Vehicle Defect IMPACT Analysis David B. Brown University of Alabama Center for Advanced Public Safety (CAPS) November 1, 2017

For more information on this subject from NHTSA and other sources, please see: <u>http://www.safehomealabama.gov/tag/defects-recalls/</u>

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1.0 Introduction: C101 Causal Unit Type

The high level analysis of vehicles in general for vehicle defects showed a high correlation of the defect type and the vehicle type, which is expected since certain defects apply only to trucks. The Causal Unit analysis given immediately below establishes that: (1) the most over-represented vehicles are heavy trucks (as we might expect), but (2) the highest frequency is in the Passenger Cars and SUVs, which are the most UNDER-represented.

CA Ei				- 2012-20 t <u>L</u> ocations		ma Integra _{Indow <u>H</u>elp}	ted Crash	Data - Veh	icle Defect	: C22 — 🗖	- 2
	2012-2016 Alaban			v		Defect C222			9 10	1/ 1/2012 v 12/31	1/2016 v
	Max Gain	✓ Desce		7			<i>c</i> .	it Que			2.0
	Causal Unit (CU		-		s Zero-Valued R			nificance: Over	-	Threshold: Init (CU) Type	2.0
.101.) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 📼	CTOT. Cause	ar Offic (CO) Type	
	E Tractor/Semi-T		825	5.50	11453	1.76	3.129*	561.373			
	Pick-Up (Four-Tin		3310	22.06	122198	18.75	1.177*	497.231			
	E Single-Unit True		274 193	1.83	5110 2251	0.78	2.329* 3.725*	156.377 141.186			
	Motorcycle	CK (3 Addes U	199	1.23	5588	0.35	1.547*	70.375			
	E Truck (6 or 7) v	vith Trailer	102	0.68	1420	0.22	3.121*	69.314			
	Motor Home/Rec	reational Ve	56	0.37	302	0.05	8.056*	49.049			
	E Other Heavy Tr	ruck (Cannot	39	0.26	619	0.09	2.737*	24.752			
	E Tractor/Double		21	0.14	161	0.02	5.667*	17.294			
	E 4-Wheel Off Ro	ad ATV	27	0.18	525	0.08	2.234*	14.915			
	P Other Truck*		18	0.12	326	0.05	2.399	10.496			
	E Cargo Van (100 E Passenger Van		88	0.59	3402 1790	0.52	1.124	9.692 8.798			
	E Other Light Tru		10	0.07	226	0.27	1.922	4.798			
	Station Wagon		54	0.36	2234	0.34	1.050	2.577			
	E Other Passenge	er Vehicle	17	0.11	630	0.10	1.172	2.499			
	E Other Bus (Sea	ts More than	13	0.09	814	0.12	0.694	-5.737			
	E Van or Mini-Var	ı	131	0.87	6490	1.00	0.877	-18.388			
	E Mini-van		233	1.55	12121	1.86	0.835*	-46.003			
	E Unknown Type		11	0.07	5973	0.92	0.080	-126.487			
	E Sport Utility Ver	nicle (SUV)	2642	17.61 44.59	125956 342245	19.32 52.50	0.911*	-257.272	L		
_	Passenger Car		0031	44.05	342243	52.50	0.043	-1100.040	Sort by Sum	of Max Gain	
G	1 🗇 🖉 📔									Display	Filter N
				2	2012-2016 Alaba	ama Integrated C	rash Data				
					C101: Ca	usal Unit (CU) Ty	/pe				
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	Lrequency										
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	20										
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	5 1		Motorcy	cle	E 4-Wheel C	Off Road ATV	Static	on Wagon	E Unkr Motor	10wn Type of ized Vehicle	
					C10	1: Causal Unit (C	U) Type				

This demonstrates that Passenger Cars and SUVs are getting the high number of vehicle defect crashes not because they have more defects per vehicle, but because of their sheer number on the roadway.

This led to the decision to separate passenger cars from large trucks in this analysis because considering them simultaneously would produce confusing results, with some vehicle defects resulting from the cars and others almost exclusively from the trucks. To solve this problem, two separate runs were performed, where the subdivision is based on C101 - CU Unit Type and C501 Vehicle 2 Type. Specifically, the display below indicates how "large trucks" were defined for this study.

Filter Logic: Large Truck Involved AND Vehicle Defect C222 — 🗖	×
Logic Tree Logic Text	
. All of the following are true (AND)	^
One or more of the following are true (OR)	
One or more of the following are true (OR)	
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Single-Unit Truck (2-Axle/6-Tire)	
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Tractor/Triples	
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Other Heavy Truck (Cannot Classify)	
⊡ One or more of the following are true (OR)	
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Single-Unit Truck (2-Axle/6-Tire)	
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Single-Unit Truck (3 Axles or Less)	
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Truck (6 or 7) with Trailer	
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Other Heavy Truck (Cannot Classify)	¥
1777 records selected by this filter.	.:

Similarly, the display at the top of the following page shows how "passenger cars" were defined for this study.

The goal of the two analyses was to determine the other attributes given in the crash report that are correlated with vehicle defects. These are given in the Table of Contents above. Each of the analyses will start out with a summary of the Causal Unit (CU) vehicle defects themselves (C222 CU Contributing Vehicle Defect). This is followed by a number of attributes that were considered to be relevant from the results.

Filter Logic: Passenger Types Involved AND Vehicle Defect C222	– 🗆 🗙
Logic Tree Logic Text	
All of the following are true (AND) One or more of the following are true (OR) <p< td=""><td>le (SUV)</td></p<>	le (SUV)
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Van or Mini-Van 2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Sport Utility Vehicle (2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Mini-van	(SUV)
13923 records selected by this filter.	

2.0 Large Truck Analysis

2.1 C101 Causal Unit (CU) Type Analysis When Large Truck Involved

This comparison is between vehicles with defects against those without defects, restricted to crashes that involved large trucks (on both sides of the comparison). Most of the two-vehicle crashes involve a passenger car, since truck-truck crashes are rare. The following display indicates the vehicle type for the unit that caused the crash. Large truck involvement is no implication that the truck caused the crash; but since both subsets were constrained to involve trucks, it is reasonable that a relatively large number of the crashes would be caused by large trucks.

C/	ARE 10.1.0.19 - [IMPA	CT Results	- 2012-20)16 Alaban	na Integrat	ed Crash	Data - Laro	ge Truck Involv 🗕 🗖 🗙
💀 E	ile <u>D</u> ashboard <u>F</u> ilters <u>A</u>	nalysis <u>I</u> mpact	t <u>L</u> ocations	<u>T</u> ools <u>W</u> ii	ndow <u>H</u> elp			_ @ X
1	2012-2016 Alabama Integrated Cr	ash Data	~	Large Tru	ck Involved AND	Vehicle Defect	C222	✓ ♥ 1/ 1/2012 ∨ 12/31/2016 ∨)
Order	∵ Max Gain v Desce	ending v	Suppress	s Zero-Valued R	ows	Sigr	nificance: Over	Representation v Threshold: 2.0
C101	: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻	C060: Number Killed C061: Number of Railroad Trains
	E Tractor/Semi-Trailer	825	46.43	11453	33.81	1.373*	224.204	C062: Has Railroad Crossing Number
	E Single-Unit Truck (3 Axles o	193	10.86	2251	6.65	1.634*	74.918	C080: CMV Involved
	E Truck (6 or 7) with Trailer	102	5.74	1420	4.19	1.369*	27.510	C081: E Has Truck Bus Supplement C101: Causal Unit (CU) Type
	E Tractor/Doubles	21	1.18	161	0.48	2.486*	12.554	C102: CU Non-Motorist Indicator
	E Other Heavy Truck (Cannot	39	2.19	619	1.83	1.201	6.529	C103: CU Commercial Motor Vehicle Inc
	E Single-Unit Truck (2-Axle/6	274	15.42	5110	15.08	1.022	5.942	C104: CU Left Scene
	E Mobile Home Transport	2	0.11	0	0.00	0.000	2.000	C105: CU Driver Age Range 1 C106: CU Driver Age Range 2
	E Maintenance/Construction	2	0.11	3	0.01	12.709	1.843	C106: CO Driver Age Range 2 C107: CU Driver Raw Age
	Motor Home/Recreational Ve	2	0.11	19	0.06	2.007	1.003	C108: CU Driver Race
	E Cargo Van (10000 lbs or Le	7	0.39	118	0.35	1.131	0.810	C109: CU Driver Gender
	E 4-Wheel Off Road ATV	1	0.06	7	0.02	2.723	0.633	C110: CU Driver Residence Distance
	Farm Equipment	1	0.06	7	0.02	2.723	0.633	C111: CU Driver License State
	E Tractor/Triples	1	0.06	19	0.06	1.003	0.003	C112: CU Driver First License Class C113: CU Driver Second License Class
•	E Unknown Type of Motorize	2	0.11	41	0.12	0.930	-0.151	C114: CU Driver License Status
	E Other Bus (Seats More than	1	0.06	36	0.11	0.530	-0.888	C115: CU Driver CDL Status
	E Passenger Van	1	0.06	49	0.14	0.389	-1.570	C116: CU DL Restriction Violations #1
	Motorcycle	1	0.06	50	0.15	0.381	-1.623	C117: CU DL Restriction Violations #2
	E Van or Mini-Van	1	0.06	140	0.41	0.136	-6.344	C118: CU Endorsement Violations #1 C119: E CU Endorsement Violations #2
	E Truck Tractor Only (Bobtail)	8	0.45	285	0.84	0.535	-6.950	C120: E CU Driver Employment Status
	E Mini-van	4	0.23	281	0.83	0.271	-10.741	C121: CU Driver Condition
	Pick-Up (Four-Tire Light Truck)	98	5.51	2560	7.56	0.730*	-36.291	C122: CU Driver Officer Opinion Alcohol
	E Sport Utility Vehicle (SUV)	51	2.87	2187	6.46	0.445*	-63.725	C123: CU Driver Officer Opinion Drugs
	Passenger Car	140	7.88	6948	20.51	0.384*	-224.475	C124: CU Driver Alcohol Test Type Given
) @ <i>\$</i>							Display Filter Name
			2	2012-2016 Alaba	ma Integrated Cra	ash Data		
					ısal Unit (CU) Ty			
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	^같 40							
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	0	E Other Heavy	Truck	E Cargo Van (1000)	(hs or Less)	E Other Bus	Seats	E Mini-van
		(Cannot Clas	isify)			More than	15)	
JI				C10	1: Causal Unit (C	11) Tyne		

