

Uncontrolled Multi-Lane Crosswalks: Hazards, Screening, and Prioritization

> Joe Gustafson, PE, PTOE Minnesota Toward Zero Deaths Conference October 23rd, 2018



Multiple Threat Crashes









Multiple Threat Crosswalk Analysis Tool (MTCAT)

The MTCAT spreadsheet makes it possible to calculate the maximum vehicle speed at which a driver is <u>able</u> to react and avoid colliding with a pedestrian who is crossing at a constant speed.

How Slow is Slow Enough?

- MTCAT spreadsheet uses a few basic assumptions:
 - Vehicles are box-shaped, and tall



- Ignores rounded vehicle corners.
- Assumes it's not possible to see under or over.
- BUT, many vehicles do fit this description.
- The pedestrian crosses at a constant speed and does <u>not</u> check the adjacent lane for traffic.
- Any crosswalk intrusion = presumed crash

How Slow is Slow Enough?

- MTCAT spreadsheet allows for numerous variables:
 - PIEV ("perception-reaction") time
 - Deceleration rate
 - Crosswalk user speed
 - Crosswalk width
 - Lane Width
 - Vehicle width
 - Advance stopping position
 - And more



Image: Second	PAC PAC PAC PAC PAC PAC PAC PAC	$\begin{tabular}{lllllllllllllllllllllllllllllllllll$	F	G G		E AutoSum Fill - Clear * I	s · Arg Sort Filte Editing	7 J 8. Find 8 r · Select ·	E Gust
Hold R027 Cory Image: Cory Cory Image: Cory Cory Image: Cory Tornet Process Image: Cory There Corserved Image: Cory	PAC PAC	UNCUT FORMULS DATA A PAYEN VEW VEW LINCUT FORMULS DATA A PAYEN VEW LINCUT FORMULA PAYEN VEW LINCUT FORMULS DATA A PAYEN VEW LINC	F	G G	H	AutoSum Fill Fill I	J	K	L
And And And Bit And Bit And Bit And Call And Ano	al I U D D D D D D D D D D D D D	Characterial in the second secon	F	Cells	H	2 milodum (1) milo (1	27 Sort Filte Editing	K	L
Numerical Protein B Particle B Particle Charlen	I U D Inalysis PTOE e of Var and t t t t t t t t t t	Image:	F	G G	H	1	Sort Filte Editing	8. Find 8	L
S S Care S S	J D Unalysis PTOE e of Var Joit t t t t t t	First G Algence Reserve Operation Operation 0 First Section Section Special Special 0 MCANTY Section Special Special Special 0 MCANTY Section Special Special Special 0 MCANTY Special space Special Special Special 0 MCANTY Special space Special space Special Special Special MCANTY Special space Special space Special space Special Special MCANTY Special space Special spicinter Spe	F	G	H		J	K	L
Image: Constraint of the second sec	J D Innalysis PTOE en of Var Init t t t t t t	6 6 7 6 7 6 7 6 7 6 7 7 6 7	F	G	H		,	K	L
Constanting, Reg. 70 Constanting, Reg	D D Inalysis PTOE e of Var Init t t t t t t t t		F	G	H	1	1	K	L
B C Torotad Crosseskin, PE, P. Torotad Crosseskin, P. Torotad Crotad Crosseskin, P. Torotad Crosseskin, P. Torotad C	D Inalysis PTOE en of Van Jeilt t t t t t	oof (MTCAT) - Scenario analysis for a crosswalk user who does not adequating check for a single gap in the adgocent late deter "Morksheet Tab and enter variables is green boxes. See below and "Table Oxfput" sits for results. See Delow and the set of the set with the set of the set with the set of the se	F	6	H		1	K	
Entred Crosswalk AA Joo Gistaface, PE, PT Joo Gistaface, P	Inalysis PTOE n of Var Init t t t t t	or MITCAT. Security analysis for a consensitives in the local one of adequating clocks for a safe gap in the digitized late. deles "Worksheet Tab and enter variables is green bases. See below and "Table Oxplor" also for evalus. Becryption Utility of the car, 0.5.16 transit bas. Water Greater Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of anyone which (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (1%-12 Elystic Lamoreur - Constair Rais) Utility of advance tables (
Joo Cristinico, Fie. 19 Historiatoro Value Name: 0.000 (1000) 0.000 (1000)	PTOE en of Van Jmit t t t t t t t	Alles "Worksheet Tab and enter variables is green bases. See before and "Table Oxigen" sub for results. See Option Min drowing which is the cost 24 for 24 for the transmission of contain Rink) Min drowing which is the cost 24 for							
Value Name Uit 0 Wow R 90.5 Wow R 91.5 Mode R 92.2 Q R 92.2 Q R 92.0 Q R 93.0 V/r R 94.0 Q R	Jnit t t t t t	Secception Using of reading uniform (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) Using of reading uniform (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) Using of regression values (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) Using of regression values (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) using of uniform (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) using of uniform (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) using of uniform (if Bit cars, 0.5.8 for transit blues. Uniform (if Bit cars, 0.5.8 for transit blues. Uniform (if Bit cars, 0.5.8 for transit blue blues) using of uniform (if Bit cars, 0.5.8 for transit blues. Wider = Orealer Risk) wider (if Bit cars, 0.5.8 for transit blues and a finet. 1.3.3 for (if Bit cars) wider (if Bit cars, 0.5.8 for transit blues. Wider af davies and a finet. 1.3.3 for (if Bit cars) wider (if Bit cars, 0.5.8 for transit blues. Wider af davies and a finet. 1.3.3 for (if Bit cars) wider (if Bit cars) af a finet af davies and a finet. 1.3.3 for (if Bit cars) wider (if Bit cars) af a finet af a finet and a finet af a finet and a finet af a fi							
