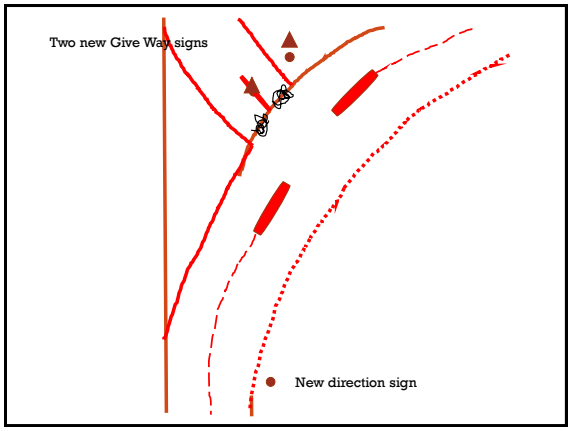

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Stage 2
Crash reduction factor 85% for 20 years

Crash savings = $11,900,000

The removal of the Y junction, signs, lines plus lighting will cost $925,000

Benefits = $11,900,000
Costs = $925,000

BCR = 12.9

BCR

This project will be compared with all other blackspots in the country – those with the highest BCR's will be treated first. The others will wait for next year.....

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4 A blackspot in suburban Melbourne

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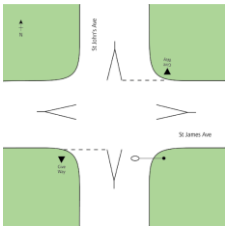
St James/St Johns Ave, in suburban Melbourne

- Intersection of local streets
- Give way signs north & south
- 14 reported crashes in 5+years
- 9 of these were from the north (travelling south)
- All were right angle (DCA 110)
- O fatalities, 9 casualty crashes, 5 property only crashes



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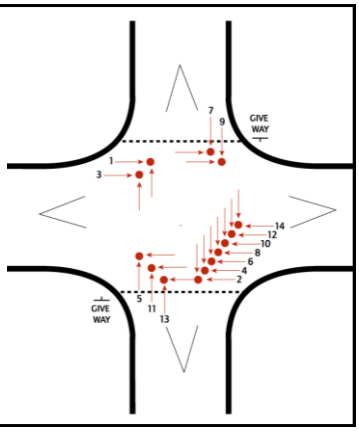
COLLISION DIAGRAM –
ST JAMES/ ST JOHNS



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CRASH FACTOR GRID – ST JAMES/ ST JOHNS

Accident Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: day: month	1307	0409	1912	0806	0307	0711	3012	2702	0305	2407	1804	2105	1406	2008
Date: year	16	16	16	17	17	17	17	17	18	18	18	19	19	19
Day of week	Sat	Wed	Thu	Sun	Thu	Fri	Tue	Fri	Sun	Fri	Sun	Fri	Mon	Fri
Time of day	1700	1855	1530	1900	1345	2145	1900	1220	1800	2000	1845	1610	1735	1855
Severity	3	3	2	3	2	4	3	3	4	2	3	2	2	3
Light conditions														
Road Conditions	W	W	D	D	D	D	D	D	D	D	D	D	W	D
DCA Code	110	110	110	110	110	110	110	110	110	110	110	110	110	110
Object 1	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Van	Car
Object 2	Car	Car	Truck	Car	Car	Car	Car	Truck	Car	Car	Car	Car	Car	Car
Object 3					Car			Car			Car			
Direction 1	N	S	N	S	N	S	S	S	S	S	N	S	N	S
Direction 2 (& 3)	E	W	E	W	W,E	W	E	W,N	E	W	W,E	W	W	W
Other														

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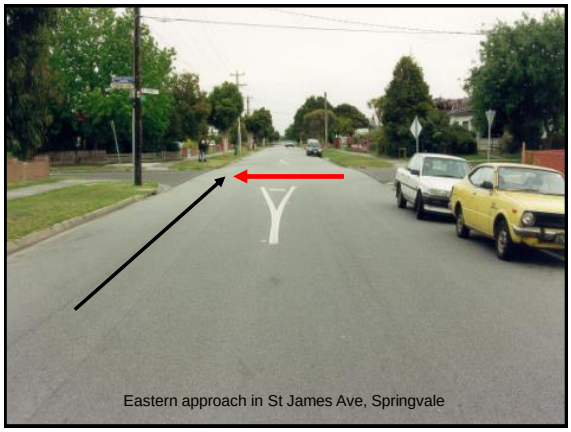

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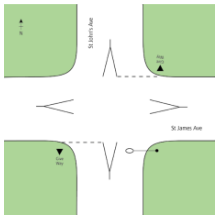
St James/St Johns Ave, Springvale

- What may be causing the crashes?
- What countermeasures do you suggest?
- What will they cost?
- Estimated benefits?
- BCR?



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What was the agreed countermeasure for this intersection?

A small diameter roundabout was built

Installation cost $40,000 - life of 20 years

Maintenance ($2000pa. @6%) = $23,000

Cost = $63,000

104

Benefits

Estimated benefits – an 85% reduction of 14 crashes (from crash reduction factor sheet)

ie 12 crashes in 5 years @ $18,200 per crash

About $218,400 may be saved in 5 years.