The output above is ordered by Max Gain, which considers both the number of crashes in which the unit was at fault (the first numerical column) and the over-representation (as measured by the Odds Ratio). The Max Gain is the number of crashes that would be eliminate if there was some countermeasure implemented that could eliminate its over-representation. In the first item list, which has a causal frequency of 825 crashes, 224 of these could be eliminated if the effect of vehicle defects was eliminated. This list enables motor-carrier professionals to determine which vehicle types need the greatest emphasis when it comes to reducing their vehicle defects.

We will continue with the IMPACT results that had the highest total max gains, and also those with the most practical significance.

2.2 C222 CU Contributing Vehicle Defect

This summary result (top of next page) was not produced to do an IMPACT comparison because the control subset does not have defects, so the control items all came out to be zero. However, this shows what defects this overall large truck analysis is considering; and it answers in general the question of in general, what vehicle defects are being considered in the analysis given above. Further per-vehicle-type analysis are easily obtained by a cross-tabulation of C101 by C222. The following is a partial example of such a cross-tabulation. All of the vehicle types are included, but the vehicle defect types are truncated at Fuel System.

CARE 10.1.	.0.19 - [Cros	stab Results	- 2012-2016	Alabama Int	egrated Cras	h Data - Filte	r = Large Tru	ick Involved /	AND Veh	- 🗆 🗙
File Dashbo	oard <u>F</u> ilters <u>4</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>L</u> ocations <u>T</u>	ools <u>W</u> indow	<u>H</u> elp					_ @ ×
2012-2016 A	labama Integrated C	irash Data	~	Large Truck Involve	d AND Vehicle Defec	± C222 ∨	🌱 🏆 1/ 1	/2012 v 12/31/20	16 🗸 🔋 Numb	er Kille 🕨 🗊 🥞
Suppress Zero Valu	ues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🔹 %	9			Column: CU Con	tributing Vehicle Def	ect ; Row: Causal U	nit (CU) Type 🚺
	Brakes	Steering	E Tire Blowout/Separatio	E Improper Tread Depth	Wheels	Windows/Windshi eld	E Mirrors	Trailer Hitch/Coupling	Power Train	Fuel System
Passenger Car	51	11	37	21	9	4	0	0	2	0
Pick-Up (Four- Tire Light Truck)	30	3	18	10	16	1	0	5	2	0
E Van or Mini-Van	0	1	0	0	0	0	0	0	0	0
E Cargo Van (10000 lbs or Les	2	2	2	0	0	0	0	0	0	0
E Sport Utility Vehicle (SUV)	15	1	19	5	3	0	0	4	2	0
E Single-Unit Truck (2-Axle/6-Ti	95	18	76	6	19	1	1	18	18	3
E Single-Unit Truck (3 Axles or	54	5	84	3	15	0	0	5	16	0
E Truck (6 or 7) with Trailer	16	7	30	0	16	0	1	18	7	1
E Truck Tractor Only (Bobtail)	3	0	2	0	1	0	0	1	1	0
E Tractor/Semi- Trailer	195	28	372	7	77	1	1	40	51	13
E Tractor/Doubles	6	0	10	0	2	0	0	2	0	0
E Tractor/Triples	0	0	0	0	0	0	0	1	0	0
E Other Heavy Truck (Cannot Cla	18	1	7	0	3	0	0	2	3	0
Motor Home/Recreation	1	0	0	0	1	0	0	0	0	0
E Mobile Home Transport	0	0	2	0	0	0	0	0	0	0
Motorcycle	0	0	0	0	0	0	0	0	0	0
E 4-Wheel Off Road ATV	0	0	0	1	0	0	0	0	0	0
E Other Bus (Seats More than	0	0	1	0	0	0	0	0	0	0
Farm Equipment	0	1	0	0	0	0	0	0	0	0
E Maintenance/Con	1	0	0	0	0	0	0	0	0	1
E Unknown Type of Motorized Vehi	0	0	1	0	1	0	0	0	0	0
E Mini-van	1	0	2	0	1	0	0	0	0	0
E Passenger Van	1	0	0	0	0	0	0	0	0	0
TOTAL	489	78	663	53	164	7	3	96	102	18
<										>

The display below gives the distribution of the vehicle defects that occurred in the vehicles given in the analysis in Section 2.1. The table indicates that Tire Blowout/Separation is the highest frequency, with Brakes, Wheels and Power Train following. Apparently Improper Tread Depth is not as large a problem for large trucks as it is for passenger cars, as we will see in comparing this output with the one given for cars in Section 3.2 below. We expect this is because of the continual inspections given to large trucks by FMCSA and the ALEA Motor Carrier unit.

C/	ARE 10.1.0.19 - [IMPA	CT Results	- 2012-20	16 Alaban	na Integrat	ed Crash	Data - Larg	ge Truck In	volv — 🗖	x
💀 E	<mark>ile <u>D</u>ashboard <u>F</u>ilters <u>A</u></mark>	nalysis <u>I</u> mpac	t <u>L</u> ocations	<u>T</u> ools <u>W</u> ii	ndow <u>H</u> elp				-	đΧ
6	2012-2016 Alabama Integrated Cra	ash Data	~	Large Tru	ck Involved AND	Vehicle Defect	C222	¥ 💡 🌃	1/ 1/2012 v 12/31/20	16 🗸
	r: Max Gain 🗸 Desce	-	Suppress	s Zero-Valued R	ows	Sigr	nificance: Over	-	✓ Threshold: 2.0	
C222	CU Contributing Vehicle Defec	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 📼		ontributing Vehicle Defectory ry Contributing Circums	
•	E Tire Blowout/Separation	663	37.31	0	0.00	0.000	663.000		ontributing Circumstance	е
	Brakes	489	27.52	0	0.00	0.000	489.000		Sequence of Events #1 Iarmful Event	
	Wheels	164	9.23	0	0.00	0.000	164.000		hicle Most Harmful Ever	nt
	Power Train	102	5.74	0	0.00	0.000	102.000		nicle Most Harmful Even	
	Trailer Hitch/Coupling	96	5.40	0	0.00	0.000	96.000		t Harmful Event	
	Steering	78	4.39	0	0.00	0.000	78.000	C023: E Man		
	E Improper Tread Depth	53	2.98	0	0.00	0.000	53.000	C563: V2 Est C562: V2 Sp	timated Speed at Impac	t
	Suspension	41	2.31	0	0.00	0.000	41.000	1	int of Initial Impact	
	E Body/Doors	25	1.41	0	0.00	0.000	25.000		hicle Maneuvers	
	E Tail Lights	19	1.07	0	0.00	0.000	19.000		timated Speed at Impac	t
	Fuel System	18	1.01	0	0.00	0.000	18.000	C002: City		
	Tum Signal	12	0.68	0	0.00	0.000	12.000	C040: Agency C223: CU Sp		
	Windows/Windshield	7	0.39	0	0.00	0.000	7.000	C031: Locale		
	E Headlights	4	0.23	0	0.00	0.000	4.000		ntributing Circumstance	
	E Mirrors	3	0.17	0	0.00	0.000	3.000		Sequence of Events #2	
	Exhaust	2	0.11	0	0.00	0.000	2.000		er of Vehicles	
	E Cruise Control	1	0.06	0	0.00	0.000	1.000	C233: CU Po ✓ Sort by Sum	of Max Gain	~
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2.3 C219 CU Attachment