Value Name Us 0 W _{en} ft 19.5 W _{en} ft 8.5 W _{en} ft 9.00 ft ft 9.00 G ft 9.22 0 ft 9.00 G ft 9.00 G ft	Jenit t t t t t t	Net crystem Initial of the car. 6.5 fbo transit loss. Water - Greater Riss: I and rowing windles (of the car. 6.5 fbo transit loss. Water - Greater Riss: I are Wint in land of change windles (of the car. 6.5 fbo transit loss. Creater Riss: I are Wint in land of change windles (of the car. 6.5 fbo transit loss. Creater Riss: I are Wint in land of change windles (of the car. 6.5 fbo transit loss.) I and of change windles (o							
0 W _{Hall} R 105.5 W _{Hall} R 100.6 M _{Hall} R 100.7 R R 100.8 V _H R 100.8 V _H R 100.8 V _H R 100.8 V _H R 100.9 V _H R 100.0 V _H R 000.0 V _H R	t t t t t t	the dimension particle (3 fbor case 15 hor transit bas, Weer Consert Rate) week With it lead forwards which (12-15 fbor transit bas, Weer Consert Rate) billion of integrate value (2 fbor case 15 hor transit bas, Weer Consert Rate) week With in lead of utegrate value (2 fbor case). The consert Rate) week With in lead of utegrate value (3 fbor case) to serve Consert Rate) week With in lead of utegrate value (3 fbor case). The consert Rate) week With in lead of utegrate value (3 fbor case) to serve Consert Rate) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert Rate (3 fbor case) week With in lead of utegrate value (3 fbor case). The consert week (3 fbor case) week With (3 fbor case). The consert week (3 fbor case) is the consert Value (3 fbor case). The consert With (3 fbor case) week With (3 fbor case). The consert week (3 fbor case) is the consert value (3 fbor case). The consert With (3 fbor case) week With (3 fbor case). The consert week (3 fbor case) is the consert week (3 fbor case). The consert week (3 fbor case) week week (3 fbor case). The consert week (3 fbor case) is the consert week (3 fbor case). The consert week (3 fbor case) week (3 fbor case). The consert week (3 fbor case) week (3 fbor case). The consert week (3 fbor case) week (3 fbor case). The consert week (3 fbor case) week (3 fbor case), week (3 fbor case). The consert week (3 fbor case) week (3 fbor case). The consert week (3 fbor case) week (3 fbor case), week (3 fbor case). The consert week (3 fbor case) week (3 fbor case). The consert week (3 fbor case) week (3 fbor case), week (3 fbor case), week (3 f							
10.5 W ₁₀₀ R 8.5 W ₁₀₀ R 10.5 W ₁₀₀ R 10.6 D ₁₀₀ R 10 D ₁₀₀ R 10 D ₁₀₀ R 10.0 G W ₁₀ 0.0 V ₁₀ W ₁₀ 0.00 G W ₁₀ 0.00 G W ₁₀	t t t t t t	ane Wildlin into of moning which (17-12 Biglical, Namower - Organir Risk) Mill of Angeleval which (17-12 Carl) and (17-12 Carl) (17-12							
	t t t t t t/s	Utility of integrate vehicle (21 Bits case, 51 Bits transmitters, Weiter - Constant Reis) and if where the set of the and if where the set of the device (31 Bits case). If the set of the set of the set of the set of the set of t							
10.5 W ₁₀ ħ 6 D ₂₀ ħ 6 D ₂₀ ħ 7.33 O ₂ ħ 8 W ₄ ħ 8 W ₄ ħ 9 M ₂ ħ 10.00 G % 11.554 A ₂₀ ħ 2 V ₂ ħ 2 Q ₂ ħ 0 V ₁ ħ 0.22 Q ħ 0.22 Q ħ 0.20 V ₁ ħ 0.20 O H	t t t t Vis	une Wilden inter of robuped whole (15 / 12 thpical Namowar - Constant Ram) and Wilden inter of displayed whole (15 / 12 thpical Namowar - Constant Ram) Miner Selback (statance to diver use how Tool of diverse which (2 thpical, otherwise distance tom crosswalls to addance atop line) Miner Selback (statance to diver use how Tool of diverse which (2 thpical, otherwise distance tom crosswalls to addance atop line) Miner Selback (statance to diverse which (2 thpical) Miner Selback (statance to diverse which (2 thpical) Miner Selback (statance to diverse which (2 thpical) Dosswall Wild Blogical, Namowar of creater Raw) Dosswall Wild Blogical, Stater Raw, Lean Miner, Raw II Namowar of creater Raw (Stater Raw) Dosswall Wild Blogical, Namowar of Creater Raw, Lean March (Stater Raw) Dosswall Wild Blogical, Namowar of Creater Raw, Lean Miner, Raw II Namowar of creater Raw) Dosswall Wild Blogical Raw (Stater Raw) Dosswall Raw) Dosswa							
	t t t Vis	angli if shafes allows database have algo all consensiti to that the stopped values (3 th goal, dimensis database have provided and shafes) where the bin tool of the shafe shafes allows and the shafes allows allows allows and the shafes allows and the shafes allows and the shafes allows							