That is about $873,600 saved in the 20 year life of the roundabout.

Benefits = $0.87 million

105

$0.87 million (Benefits) divided by $63,000 (Cost) yields the BCR of 13.8 to 1

BCR = 13.8

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After - northern approach

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The roundabout is working well.

There have been no reported crashes.

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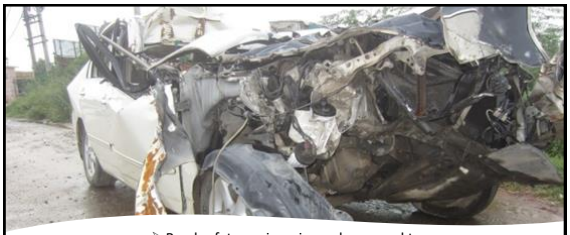

Summary

- Road safety engineering reduces road trauma
- Perseverance is often needed
- Be a "detective" (or a doctor), your "patient" cannot speak
- Aim for countermeasures with high BCR's
- Road safety engineering is the last "safety net" when enforcement, education and publicity have failed
- We have a responsibility to investigate thoroughly, to spend funds wisely and to protect all road users

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YOUR BLACKSPOT HOMEWORK

Two blackspots –

1 Urban arterial, pedestrian crash problem, right side driving

2 Rural Y-junction, left side driving

Select just one – investigate it, and then report your recommendations for it

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Homework Option 1

Urban arterial pedestrian collision problem. Mainly night time.

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CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATE	12/3	5/5	11/10	29/11	20/1	28/3	1/4	5/9	8/12	31/12	2/2	10/3	5/6	7/9
DAY OF WEEK	SUN	FRI	WED	WED	SAT	WED	SUN	WED	SAT	MON	MON	SUN	WED	SAT
TIME OF DAY	01.15	22.30	19.20	17.50	11.10	20.55	18.30	23.00	14.40	04.00	06.45	23.30	?	20.30
SEVERITY	1	2	2	3	3	3	2	1	3	1	3	1	2	2
LIGHT CONDITION													?	
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	DRY	DRY	?	DRY
CRASH TYPE	003	003	001	303	001	102	207	002	102	004	001	502	?	301
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	CAR	M/C	CAR	CAR	CAR	M/C	M/C	PED	CAR
VEHICLE 2	PED	PED	PED	TRUCK	PED	BIKE	CAR	PED	M/C	PED	PED		?	CAR
VEHICLE 3				CAR										CAR
DIRECTION VEH. 1	E	E	E	W	W	E	W	W	E	E	W	E	?	E
DIRECTION VEH.2	N	N	N	W	S	S	W	N	S	N	S	N	?	?
DIRECTION VEH.3				E										W
OBSERVATIONS	ALC	ALC	SPEED					ALC & SPEED				SPEED		U TURN

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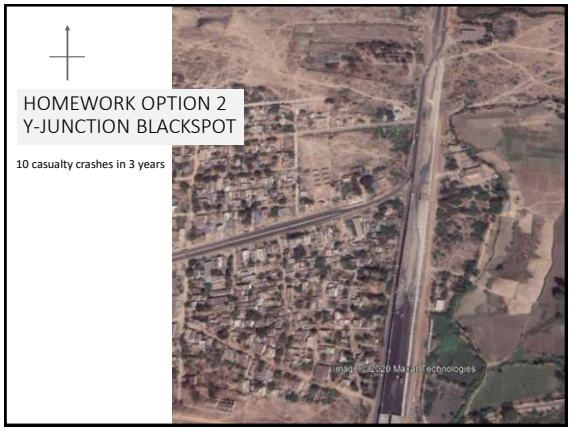

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CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
DATE	12/3	?	11/7	29/1	28/3	1/4	5/9	8/2	31/4	?	10/8	7/9
DAY OF WEEK	SUN	FRI	WED	WED	WED	SUN	WED	SAT	MON		SUN	SAT
TIME OF DAY	01.00	?	19.30	17.50	?	18.30	22.00	14.40	04.00	?	23.30	20.30
SEVERITY	1	2	2	3	3	2	2	3	1	2	1	2
LIGHT CONDITION												
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	DRY	DRY	DRY
CRASH TYPE	202	202	301	301	202	202	002	202	301	701	202	202
VEHICLE 1	TRUCK	CAR	BUS	BUS	CAR	M/C	PED	TRUCK	CAR	TRUCK	M/C	TRUCK
VEHICLE 2	BUS	TRUCK	TRUCK	TRUCK	M/C	BUS	CAR	M/C	CAR		TRUCK	CAR
VEHICLE 3												
DIRECTION VEH. 1	S	S	S	S	S	S	E	S	N	N	E	E
DIRECTION VEH.2	N	N	S	S	N	N	N	N	N		N	?
DIRECTION VEH.3												W
OBSERVATIONS			SPEED	SPEED							SPEED	

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