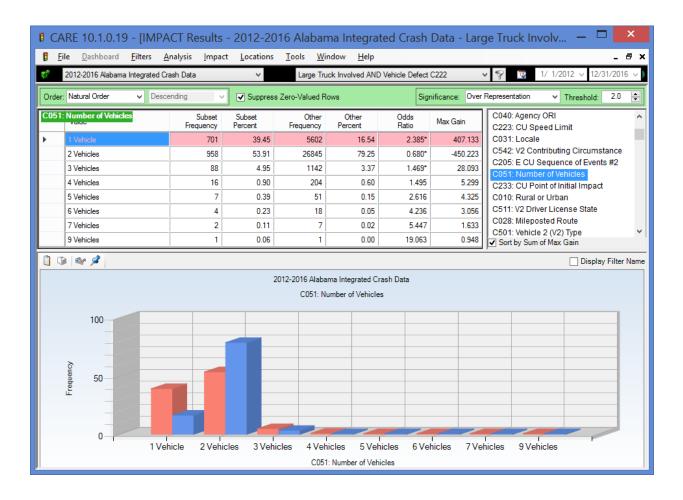
Eile <u>D</u> ashboard	<u>F</u> ilters	<u>A</u> nalysis	<u>I</u> mpac	t <u>L</u> ocations	<u>T</u> ools <u>W</u> i	ndow <u>H</u> elp			- 8
2012-2016 Alabar	na Integrat	ed Crash Data		~	Large Tru	ick Involved AND	Vehicle Defect	C222	✓ ♥ 1/ 1/2012 ∨ 12/31/2016 ∨
)rder: Max Gain	~	Descending	Ý	Suppress	s Zero-Valued R	ows	Sigr	nificance: Over	Representation V Threshold: 2.0
219: CU Attachment			Subset uency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻	C210: CU Body (Passenger Cars Only) C211: E CU Owners State
E Other Semi Tra	iler		624	35.12	8780	25.92	1.355*	163.423	C212: CU License Tag State
E Log Trailer			130	7.32	1210	3.57	2.048*	66.526	C213: CU Vehicle Usage
E Large Utility (2+	+ Axles)		114	6.42	1189	3.51	1.828*	51.628	C214: E CU Emergency Status C215: E CU Placard Required
Tanker			47	2.64	445	1.31	2.013*	23.656	C216: E CU Placard Status
E Small Utility (1)	Axle)		31	1.74	219	0.65	2.698*	19.512	C217: CU Hazardous Cargo
Other			44	2.48	471	1.39	1.781*	19.292	C218: E CU Hazardous Released
Double/Triple Tra	ailer		30	1.69	241	0.71	2.373*	17.358	C219: CU Attachment
Towed Vehicle			26	1.46	172	0.51	2.882*	16.977	C220: CU Oversized Load Requiring Per C221: CU Had Oversized Load Permit
Mobile Home			20	1.13	77	0.23	4.951*	15.961	C222: CU Contributing Vehicle Defect
Camper Trailer			8	0.45	43	0.13	3.547	5.744	C223: CU Speed Limit
Boat Trailer			6	0.34	37	0.11	3.091	4.059	C224: CU Estimated Speed at Impact
Pole Trailer			7	0.39	83	0.25	1.608	2.646	C225: CU Citation Issued
E Steerable Front	Axle		1	0.06	6	0.02	3.177	0.685	C226: CU Vehicle Damage C227: CU Vehicle Towed
Not Applicable			15	0.84	431	1.27	0.663	-7.609	C230: CU Areas Damaged #1
Unknown			12	0.68	1741	5.14	0.131	-79.329	C231: E CU Areas Damaged #2
None			662	37.25	18730	55.29	0.674*	-320.530	C232: E CU Areas Damaged #3 Sort by Sum of Max Gain
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0			E 9	Small Utility (1	Axle)	C	amper Trailer		Unknown
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The Attachment display above tends to show the causal vehicle use. The causal vehicle would except in rare cases have a vehicle defect, although it might not be indicated in all crashes as the cause for the crash. The above comparison is against the same types of vehicles but which did not have defects. As an example, log trucks (second vehicle listed) had 7.32% of the defective vehicle crashes, but only 3.57% of the non-defective vehicle crashes, creating an odds ratio of over twice what would be expected (2.048). The Max Gain of 66.526 crashes represents the

number that could be reduced if the over-representation was eliminated (i.e., the Odds Ratio somehow was forced to be 1; reducing the 7.32% to its expected value of 3.57%.

2.4 C051 Number of Vehicles

This attribute plays a large role in many of the attributes discussed in the following sections. Single vehicle crashes are over-represented, as are all multi-vehicle crashes with three or more vehicles. Two vehicle crashes are under-represented with 0.680 of the proportion that occurs in non-vehicle-defect crashes. The Odds Ratio indicates that single vehicle crashes occur over twice their expected proportion. These results are quite similar to those for passenger cars (Section 3.3).



2.5 C019 Most Harmful Event

	2012-2016 Alabama Integrated Crash Da		¥	-	Involved AND V			√ Ŷ 1/ 1/2012 √ 12/31/2016
	Max Gain v Descending		 Suppress Ze 				ficance: Over F	
D19:	E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	C019: E Most Harmful Event
	Collision with Other Non-Fixed Object	229	13.61	442	1.37	9.933*	205.947	
	Overtum/Rollover	232	13.78	1931	5.98	2.304*	131.285	
	Fire/Explosion	131	7.78	195	0.60	12.880*	120.829	
	Vehicle Defect/Component Failure	118	7.01	48	0.15	47.133*	115.496	
	Collision with Guardrail Face	48	2.85	201	0.62	4.579*	37.516	
	Collision with Tree	57	3.39	439	1.36	2.489*	34.103	
	Other Non-Collision	32	1.90	99	0.31	6.197*	26.836	
	Collision with Ditch	41	2.44	350	1.08	2.246*	22.745	
	Thrown or Falling Object	27	1.60	103	0.32	5.026*	21.628	
	Cargo/Equipment Loss or Shift	32	1.90	237	0.73	2.589*	19.639	
	Collision with Cable Barrier	15	0.89	80	0.25	3.595	10.827	
	Collision with Concrete Barrier	19	1.13	161	0.50	2.263	10.603	
	Separation of Units	11	0.65	20	0.06	10.545	9.957	
	Jackknife	17	1.01	156	0.48	2.089	8.864	
	Collision with Bridge Abutment/Rail	11	0.65	133	0.41	1.586	4.063	
	Collision with Utility Pole	17	1.01	307	0.95	1.062	0.988	
	Collision with Other Fixed Object	21	1.25	397	1.23	1.014	0.294	
	Collision with Falling/Shifting Cargo	14	0.83	312	0.97	0.860	-2.273	
	Collision with Vehicle in (or from) Ot	24	1.43	609	1.89	0.756	-7.764	
	Collision with Parked Motor Vehicle	41	2.44	1795	5.56	0.438*	-52.622	
	Collision with Vehicle in Traffic	546	32.44	23821	73.82	0.439*	-696.430	Sort by Sum of Max Gain
G	i 🞯 🖉							Display Filter N
			2012	2-2016 Alabama	Integrated Cras	h Data		
				C019: E Mos	t Harmful Event			
	100							
	<u>ک</u>							
	රිෂ 50							
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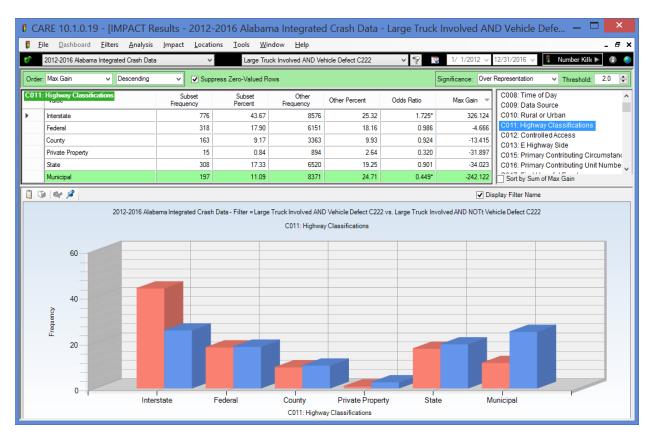
The following was trimmed to exclude all events that had less than ten occurrences.

Red in the tabular portion of the output indicates that that Harmful Event had an over-representation of twice its expectation (odds ratio > 2) when compared to crashes for that harmful event that were not caused by a vehicle defects. Clearly there are many harmful events whose probabilities of occurrence are greatly increased by vehicle defects.

2.6 C023 Manner of Crash

For two-vehicle crashes, this gives an idea of how the two vehicles came together. But note that a large plurality of crashes (44.09%) were single vehicle, much higher than expected. The same is true for the non-collisions. An example of this might be where a defective tire caused a vehicle to run off the road and the incident was reported even though no collision resulted.

	ARE 10.1.0.19 - [IMPA File Dashboard Filters A		- 2012-20 t <u>L</u> ocations		na Integra	ted Crash	Data - Larg	je Truck Inv	/01/ — —	× ₽×
10 I	2012-2016 Alabama Integrated Cr		v		ck Involved AND	Vehicle Defect	C222 V	9 7	1/ 1/2012 y 12/31/2016	_
Orde	r: Max Gain 🗸 Desc	ending v	Suppress	Zero-Valued R	ows	Sigr	nificance: Over F	Representation	✓ Threshold: 2.0	÷
C023	: E Manner of Crash	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻	C023: E Mann	ner of Crash	_
•	Single Vehicle Crash (all types)	612	44.09	5057	15.89	2.775*	391.488			
	Non-Collision	201	14.48	563	1.77	8.187*	176.450			
	Head-On (front to front only)	23	1.66	448	1.41	1.177	3.465			
	Angle Oncoming (frontal)	17	1.22	408	1.28	0.956	-0.791			
	Angle (front to side) Opposite	24	1.73	744	2.34	0.740	-8.442			
	Causal Veh Backing: Rear to	5	0.36	384	1.21	0.299	-11.744			
	Angle (front to side) Same Dir	30	2.16	1213	3.81	0.567*	-22.893			
	Sideswipe - Opposite Direction	17	1.22	1156	3.63	0.337	-33.408			
	Side Impact (90 degrees)	49	3.53	2126	6.68	0.529*	-43.705			
	Side Impact (angled)	90	6.48	3094	9.72	0.667*	-44.915			
	Rear End (front to rear)	214	15.42	8875	27.88	0.553*	-172.997			
	Sideswipe - Same Direction	106	7.64	7566	23.77	0.321*	-223.918	Sort by Sum o	of Max Gain	
n) @ Ø								Display Filter	Name
			2		ma Integrated Cr					
				C023: E	Manner of Crasi	1				
	60									
	40									
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	20 —									
	0									
	·	Non-Collision	Angle Oncom (frontal)	ing Causa Re	IVeh Backing: arto Side	Sideswipe - Opposite Directi	Side Impa ion	act (angled)	Sideswipe - Same Direction	
				C02	3: E Manner of C	Crash				
h.										