6 Opp. ft 1.33 Op. ft 8 W ₂ , ft 3.5 V ₂ , ft 18.354 a _{min} ft 2 Verv 56 11.354 a _{min} ft 2 Verv	t t Vs	New Selacu (status to diver eye hom hot of divers vertice, 6 typical) New Selacu (status to diver eye hom hot of divers vertice, 6 typical) Dossawa Wen (See B) fail (status to divers eyet, in set, 1.33 fbpical) Dossawa Wen (See B) fail for logings, 4 Sho (Sho (Sho) (Sho (Sho) (Sho (Sho (Sho (Sho (Sho (Sho (Sho (Sho							
1.33 Oc. # 8 W/c. R. 3.5 V. 80 6.80 G. 40 18.354 A.m. 80 2 bey se FIXED VALUES: 32.2 g. Ris 0 V. 80 CALCULATED VALUE 0.00 (Y. 80 0.00 G. 60 0.00 G. 60	t t Vis	New Office I distance two centre of whole to over if divers and in Net 133 flypcial how Office I distance that a centre of distance and a centre of the state of the state of the state of the state Distance United State of Langever Calendary and State Distance and the state of the state of the state of the state of the Distance United State of the state o							
8 W. R 3.5 V., R0 8.00 G % 18.354 A	t Vs	Dooswalk Wang (Regical, Nanower - Grader Reas) Sooswalk User Speed 3 Bits for forgoar, 26 Ste bignal SPARie walking, 3 S Ris used for ped interval. Faster Crosswalk User Speed = Greater Risk. Usain Bolt = 40.8 Ris) S Grade in Greador of Doosswalk approach. (Either as multier, a gr. 550). Negative - Downlik S drade in Greador of Doosswalk approach. (Either as multier, a gr. 550). Negative - Downlik							
3.5 V, BY 8.00 G % 18.354 a _{main} Bris 2 b _{BT} set 18.22 g Bris 32.2 g Bris 0 V, mg CALCULATED VALUES: 0.00 V, Bris 0.00 G de 0.00 G de	08	zostwaru ber speed (is die for jogging, 4 site Spical schwie waaning, 3 site used of ped interval, Haster Crosswark User Speed = Greater Kesk. Usam sont = 40 bits) 6 Grade in direction of crosswalk approach (Enter as number, e.g. * 50°, Negative = Downhill 6 al die fab Bath : Amerikaan in direction of constraints and and the state of the state of the state state of the state of t							
BL354 Buss Bt 18.354 Buss Bt 2 Incu se HXED VALUES: St St 32.2 g ft% 0 V, mg CALCULATED VALUE CALCULATED VALUE 0.00 V, ft% 0.00 V, ft%		s urace in direction or crosswark approach (einer as number, 2, 15 sort, Negative = Downnai) Sort of the Description response of the structure							
18.354 Daum 100 2 brg:// Se 7 brg:// Se 10 V/ N/ 0 0 V/	h	Cast of the Danis" emerseony braking deceleration rate (Ris*) relative to road surface. Cas hits (Insteb thus dat any innertified, materburgers 10020 chas. 2 cfm. 16,20 Ris* per MACTO							
	052	Source of the name of the second	0.						
FIXED VALUE S: 32.2 g ft/s 0 V/ mg CALCULATED VALUE 0.00 V/ 0.00 V/ ft/s 0.00 V/ ft/s	HEC.	itev ("reception-reaction") time (25 sec detaut per AGPEO/MOTCO, best case scenario for braking 0.55 sec Piev per Mytholsters, test, clover Piev ente – Greater Posk).							
32.2 g fi/s 0 V/ mg CALCULATED VALUE 0.00 V/ ft/s 0.00 Ø de									
OLL S Ho 0 Vr mg 0.00 Vr ft/s 0.00 O de 0.00 O de	tis2	November of the second s							
CALCULATED VALUE 0.00 V, ft/s 0.00 Θ de	noh	That speed of moving vehicle upon completion of braking maneuver (mph) Fixed at Zero for Stopping Condition.							
CALCULATED VALUE 0.00 V/ ft/s 0.00 Ø de									
0.00 V/ ft/s 0.00 O de	JES FOR	NITIAL SPEED ENTERED ABOVE (See "Table Output" table of all other initial speeds)							
0.00 O de	Us	inal Speed of moving vehicle in fils							
0.00 0 01	degrees	ingle of Approach Grade Relative to Horizontal Plane (degrees)							
0.00 01 103	t/s2	iliding Acceleration due to Gravity (g sin 0) (Positive values indicate driver feeling pulled towards the front of the car)							
18.35 Burning 11/5	Vs2	Jeceleration from Braking (fVs ²) - Add to G, to get a _{cont}							
2.40 triang Se	ec	Ime (s) from when the brakes are applied to when V, is reached. Does not include PIEV time.							
4.40 toxi se	ec	ime (s) from when the craxes are appred to when VF is reached INCLUDING PIEV time.							
52.74 durating R		Instance over which the praces are actuary applied (R)	-						
141 duni 1		raking uistance (t) inducing reaction time from where the facator is first observed	-						
0.12 min 11	-	tex visios (respiration single vinitemp) ventue part at time tractice procession seturities of the contract vision	-						
0.05 8	ad	valiable viewing angle (in RADANS) at the moment a dynamic must be and occurring water (investigation (massard from the dynamic set))	-						
ward Presery 145		na na sala sala na sala sal	-						
		Iraking Deceleration rate opter:							
		in an angle and an an and then in 1990. In the ITCD is account for deceleration in winter conditions. 11.2 Bin in 2015 addition							

K 🖩 🔒	ち・ 、 HOME INSERT	PAGE LAYOUT	FORMULAS	data re	VIEW VIEW		MTCAT Multi	ple Threat Crosswa	ılk Analysis Tool -	Excel	
* *	Cut	bri - 1	1 - A A =	= =	📴 Wrap Text	Gen	eral -		Norma	l Bad	
aste	Copy + B	IU	<u>.</u> - <u>A</u> -	===	E Merge & G	Center - \$	- % • • • • • •	Conditional Fo	mat as Neutra	l Calcu	lation
* 🍑	rormat Painter	Fort	· · · ·		ionment		Number	Formatting • T	able -	Stular	
Cilp	la la	ront	12	A	igninen	Cal.	Number 14			Styles	
4		$\checkmark f_x$									
A	в	с	D	E	E	G	н	1	j.	к	1
		_									
Enter	Values on Previous	Tabl									
See "D	Data Entry" tab for de	efinition of varia	ables and "Illust	ration of Variat	les" tab for visu	al representat	ion.				
Result	ts assume rectangula	ar vehicles and t	hat the pedestr	an cannot be s	en by looking o	ver or under s	topped vehicle (e	.g. tall vehicle s	uch as a box tru	uck or transit bu	s)
0	es assance rectangan		not the process	an cannot be b			cobbee terrere (e	-8. ten rentere s			- 1
Result	ts assume that pede	strian forward s	peed remains c	onstant and tha	t driver maintain	ns constant dir	ection (does not s	werve out of la	ne).		
Result	ts assume that pede	strian forward s	peed remains o	onstant and tha	t driver maintain	ns constant dir	ection (does not s	werve out of la	ne).		
Result	ts assume that pede	strian forward s	peed remains o	onstant and tha	t driver maintain	dute	ection (does not s	werve out of la	ne). Buinning	Result:	
Result	ts assume that pede	strian forward s Final Speed	peed remains of t _{braking}	onstant and tha t _{total}	t driver maintain d _{braking} ft	d _{total}	ection (does not s	werve out of la α _{viewing} rad	β _{viewing}	Result:	
Result	ts assume that pede Initial Speed mph 1	strian forward s Final Speed mph	peed remains of t _{braking} sec 0.08	t _{total}	t driver maintain d _{braking} ft 0.06	d _{total}	Pmin ft 7.28	werve out of la α _{viewing} rad	ne). β _{viewing} rad	Result:	
Result	ts assume that pede Initial Speed mph 1 2	strian forward s Final Speed mph 0	peed remains of t _{braking} sec 0.08 0.16	t _{total} 2.08	t driver maintair d _{braking} ft 0.06 0.23	d _{total} ft 2.99	Pmin ft 7.28 7.56	werve out of la α _{viewing} rad 0.73 0.64	Priewing rad	Result:	
Result	Initial Speed mph 1 2 3	strian forward s Final Speed mph 0 0	tbraking Sec 0.08 0.16 0.24	t _{total} 2.08 2.16 2.24	t driver maintair	d _{total} ft 2.99 6.10	Pmin ft 7.28 7.56 7.84	werve out of la α _{viewing} rad 0.73 0.64 0.56	βviewing rad 1.44 1.07 0.80	Result: OK OK	
Result	ts assume that pede Initial Speed mph 1 2 3 4	strian forward s Final Speed mph 0 0 0 0	tbraking sec 0.08 0.16 0.24 0.32	t _{total} 2.08 2.16 2.24 2.32	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94	d _{total} ft 2.99 6.10 9.33 12.67	Pmin ft 7.28 7.56 7.84 8.12	werve out of la α _{viewing} rad 0.73 0.64 0.56 0.50	B _{viewing} rad 1.44 1.07 0.80 0.62	Result: OK OK OK	
Result	ts assume that pede Initial Speed mph 1 2 3 4 5	strian forward s Final Speed mph 0 0 0 0 0 0	tbraking sec 0.08 0.16 0.24 0.32 0.40	ttotal 2.08 2.16 2.24 2.32 2.40	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47	d _{total} ft 2.99 6.10 9.33 12.67 16.13	Pmin ft 7.28 7.56 7.84 8.12 8.40	werve out of la α _{viewing} rad 0.73 0.64 0.56 0.50 0.45	βviewing rad 1.44 1.07 0.80 0.62 0.49	Result: ОК ОК ОК ОК ОК	
Kesun	Initial Speed mph 1 2 3 4 5 6	strian forward s Final Speed mph 0 0 0 0 0 0 0 0	peed remains of t _{braking} Sec 0.08 0.16 0.24 0.32 0.40 0.48	ttotal 2.08 2.16 2.24 2.32 2.40 2.48	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68	werve out of la a viewing rad 0.73 0.64 0.56 0.50 0.45 0.41	β _{viewing} rad 1.44 1.07 0.80 0.62 0.49 0.40	Result: OK OK OK OK CRASH	