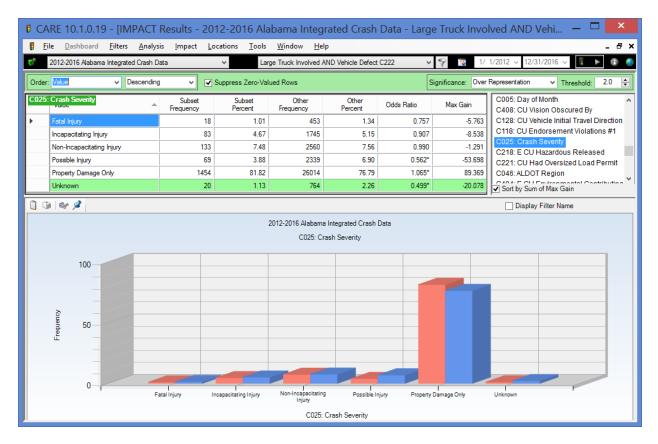


2.7 C011 Highway Classification and Speeds

All other things being equal, it is expected that each Highway Classification will have the same proportion of crashes as the defective vehicle-miles traveled on it over the course of the study. In this case, Interstates probably have over twice the traffic of vehicle-miles (in this case by large trucks) that might have vehicle defects. So the over-representation on Interstate highways is reasonable. Also, tire blowouts tend to occur at higher speeds, as shown in the following cross-tabulation of impact speeds by vehicle defect.

CARE 10.1	.0.19 - [Cros	stab Results	- 2012-2016	Alabama Int	egrated Cras	h Data - Filte	er = Large Tru	uck Invol	_ 🗆 🗙				
🚦 <u>F</u> ile <u>D</u> ashb													
2012-2016	Nabama Integrated (Crash Data	~	Large Truck Involve	d AND Vehicle Defe	ct C222 ∨	9 1/ 1	1/2012 y 12/31/20	016 🗸 🚺 🚯 🧐				
Suppress Zero Va	lues: Rows and Co	lumns 🗸 Select	Cells: 🔳 🔹 %	9	Colu	imn: CU Estimated S	ipeed at Impact ; Rov	w: CU Contributing V	ehicle Defect ญ				
31 to 35 MPH 36 to 40 MPH 41 to 45 MPH 46 to 50 MPH 51 to 55 MPH 56 to 60 MPH 61 to 65 MPH 66 to 70 MPH													
Brakes	31	21	31	13	37	13	24	17	0				
Steering	4	1	12	3	8	5	7	6	2				
E Tire Blowout/Separatio	9	13	21	37	88	68	170	140	13				
E Improper Tread Depth	1	3	2	3	6	9	4	5	3				
Wheels	6	6	19	17	14	16	23	23	1				
Windows/Windshi eld	0	0	1	0	1	0	0	0	0				
E Mirrors	0	0	1	0	0	0	1	0	0				
Trailer Hitch/Coupling	6	7	4	9	13	4	5	7	0				
Power Train	1	4	5	2	9	10	18	14	0				
Fuel System	0	1	2	1	5	2	0	1	0				
Exhaust	0	0	0	0	0	1	0	0	0				
E Headlights	0	0	1	0	1	1	0	0	0				
E Tail Lights	2	0	2	3	0	0	1	0	0				
Turn Signal	0	1	0	0	0	0	0	0	0				
Suspension	3	4	5	2	7	2	5	4	1				
E Cruise Control	0	0	0	0	0	0	1	0	0				
E Body/Doors	2	0	3	0	3	1	2	3	0				
TOTAL	65	61	109	90	192	132	261	220	20				
<									>				

2.8 C025 Crash Severity



Crashes involving large trucks that caused by vehicle defects are much less severe than those caused by other factors. We surmise that this is because the drivers can sense when something is not quite right, and they slow down or stop to address the problem. Even if they only reduce speed in anticipation of a potential problem, this can dramatically lower the severity of the crash. Other studies have shown that the probability of a fatality approximately doubles for every 10 MPH increase in impact speed.

2.9 C208 CU Model Year

The age of the vehicle would definitely impact its chances for its containing defective components. The model years begin to be significantly over-represented in1991, and this continues through 2001, after which they become under-represented.

CARE 10.1.0.19 - [IMPACT	Results - 20)12-2016 Al	labama Inte	grated Cras	h Data - Lar	ge Truck Invo	lved AND Vehi 🗕 🗖	x
📴 Eile Dashboard Eilters Analy	sis <u>I</u> mpact <u>L</u>	ocations <u>T</u> ool	s <u>W</u> indow <u>H</u>	<u>H</u> elp			_ t	σ×
2012-2016 Alabama Integrated Crash E	Data		arge Truck Involve	d AND Vehicle Defe	ect C222	▼ ♥ 1/	1/2012 v 12/31/2016 v 👔 🕩 🚯	•
Order: Max Gain V Descendin	g v v	Suppress Zero-V	alued Rows			Significance: Over	Representation Y Threshold: 2.0	÷
C208: CU Model Year	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain ^	C208: CU Model Year	
1988	11	0.64	99	0.32	2.008	5.523		
1989	17	0.98	142	0.46	2.164	9.144		
1990	16	0.93	135	0.43	2.142	8.531		
1991	27	1.56	131	0.42	3.725*	19.752		
1992	14	0.81	183	0.59	1.383	3.875		
1993	27	1.56	270	0.87	1.807*	12.062		
1994	40	2.32	400	1.28	1.807*	17.870		
1995	50	2.90	547	1.75	1.652*	19.737		
1996	60	3.48	583	1.87	1.860*	27.745		
1997	62	3.59	727	2.33	1.541*	21.778		
1998	65	3.77	922	2.96	1.274	13.990		
1999	90	5.21	1158	3.71	1.405*	25.933		
2000	103	5.97	1483	4.75	1.255	20.952		
2001	95	5.50	1276	4.09	1.346*	24.404	Sort by Sum of Max Gain	
2002	60	3.48	1182	3.79	0.917	-5.395 ¥	· ·	
							Display Filter Name	
			2012-2016 Alaba	ima Integrated Cras	h Data			
			C208:	CU Model Year				
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Kounente 5								
nba-								
			-					
_		-						
		288 B	ah Dill					
0 1		1988		1998		2008		
			(C208: CU Model Ye	ar			

3.0 Passenger Vehicle Analysis

3.1 C101 Causal Unit (CU) for Passenger Vehicles Involved

The filter used to perform this study required that a passenger vehicle was either the Causal Unit or the victim unit (Vehicle 2) in the cases that included two-vehicle crashes. Large trucks were not excluded from consideration, but unlike the analysis above, there was no requirement for the presence of a large truck in the crash. See the Introduction (Section 1.0) above for a formal definition of the particular vehicle type that had to be involved to qualify for these analyses.

	2012-2016 Alabama Integrated C	rash Data	~	✓ Passenger Types Involved AND Vehicle Defect C222 ✓ ♥ ♥ 1/ 1/2012 ✓ 12/31/2016 ✓							
rder:	Subset Frequency 🗸 Desc	ending v	Suppress	Zero-Valued Row	/S	Sig	nificance: Over	Representation V Threshold: 2.0			
101:	Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	C062: Has Railroad Crossing Number C080: CMV Involved			
	Passenger Car	6691	48.06	342245	53.48	0.899*	-755.550	C081: E Has Truck Bus Supplement			
	Pick-Up (Four-Tire Light Truck)	3310	23.77	122198	19.10	1.245*	651.222	C101: Causal Unit (CU) Type			
	E Sport Utility Vehicle (SUV)	2642	18.98	125956	19.68	0.964	-98.545	C102: CU Non-Motorist Indicator C103: CU Commercial Motor Vehicle In			
	E Tractor/Semi-Trailer	366	2.63	6560	1.03	2.564*	223.268	C103: CU Left Scene			
	E Mini-van	233	1.67	12121	1.89	0.883	-30.728	C105: CU Driver Age Range 1			
	E Van or Mini-Van	131	0.94	6490	1.01	0.928	-10.209	C106: CU Driver Age Range 2			
	E Single-Unit Truck (2-Axle/6	115	0.83	3587	0.56	1.473*	36.954	C107: CU Driver Raw Age			
	E Single-Unit Truck (3 Axles or	. 90	0.65	1453	0.23	2.847*	58.386	C108: CU Driver Race			
	Station Wagon	54	0.39	2234	0.35	1.111	5.393	C109: CU Driver Gender C110: CU Driver Residence Distance			
	E Truck (6 or 7) with Trailer	50	0.36	911	0.14	2.523*	30.179	C111: CU Driver License State			
	E Cargo Van (10000 lbs or Less)		0.32	2667	0.42	0.758	-14.028	C112: CU Driver First License Class			
		38	0.32	1614	0.42	1.082	2.883	C113: CU Driver Second License Class			
_	Motorcycle			462				C114: CU Driver License Status			
	E Other Heavy Truck (Cannot		0.19		0.07	2.686*	16.948	C115: CU Driver CDL Status			
	Motor Home/Recreational Vehi.		0.14	183	0.03	4.772	15.018	C116: CU DL Restriction Violations #1 C117: CU DL Restriction Violations #2			
	E Passenger Van	17	0.12	1385	0.22	0.564	-13.135	C117: CO DL Restriction Violations #2 C118: CU Endorsement Violations #1			
	P Other Truck*	11	0.08	246	0.04	2.055	5.648	C119: E CU Endorsement Violations #1			
	E Other Passenger Vehicle	10	0.07	437	0.07	1.052	0.492	C120: E CU Driver Employment Status			
	E Other Light Truck (10000 lbs	. 7	0.05	178	0.03	1.807	3.127	C121: CU Driver Condition			
	E 4-Wheel Off Road ATV	7	0.05	177	0.03	1.818	3.149	C122: CU Driver Officer Opinion Alcohol			
	E Unknown Type of Motorized .	. 7	0.05	5428	0.85	0.059	-111.102	C123: CU Driver Officer Opinion Drugs			
	E Tractor/Doubles	6	0.04	68	0.01	4.055	4.520	C124: CU Driver Alcohol Test Type Give C125: E CU Driver Drug Test Type Give			
	E Other Bus (Seats More than	6	0.04	617	0.10	0.447	-7.425	C126: CU Driver Alcohol Test Results			
	E Other Motor Vehicle	5	0.04	125	0.02	1.838	2.280	C127: E CU Driver Drug Test Results			
	P Van*	5	0.04	739	0.12	0.311	-11.079	C128: CU Vehicle Initial Travel Direction			
	P Truck Tractor*	5	0.04	280	0.04	0.821	-1.092	C129: CU Vehicle Maneuvers			
	E Mobile Home Transport	4	0.03	10	0.00	18.384	3.782	C130: E CU Non-Motorist Maneuvers			
	E Truck Tractor Only (Bobtail)	3	0.02	182	0.03	0.758	-0.960	C201: CU Vehicle Most Harmful Event C202: CU Contributing Circumstance			
	E Motor Coach/Motor Home	3	0.02	38	0.01	3.628	2.173	C203: CU First Harmful Event Location			
	E Other Motorized Cycle/Low	3	0.02	68	0.01	2.028	1.520	C204: E CU Sequence of Events #1			
	Moped	2	0.02	55	0.01	1.671	0.803	C205: E CU Sequence of Events #2			
	E School Bus (Seats More tha	2	0.01	191	0.01	0.481	-2.156	C206: E CU Sequence of Events #3			
				191	0.03			C207: E CU Sequence of Events #4			
	E Other Small Bus (Seats 15 or		0.01			0.481	-2.156	C208: CU Model Year C209: CU Make			
	E Low Speed Vehicle	2	0.01	43	0.01	2.138	1.064	C209. CO Make C210: CU Body (Passenger Cars Only)			
	P Commercial Bus*	2	0.01	22	0.00	4.178	1.521	C211: E CU Owners State			
	P Other	2	0.01	375	0.06	0.245	-6.159	C212: CU License Tag State			
	E Maintenance/Construction V		0.01	72	0.01	0.638	-0.567	C213: CU Vehicle Usage			
	E Other Vehicle Seating 9 or M	. 1	0.01	43	0.01	1.069	0.064	Sort by Sum of Max Gain			

The above was listed out in order of crash frequency, which is useful in determining patterns for causal vehicles. The following is the same analysis, but in order of Max Gain. While pick-up truck have the highest Max Gain, the over-representation leaders for this crash subset are the large trucks despite the fact that they were to some extent excluded from the test subset. Despite their over-representation, however, they account for a relatively small percentage of these crashes – note that the combination of pick-ups and passenger cars adds up to over 10,000 crashes as compared to about 800 in the heavy truck category. The creation of the two subsets being compared had no consideration at all for the causal vehicle type.

	2012-2016 Alabama Int	egrated Cra	ish Data	¥	Passenger	Types Involved A	ND Vehicle Def	ect C222 V	¶ 1/ 1/2012 ∨ 12/31/2016 ∨
rder:	Max Gain	V Descer	nding	 Suppress 	Zero-Valued Rov	vs	s	ignificance: Over	Representation v Threshold: 2.0
101:	Causal Unit (CU) Ty	pe	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻	C062: Has Railroad Crossing Number C080: CMV Involved
	Pick-Up (Four-Tire Lig	nt Truck)	3310	23.77	122198	19.10	1.245	• 651.222	C081: E Has Truck Bus Supplement
	E Tractor/Semi-Trailer		366	2.63	6560	1.03	2.564	• 223.268	C101: Causal Unit (CU) Type
	E Single-Unit Truck (3	Axles or	90	0.65	1453	0.23	2.847	• 58.386	C102: CU Non-Motorist Indicator C103: CU Commercial Motor Vehicle II
	E Single-Unit Truck (2	-Axle/6	115	0.83	3587	0.56	1.473	• 36.954	C104: CU Left Scene
	E Truck (6 or 7) with T	railer	50	0.36	911	0.14	2.523	• 30.179	C105: CU Driver Age Range 1
	E Other Heavy Truck	(Cannot	27	0.19	462	0.07	2.686	• 16.948	C106: CU Driver Age Range 2
	Motor Home/Recreati	onal Vehi	19	0.14	183	0.03	4.77	2 15.018	C107: CU Driver Raw Age
	P Other Truck*		11		246	0.04	2.05		C108: CU Driver Race
	Station Wagon		54		2234	0.35	1.11		C109: CU Driver Gender
	E Tractor/Doubles		6		68	0.01	4.05		C110: CU Driver Residence Distance C111: CU Driver License State
			4		10				C112: CU Driver First License Class
	E Mobile Home Transp					0.00	18.38		C113: CU Driver Second License Clas
	E 4-Wheel Off Road A		7		177	0.03	1.81		C114: CU Driver License Status
	E Other Light Truck (1	0000 lbs	7		178	0.03	1.80		C115: CU Driver CDL Status
	Motorcycle		38	0.27	1614	0.25	1.08	2 2.883	C116: CU DL Restriction Violations #1
	E Other Motor Vehicle		5	0.04	125	0.02	1.83	3 2.280	C117: CU DL Restriction Violations #2
	E Motor Coach/Motor	Home	3	0.02	38	0.01	3.62	3 2.173	C118: CU Endorsement Violations #1 C119: E CU Endorsement Violations #
	P Commercial Bus*		2	0.01	22	0.00	4.17	3 1.521	C120: E CU Driver Employment Status
	E Other Motorized Cyc	le/Low	3	0.02	68	0.01	2.02	3 1.520	C121: CU Driver Condition
	E Low Speed Vehicle		2	0.01	43	0.01	2.13	3 1.064	C122: CU Driver Officer Opinion Alcoho
	Moped		2	0.01	55	0.01	1.67	1 0.803	C123: CU Driver Officer Opinion Drugs
	E Other Passenger Ve	hicle	10	0.07	437	0.07	1.05	2 0.492	C124: CU Driver Alcohol Test Type Give
	E Other Vehicle Seatir		1	0.01	43	0.01	1.06	0.064	C125: E CU Driver Drug Test Type Give
	E Maintenance/Const	-	1	0.01	72	0.01	0.63	3 -0.567	C126: CU Driver Alcohol Test Results C127: E CU Driver Drug Test Results
	E Truck Tractor Only		3		182	0.03	0.75		C128: CU Vehicle Initial Travel Directio
	P Truck Tractor*	bobtaily	5		280	0.03	0.82		C129: CU Vehicle Maneuvers
_	E School Bus (Seats M	Anna Alan	2		191	0.04	0.62		C130: E CU Non-Motorist Maneuvers
			2		191	0.03	0.48		C201: CU Vehicle Most Harmful Event
_	E Other Small Bus (Se	ats 15 or							C202: CU Contributing Circumstance
	P Other		2	_	375	0.06	0.24		C203: CU First Harmful Event Location C204: E CU Sequence of Events #1
	E Other Bus (Seats Mo	pre than	6		617	0.10	0.44		C205: E CU Sequence of Events #1
	E Van or Mini-Van		131		6490	1.01	0.92		C206: E CU Sequence of Events #3
	P Van*		5		739	0.12	0.31		C207: E CU Sequence of Events #4
	E Passenger Van		17	0.12	1385	0.22	0.56	4 -13.135	C208: CU Model Year
	E Cargo Van (10000 lb	os or Less)	44	0.32	2667	0.42	0.75	3 -14.028	C209: CU Make
	E Mini-van		233	1.67	12121	1.89	0.88	3 -30.728	C210: CU Body (Passenger Cars Only
	E Sport Utility Vehicle	(SUV)	2642	18.98	125956	19.68	0.96	4 -98.545	C211: E CU Owners State C212: CU License Tag State
	E Unknown Type of N	lotorized	7	0.05	5428	0.85	0.05	9 -111.102	C213: CU Vehicle Usage
	Passenger Car		6691	48.06	342245	53.48	0.899	-755.550	Sort by Sum of Max Gain

3.2 C222 CU Contributing Vehicle Defect

Per-vehicle-type defect analyses are easily obtainable by a cross-tabulation of C101 by C222. The following is a partial example of such an analysis. In this example the vehicle types are truncated at E School Bus, and the vehicle defect types are truncated at Fuel System.