Kesuit	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7	Final Speed mph 0 0 0 0 0 0 0 0 0 0	tbraking sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56	total \$ec 2.08 2.16 2.24 2.32 2.40 2.48	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96	werve out of la a.viewing rad 0.73 0.64 0.56 0.50 0.45 0.41 0.38	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34	Result: OK OK OK OK CRASH	
	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8	Strian forward s Final Speed mph 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.54	total sec 2.08 2.16 2.24 2.32 2.40 2.48 2.56	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75	d _{total} d _{total} 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22	ection (does not s Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24	werve out of la α _{viewing} rad 0.73 0.64 0.56 0.50 0.45 0.41 0.38 0.35	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34	Result: OK OK OK OK CRASH CRASH	
	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9	strian forward s Final Speed mph 0 0 0 0 0 0 0 0 0 0 0 0 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72	testal \$ec 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 4.75	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31 15	ection (does not s Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52	werve out of la a a a a a a a a a a a a a	P.iewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.29 0.25	Result: OK OK OK OK CRASH CRASH CRASH	
	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9 10	strian forward s Final Speed mph 0 0 0 0 0 0 0 0 0 0 0 0 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72 0.80	testal testal 2.08 2.16 2.24 2.32 2.40 2.56 2.64 2.72 2.80	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 4.75 5.86	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15	ection (does not s Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52 9.80	a yiewing rad 0.73 0.64 0.56 0.50 0.45 0.45 0.41 0.38 0.35 0.32 0.30	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.29 0.25	Result: OK OK OK OK CRASH CRASH CRASH CRASH	
	ts assume that pede initial Speed mph 1 2 3 4 5 6 7 8 9 10 11	Strian forward s Final Speed mph 0	toraking sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72 0.80 0.82	total \$ec 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64 2.72 2.80 2.82	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 4.75 5.86 7.09	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52 9.80 10.02	werve out of la acviewing rad 0.73 0.64 0.56 0.50 0.45 0.41 0.38 0.32 0.32 0.32 0.32	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.25 0.22 0.30	Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH	
	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9 10 11 12	Strian forward sp Final Speed mph 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72 0.80 0.88 0.96	total \$ec 2.08 2.16 2.24 2.32 2.40 2.42 2.56 2.64 2.72 2.80 2.88 2.96	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 3.75 5.86 7.09 8.44	d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 39.36 42.64	ection (does not s Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52 9.80 10.08 10.08	werve out of la a viewing rad 0.73 0.64 0.56 0.50 0.45 0.45 0.41 0.38 0.35 0.32 0.30 0.28 0.37	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.29 0.25 0.20 0.19	Result: OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH	
Result 0	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9 10 11 12 12	strian forward sp Final Speed mph 0 0 0 0 0 0 0 0 0 0 0 0 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72 0.80 0.88 0.96 1.94	total \$ec 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64 2.72 2.80 2.88 2.96 2.90	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.54 1.47 2.11 2.87 3.75 4.75 5.86 7.09 8.44 0.09	s constant dir. d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 39.36 43.64 49.04	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.52 9.80 10.08 10.36	werve out of la a.viewing rad 0.73 0.64 0.56 0.50 0.41 0.38 0.35 0.32 0.32 0.30 0.28 0.27 0.35	βviewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.25 0.22 0.20 0.18 0.15	Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH	