🚦 <u>F</u> ile <u>D</u> ashb	oard <u>F</u> ilters <u>A</u>	<u>A</u> nalysis <u>C</u> rossta	b <u>L</u> ocations <u>T</u>	ools <u>W</u> indow	<u>H</u> elp						- 8
2012-2016 A	Vabama Integrated C	rash Data	*	Passenger Types Inv	volved AND Vehicle [Defect C222 ∨	Sec. 1/ 1/	/2012 y 12/31/20	16 🗸 🚦 Numb	er Killed NCV Sum: 7	′8 Nu ► 🗊
Suppress Zero Val	ues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🗸 🔣	9				Column: CU C	Contributing Vehicle [)efect ; Row: Causal	Unit (CU) Type
	Brakes	Steering	E Tire Blowout/Separatio	E Improper Tread Depth	Wheels	E Wipers	Windows/Windshi eld	E Mirrors	Trailer Hitch/Coupling	Power Train	Fuel System
Passenger Car	3001	561	1282	871	292	29	82	24	7	210	65
Station Wagon	25	7	8	6	2	0	2	0	0	3	0
Pick-Up (Four- Tire Light Truck)	1239	213	663	319	225	12	26	15	192	125	28
E Van or Mini-Van	55	6	33	6	6	1	5	1	2	5	2
E Cargo Van (10000 Ibs or Les	24	1	3	1	6	0	0	0	3	5	0
E Sport Utility Vehicle (SUV)	1062	160	690	338	134	8	27	12	40	78	26
E Single-Unit Truck (2-Axle/6-Ti	59	4	17	0	8	0	0	0	6	6	1
E Single-Unit Truck (3 Axles or	29	1	26	2	6	0	0	0	2	14	0
E Truck (6 or 7) with Trailer	9	0	16	0	14	0	0	1	4	4	0
E Truck Tractor Only (Bobtail)	2	0	0	0	0	0	0	0	0	1	0
E Tractor/Semi- Trailer	66	2	213	1	34	0	1	1	2	33	2
E Tractor/Doubles	0	0	5	0	0	0	0	0	0	0	0
E Other Light Truck (10000 lbs	4	0	2	0	0	0	0	1	0	0	0
E Other Heavy Truck (Cannot Cla	15	1	3	0	1	0	0	0	2	3	0
Motor Home/Recreation	3	0	9	0	5	0	0	0	1	0	0
E Mobile Home Transport	0	0	1	0	2	0	0	0	0	1	0
Motorcycle	14	2	1	3	2	0	0	0	0	2	2
Moped	1	0	0	0	0	0	0	0	0	0	0
E 4-Wheel Off Road ATV	4	0	0	0	0	0	0	0	0	1	0
E School Bus (Seats More than	2	0	0	0	0	0	0	0	0	0	0

The following is an inversion of the above cross-tabulation, which enables the viewing of all of the vehicle defects for the vehicles that are listed across the top of the display, which are truncated at E Truck (6 or 7) with Trailer.

CARE 10.1	.0.19 - [Cros	stab Results	- 2012-2016	Alabama Int	egrated Cras	h Data - Filte	r = Passenge	er Types I	_ 🗆 🗙
🖡 <u>F</u> ile <u>D</u> ashb	oard <u>F</u> ilters <u>/</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>L</u> ocations <u>T</u>	ools <u>W</u> indow	<u>H</u> elp				_ 8 ×
😵 2012-2016 A	Nabama Integrated C	irash Data	¥	Passenger Types Inv	volved AND Vehicle [)efect C222 V	P 1/ 1	/2012 y 12/31/20	16 🗸 🚺 🚯 🌖
Suppress Zero Val	lues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🔻 %	9		Column: Causal	Unit (CU) Type ; Ro	w: CU Contributing \	/ehicle Defect 🔃
	Passenger Car	Station Wagon	Pick-Up (Four- Tire Light Truck)	E Van or Mini-Van	E Cargo Van (10000 Ibs or Les	E Sport Utility Vehicle (SUV)	E Single-Unit Truck (2-Axle/6-Ti	E Single-Unit Truck (3 Axles or	E Truck (6 or 7) with Trailer
Brakes	3001	25	1239	55	24	1062	59	29	9
Steering	561	7	213	6	1	160	4	1	0
E Tire Blowout/Separatio	1282	8	663	33	3	690	17	26	16
E Improper Tread Depth	871	6	319	6	1	338	0	2	0
Wheels	292	2	225	6	6	134	8	6	14
E Wipers	29	0	12	1	0	8	0	0	0
Windows/Windshi eld	82	2	26	5	0	27	0	0	0
E Mirrors	24	0	15	1	0	12	0	0	1
Trailer Hitch/Coupling	7	0	192	2	3	40	6	2	4
Power Train	210	3	125	5	5	78	6	14	4
Fuel System	65	0	28	2	0	26	1	0	0
Exhaust	2	0	1	0	0	0	0	1	0
E Headlights	50	0	21	2	0	18	0	0	0
E Tail Lights	23	0	78	3	0	7	3	0	0
Turn Signal	9	0	26	3	0	5	3	2	1
Suspension	68	1	48	1	0	26	1	1	1
E Cruise Control	4	0	4	0	0	6	0	0	0
E Body/Doors	34	0	18	0	1	5	7	6	0
P Tires*	74	0	47	0	0	0	0	0	0
P Lights*	3	0	3	0	0	0	0	0	0
P Restraint System	0	0	1	0	0	0	0	0	0
P Cargo	0	0	6	0	0	0	0	0	0
TOTAL	6691	54	3310	131	44	2642	115	90	50
<									>

It is clear that brakes and tire defects produce the largest numbers. We will see below that tire problems eclipse the braking issues when it comes to causing fatalities.

CA	ARE 10.1.0.19 - [IMPA	CT Results -	2012-20	16 Alabam	a Integrate	d Crash Da	ata - Passe	nger Types Inv 🗕 🗖 🔀
₿ E	ile <u>D</u> ashboard <u>F</u> ilters <u>A</u> r	nalysis <u>I</u> mpact	<u>L</u> ocations	<u>T</u> ools <u>W</u> ind	low <u>H</u> elp			_ æ >
¢°	2012-2016 Alabama Integrated Cra	ash Data	~	Passenger	Types Involved AN	ND Vehicle Defec	t C222 ∨	
	r: Max Gain 🗸 Desce		Suppress	Zero-Valued Row	/S	Sigr	nificance: Over	Representation V Threshold: 2.0
C222	: CU Contributing Vehicle Defect	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 📼	C205: E CU Sequence of Events #2 C206: E CU Sequence of Events #3
•	Brakes	5764	41.40	0	0.00	0.000	5764.000	C207: E CU Sequence of Events #4
	E Tire Blowout/Separation	3034	21.79	0	0.00	0.000	3034.000	C208: CU Model Year C209: CU Make
	E Improper Tread Depth	1561	11.21	0	0.00	0.000	1561.000	C210: CU Body (Passenger Cars Only)
	Steering	978	7.02	0	0.00	0.000	978.000	C211: E CU Owners State
	Wheels	757	5.44	0	0.00	0.000	757.000	C212: CU License Tag State C213: CU Vehicle Usage
	Power Train	502	3.61	0	0.00	0.000	502.000	C214: E CU Emergency Status
	Trailer Hitch/Coupling Suspension	264	1.90	0	0.00	0.000	264.000	C215: E CU Placard Required
	Suspension Windows/Windshield	153	1.10	0	0.00	0.000	153.000	C216: E CU Placard Status
	Fuel System	147	0.93	0	0.00	0.000	147.000	C217: CU Hazardous Cargo C218: E CU Hazardous Released
	E Tail Lights	129	0.93	0	0.00	0.000	129.000	C219: CU Attachment
	P Tires*	125	0.90	0	0.00	0.000	126.000	C220: CU Oversized Load Requiring Pe
	E Headlights	98	0.70	0	0.00	0.000	98.000	C221: CU Had Oversized Load Permit
	E Body/Doors	80	0.57	0	0.00	0.000	80.000	C222: CU Contributing Vehicle Defect C223: CU Speed Limit
	E Mirrors	56	0.40	0	0.00	0.000	56.000	C224: CU Estimated Speed at Impact
	Tum Signal	53	0.38	0	0.00	0.000	53.000	C225: CU Citation Issued
	E Wipers	50	0.36	0	0.00	0.000	50.000	C226: CU Vehicle Damage C227: CU Vehicle Towed
	E Cruise Control	15	0.11	0	0.00	0.000	15.000	C230: CU Areas Damaged #1
	P Cargo	12	0.09	0	0.00	0.000	12.000	C231: E CU Areas Damaged #2
	P Lights*	7	0.05	0	0.00	0.000	7.000	C232: E CU Areas Damaged #3
	Exhaust	5	0.04	0	0.00	0.000	5.000	C233: CU Point of Initial Impact C301: CU Non-Motorist Prior Action
	P Restraint System	3	0.02	0	0.00	0.000	3.000	Sort by Sum of Max Gain
	D 🞯 🖉							Display Filter Name
				2012-2016 Alaba	ma Integrated Cra	ish Data		
				C222: CU Con	tributing Vehicle [Defect		
	60							
	a a							
	Leduency							
	20							
		1						
		110						
	0	Wheels		Fuel Sy	stem	E Mi	rrors	P Lights*
		Vincels			Contributing Vehi			i Ligino
				0222.00	controuting vehi	olo Dolot		

The display above gives the distribution of all of the vehicle defects that occurred in the vehicles given in the analysis in Section 3.1. This result was not produced to do an IMPACT comparison because the control subset does not have defects, so the control items all came out to be zero. However, this shows the distribution of the defects that this overall passenger car analysis is considering.

3.3 C051 Number of Vehicles

This attribute plays a large role in many of the attributes discussed below. Single vehicle crashes are over-represented, as are all multi-vehicle crashes with three or more vehicles. Two vehicle crashes are under-represented with 0.675 of the proportion that occurs in non-vehicle-defect crashes. The Odds Ratio indicates that single vehicle crashes occur over twice their expected proportion.

CAP			- 2012-20 ct <u>L</u> ocations			d Crash Da	ata - Passer	nger Types Inv — 🗖 💌
\$? 2	2012-2016 Alabama Integ	grated Crash Data	~	Passenger	Types Involved AN	ID Vehicle Defec	t C222 🗸 👻	💡 🋐 1/ 1/2012 🗸 12/31/2016 🗸 🔮
Order:	Natural Order 🗸 🗸	Ascending	Suppress	Zero-Valued Rov	vs	Sig	nificance: Over F	Representation v Threshold: 2.0 🖨
C051:1	Number of Vehicles	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	C045: ALDOT Area
•	1 Vehicle	6227	44.72	135730	21.21	2.109*	3273.932	C047: ADECAAHSO Region
	2 Vehicles	6875	49.38	468347	73.19	0.675*	-3314.793	C048: Regional Planning Organization
Ī	3 Vehicles	690	4.96	30892	4.83	1.027	17.885	C049: Has Coordinate C050: E MapClick Used
	4 Vehicles	102	0.73	4170	0.65	1.124	11.274	C051: Number of Vehicles
	5 Vehicles	19	0.14	590	0.09	1.480	6.163	C052: Number of Drivers Recorded
	6 Vehicles	7	0.05	141	0.02	2.282	3.932	C053: Number of Persons Recorded
	7 Vehicles	2	0.01	40	0.01	2.298	1.130	C054: Number of Motorists Recorded C055: Number of Non-Motorists Record V
	9 Vehicles	1	0.01	4	0.00	11.491	0.913	Sort by Sum of Max Gain
					ma Integrated Cra umber of Vehicles			
	100							
1	<u>م</u>							
	50							
Ĺ	ш — (
	0	1 Vehicle 2 Veh	icles 3 Veh	icles 4 Veh	icles 5 Vehic	cles 6 Veh	icles 7 Vehi	cles 9 Vehicles
		2.00						

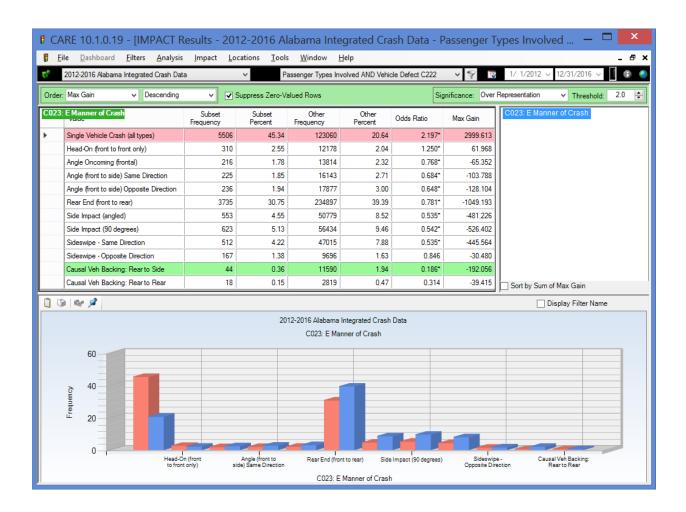
3.3 C019 Most Harmful Event

The following is a listing of Most Harmful Events for those having 40 or more occurrences. The effect of single-vehicle crashes accounts for most of the over-representations.

CA	RE 10.1.0.19 - [IMPA	CT Results -	2012-20	16 Alabam	a Integrate	d Crash Da	ata - Passe	nger Types Inv 🗕 🗖 💌
e E	ile <u>D</u> ashboard <u>F</u> ilters <u>A</u> n	alysis <u>I</u> mpact	<u>L</u> ocations	<u>T</u> ools <u>W</u> ind	low <u>H</u> elp			_ 8 :
¢?	2012-2016 Alabama Integrated Cra	sh Data	~	Passenger	Types Involved Al	ND Vehicle Defec	t C222 🗸 🗸	
Order	Max Gain 🗸 Descer	nding v	Suppress	Zero-Valued Rov	VS	Sig	nificance: Over	Representation V Threshold: 2.0
C019	E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻	C019: E Most Harmful Event
•	Overtum/Rollover	904	6.74	19902	3.23	2.088*	470.986	
	Vehicle Defect/Component Fai	439	3.27	219	0.04	92.133*	434.235	
	Collision with Ditch	714	5.32	15408	2.50	2.130*	378.763	
	Collision with Tree	802	5.98	21741	3.53	1.695*	328.974	
	Collision with Other Non-Fixed	401	2.99	3979	0.65	4.632*	314.428	
	Collision with Concrete Barrier	381	2.84	4334	0.70	4.040*	286.704	
	Collision with Guardrail Face	294	2.19	4209	0.68	3.210*	202.423	1
	Collision with Other Fixed Object	303	2.26	5401	0.88	2.578*	185.489	1
	Fire/Explosion	203 342	2.55	1242 8675	0.20	7.512*	175.977 153.255	1
	Collision with Utility Pole Ran Off Road Right	248	2.55	5123	0.83	2.225*	153.255	
	Collision with Cable Barrier	140	1.85	1375	0.83	4.680*	136.537	
	Collision with Fence	140	1.04	3361	0.22	2.434*	104.874	
	Collision with Bridge Abutment/	1/0	1.04	1814	0.33	3.547*	100.532	
	Collision with Embankment	162	1.21	3202	0.52	2.325*	92.333	
	Ran Off Road Left	149	1.11	2935	0.48	2.333*	85.142	
	Collision with Sign Post	134	1.00	3239	0.53	1.901*	63.528	
	Collision with Curb/Island/Rais	110	0.82	2373	0.39	2.131*	58.370	
	Cargo/Equipment Loss or Shift	54	0.40	453	0.07	5.479*	44.144	
	Collision with Guardrail End	70	0.52	1330	0.22	2.419*	41.063	
	Collision with Culvert Headwall	100	0.75	2841	0.46	1.618*	38.187	
	Collision with Mailbox	96	0.72	2761	0.45	1.598*	35.928	
	Thrown or Falling Object	40	0.30	333	0.05	5.521*	32.755	
	Collision with Other Post/Pole/	56	0.42	1144	0.19	2.250*	31.110	
	Collision with Light Pole (Non-B	48	0.36	1015	0.16	2.174*	25.916	1
	Collision with Vehicle in (or from	178	1.33	13726	2.23	0.596*	-120.641	1
	Record from Paper System	423	3.15	25143	4.08	0.773*	-124.045	1
	Collision with Parked Motor Ve	389	2.90	26494	4.30	0.675*	-187.439	
	Collision with Vehicle in Traffic	5912	44.09	432571	70.18	0.628*	-3499.590	Sort by Sum of Max Gain
00) 🗞 🖉							Display Filter Name
				2012-2016 Alaba	ma Integrated Cra	ash Data		
				C019: E M	lost Harmful Ever	nt		
	80							
	S 60							
	80 60 80 40 80 40							
	ق <u>ل</u> 20							
	0							
	Co	ollision with Other Ion-Fixed Object	Collisio Utility	n with Pole	Collision with Embankment	Col	lision with ardrail End	Collision with Light Pole (Non-Breakaway)
			2.000		F Most Harmful			

3.5 C023 Manner of Crash

The following presents a summary of the Manner of Crash for passenger car vehicle defect crashes. It gives insight especially into those crashes that did not involve just a single vehicle. Non-descriptive values were removed from this display, including: Other, Non-Collision, Unknown, and Record from Paper System.