Result Image: second	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9 10 11 12 13 15	Strian forward sp Final Speed mph 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72 0.80 0.88 0.96 1.04	total \$ec 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64 2.72 2.80 2.88 2.96 3.04	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 4.75 5.86 7.09 8.44 9.90 1.40	s constant din d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 39.36 43.64 48.64	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52 9.52 9.52 9.80 10.08 10.36	werve out of la a viewing rad 0.73 0.64 0.56 0.50 0.45 0.41 0.38 0.35 0.32 0.32 0.32 0.28 0.27 0.25 0.25	Briewing rad 1.44 1.07 0.80 0.62 0.49 0.40 0.34 0.29 0.22 0.20 0.18 0.16	Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH	
Result Result 1 2 3 4 4 5 5 5 7 8 9 0 1 2 2 3 4 4 5 5 5 5 7 7 8 9 0 1 1 2 2 3 1 1 1 1 1 1 1 1 1 1 1 1 1	ts assume that pede Initial Speed mph 1 2 3 4 5 6 7 8 9 10 11 12 13 14	Strian forward sp Final Speed mph 0	toraking Sec 0.08 0.16 0.24 0.32 0.40 0.45 0.56 0.64 0.72 0.80 0.88 0.96 1.04 1.12	total \$ec 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64 2.72 2.80 2.88 2.96 3.04 3.12	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.94 1.47 2.11 2.87 3.75 4.75 5.86 7.09 8.44 9.90 11.49	s constant din d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 39.36 43.64 48.64 48.64	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 8.96 9.24 9.52 9.80 10.08 10.36 10.64 10.92	werve out of la c _viewing rad 0.73 0.64 0.56 0.50 0.45 0.35 0.35 0.32 0.32 0.30 0.28 0.27 0.25 0.24 0.25	Pviewing rad 1.44 1.07 0.80 0.62 0.49 0.29 0.25 0.22 0.22 0.20 0.18 0.16 0.15	Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH CRASH	
Result Image: second	ts assume that pede nitial Speed mph 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 15	strian forward sy Final Speed mph 0 0 0 0 0 0 0 0 0 0 0 0 0	term term Sec 0.08 0.04 0.48 0.40 0.48 0.56 0.64 0.72 0.88 0.96 1.12 1.22 1.20 <td>total \$ec 2.06 2.16 2.24 2.32 2.40 2.48 2.564 2.72 2.88 2.96 3.04 3.12 3.20</td> <td>t driver maintain d_{braking} ft 0.06 0.23 0.53 0.54 1.47 2.11 2.87 3.75 5.86 7.09 8.44 9.90 11.49 13.19</td> <td>s constant din d_{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 35.36 43.64 48.04 52.55 57.19</td> <td>Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 9.24 9.52 9.80 10.08 10.08 10.08 10.03 10.64 10.92 11.20</td> <td>α_viewing rad 0.73 0.64 0.56 0.50 0.64 0.35 0.45 0.41 0.33 0.32 0.30 0.22 0.27 0.25 0.24 0.22</td> <td>Pe). Pviewing rad 1.44 1.07 0.80 0.62 0.49 0.49 0.40 0.34 0.25 0.22 0.22 0.20 0.18 0.16 0.15 0.14</td> <td>Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH</td> <td></td>	total \$ec 2.06 2.16 2.24 2.32 2.40 2.48 2.564 2.72 2.88 2.96 3.04 3.12 3.20	t driver maintain d _{braking} ft 0.06 0.23 0.53 0.54 1.47 2.11 2.87 3.75 5.86 7.09 8.44 9.90 11.49 13.19	s constant din d _{total} ft 2.99 6.10 9.33 12.67 16.13 19.71 23.40 27.22 31.15 35.19 35.36 43.64 48.04 52.55 57.19	Pmin ft 7.28 7.56 7.84 8.12 8.40 8.68 9.24 9.52 9.80 10.08 10.08 10.08 10.03 10.64 10.92 11.20	α _viewing rad 0.73 0.64 0.56 0.50 0.64 0.35 0.45 0.41 0.33 0.32 0.30 0.22 0.27 0.25 0.24 0.22	Pe). Pviewing rad 1.44 1.07 0.80 0.62 0.49 0.49 0.40 0.34 0.25 0.22 0.22 0.20 0.18 0.16 0.15 0.14	Result: OK OK OK OK CRASH CRASH CRASH CRASH CRASH CRASH	

The results are frightening

- Consider the following situation:
 - **12** ft lanes
 - -6 ft wide moving car, 6.5 ft stopped SUV
 - Stopped SUV is 5 ft from the crosswalk
 - Crosswalk is 6 ft wide
 - Pedestrian moving at 4.5 ft/s
 - Flat grade, locked-wheel braking (0.57G)
 - 2.5 second PIEV (Normal value = 2.5 sec)
 - A driver traveling at just **3 MPH** will be <u>unable</u> to avoid hitting the pedestrian!



We need to ask...

Is it realistic to expect that we can condition drivers through education and/or enforcement to slow down <u>enough</u> every time that they pass a stopped vehicle?

> To 13 mph? To 3 mph?









- Washington County has 42 marked uncontrolled multi-lane crosswalks on our system
- <u>All but 11</u> of these are on roundabout entries or exits (low speed + refuge)
- · Crosswalk user counts not available
- Point system developed



County-Wide Screening

- Risk points assigned as follows:
 - Lane Points (per direction):
 - Turn lanes = 1 pt each (low speed & volume)
 - One thru lane = 2 pts
 - Plus 4 pts for each additional thru lane
 Example: 3 thru lanes = 10 pts
 - Speed Points:
 - 15 mph = 0 pts
 - Add 1 pt for each 5 mph above 15 mph