3.6 C011 Highway Classification and Speeds

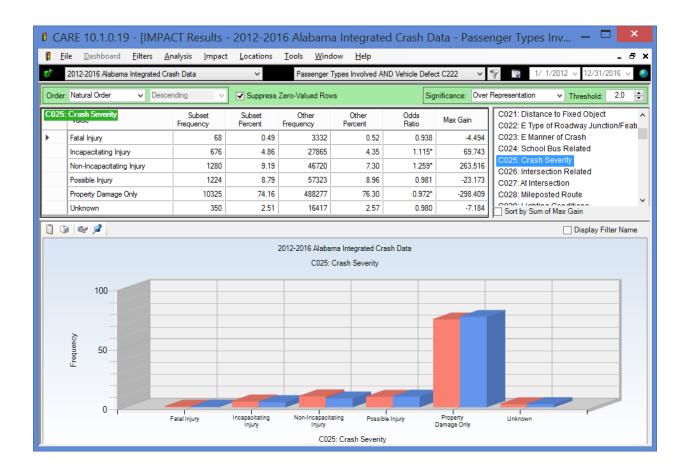
CA				16 Alabam <u>I</u> ools <u>W</u> ind	-	d Crash Da	ata - Passe	nger Types Inv — 🗖 💌
S	2012-2016 Alabama Integr		~		Types Involved AN	ND Vehicle Defec	t C222 ∨	♀ 1/ 1/2012 ∨ 12/31/2016 ∨ ●
Order:	Max Gain 🗸 🗸	Descending v	Suppress	Zero-Valued Row	vs	Sigr	nificance: Over	Representation V Threshold: 2.0
C011:	Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 📼	C006: Day of the Week C007: Week of the Year
•	Interstate	2852	20.48	60723	9.49	2.159*	1530.854	C008: Time of Day
	County	2112	15.17	96250	15.04	1.009	17.895	C009: Data Source
	P Other*	1	0.01	15	0.00	3.064	0.674	C010: Rural or Urban
	Federal	1999	14.36	95780	14.97	0.959	-84.879	C011: Highway Classifications C012: Controlled Access
	Private Property	210	1.51	15232	2.38	0.634*	-121.402	C013: E Highway Side
	State	2312	16.61	114147	17.84	0.931*	-171.488	C015: Primary Contributing Circumstance
	Municipal	4437	31.87	257787	40.28	0.791*	-1171.654	C016: Primary Contributing Unit Number
					ma Integrated Cra way Classificatio			
	60 40 20 0			2 Other*	Federal	Private Property	State	
		Interstate Co	ounty F		⊢ederal ahwayClassificat		State	Municipal
				CUTT. HIS	griwdy CidssillCdl	iona		

All other things being equal, it is expected that each Highway Classification will have the same proportion of crashes as the defective vehicles on over the course of the study. This distribution varies sharply from that of large trucks, especially in the Municipal road category. While Interstate highways still shows over twice the expected proportion, the proportion of total vehicle defect crashes in Interstate highways is 20.48% for passenger cars, while it was over twice that at 43.67% for large trucks.

Tire blowouts and tread depth issues tend to occur at higher speeds, as shown in the following cross-tabulation of impact speeds by vehicle defect. This accounts for their increased severity, which is covered in the next section.

CARE 10.1	.0.19 - [Cros	sstab Results	- 2012-2016	Alabama In	tegrated Cras	sh Data - Filte	er = Passenge	er Types I	_ 🗆 🗙
🔋 <u>F</u> ile <u>D</u> ashb	ooard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rossta	b <u>L</u> ocations	<u>T</u> ools <u>W</u> indow	<u>H</u> elp				_ & ×
2012-2016 /	Nabama Integrated (Crash Data	¥	Passenger Types In	volved AND Vehicle	Defect C222 V	S 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/ 1/	1/2012 v 12/31/20	016 🧹 👔 🌖
Suppress Zero Va	lues: Rows and Co	lumns 🗸 Select	t Cells: 🔳 🗸 %	9	Colu	umn: CU Estimated S	Speed at Impact ; Ro	w: CU Contributing V	'ehicle Defect 🕢
	36 to 40 MPH	41 to 45 MPH	46 to 50 MPH	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH	76 to 80 MPH
Brakes	299	327	131	133	51	40	49	12	3
Steering	70	109	48	73	28	35	39	6	2
E Tire Blowout/Separatio	89	197	117	295	194	384	745	82	31
E Improper Tread Depth	102	170	106	200	103	131	114	17	9
Wheels	39	58	55	74	38	42	68	3	1
E Wipers	4	2	1	3	1	1	1	0	0
Windows/Windshi eld	8	7	2	2	1	2	2	0	0
E Mirrors	4	5	0	0	0	2	2	0	0
Trailer Hitch/Coupling	27	22	10	17	9	16	11	0	0
Power Train	21	37	13	33	15	26	37	0	1
Fuel System	6	12	3	4	2	3	14	0	1
Exhaust	0	0	0	0	0	0	0	0	0
E Headlights	7	13	1	4	3	4	1	0	0
E Tail Lights	4	4	6	4	3	3	1	1	0
Turn Signal	2	0	0	1	0	1	0	0	0
Suspension	11	15	11	15	8	13	6	0	0
E Cruise Control	0	1	1	1	2	1	2	0	0
E Body/Doors	2	7	2	7	3	5	7	0	0
P Tires*	14	8	8	1	12	5	1	1	0
P Lights*	0	0	0	0	0	0	0	0	0
P Restraint System	0	0	0	0	0	0	0	0	0
P Cargo	1	0	3	0	2	1	0	0	0
TOTAL	710	994	518	867	475	715	1100	122	48
<									>

3.7 C025 Crash Severity



The severities of vehicle defect crashes are not nearly as reduced (comparatively speaking) with the passenger car subset as they were with large trucks. The difference in Fatal Injury is not statistically significant, and the increases in both Incapacitating and Non-Incapacitating injury types are significantly higher in proportion than what is expected from the non-vehicle-defect group. To analyze this attribute further, a cross-tabulation was run that analyzed the various severity levels by the vehicle defect type, as given below.

ile <u>D</u> ashbo	oard Filters	<u>A</u> nalysis <u>C</u> rossta	b Locations T	ools Window	Help		
2012-2016 A	abama Integrated (v		volved AND Vehicle D	lefect C222 V	9 10 1/ 1
							3
ess Zero Vali	es: Rows and Col		·	9		Column: Crash S	everity ; Row: CU C
	Fatal Injury	Incapacitating Injury	Non- Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
rakes	9	172	409	636	4353	185	5764
	13.24%	25.44%	31.95%	51.96%	42.16%	52.86%	41.40%
eering	1 1.47%	49 7.25%	107 8.36%	97 7.92%	689 6.67%	35 10.00%	978 7.02%
Tire	24	175	349	194	2244	48	3034
t/Separatio	35.29%	25.89%	27.27%	15.85%	21.73%	13.71%	21.79%
oper Tread	28	175	202	144	997	15	1561
Depth	41.18%	25.89%	15.78%	11.76%	9.66%	4.29%	11.21%
Annala	2	19	63	51	599	23	757
/heels	2.94%	2.81%	4.92%	4.17%	5.80%	6.57%	5.44%
Wipers	0	2	4	8	33	3	50
wipers	0.00%	0.30%	0.31%	0.65%	0.32%	0.86%	0.36%
ws/Windshi	1	7	15	9	109	6	147
eld	1.47%	1.04%	1.17%	0.74%	1.06%	1.71%	1.06%
Mirrors	0	0	3	4	48	1	56
	0.00%	0.00%	0.23%	0.33%	0.46%	0.29%	0.40%
railer /Coupling	1	7	13	12 0.98%	230 2.23%	1 0.29%	264
	0	13	33	26	425	5	502
ver Train	0.00%	1.92%	2.58%	2.12%	4.12%	1.43%	3.61%
	1	4	9	2	109	4	129
System	1.47%	0.59%	0.70%	0.16%	1.06%	1.14%	0.93%
	0	0	0	0	5	0	5
khaust	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.04%
adlights	0	12	12	11	58	5	98
saunginta	0.00%	1.78%	0.94%	0.90%	0.56%	1.43%	0.70%
ail Lights	1	16	22	8	78	4	129
	1.47%	2.37%	1.72%	0.65%	0.76%	1.14%	0.93%
n Signal	0	0.15%	8 0.63%	1 0.08%	41	2 0.57%	53 0.38%
	0.00%	0.15%	0.63%	9	0.40%	4	0.38%
pension	0.00%	0.30%	1.25%	0.74%	1.18%	4	1.10%
	0.00%	3	2	0.74%	8	2	15
se Control	0.00%	0.44%	0.16%	0.00%	0.08%	0.57%	0.11%
1./D	0	3	9	5	56	7	80
dy/Doors	0.00%	0.44%	0.70%	0.41%	0.54%	2.00%	0.57%
Tires*	0	15	4	7	100	0	126
mes	0.00%	2.22%	0.31%	0.57%	0.97%	0.00%	0.90%
Lights*	0	1	0	0	6	0	7
-	0.00%	0.15%	0.00%	0.00%	0.06%	0.00%	0.05%
estraint	0	0	0	0	3	0	3
ystem	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.02%
Cargo	0	0.00%	0.00%	0	12	0.00%	12 0.09%
	68	676	1280	0.00%	0.12% 10325	350	13923
OTAL -							

Clearly tire issues are the major factors for both severe injury and deaths. The two tire defects are quite different in the way that they cause crashes. Tire Blowout/Separation is quite intuitive in the way it would cause a loss of control. Improper Tread Depth, however, would usually have other contributing factors, such as a wet road surface, speed, or both to result in the loss of control. Comparing these two, while there are about twice as many Tire Blowout/Separations, the proportion of the most severe injury and fatal crashes are nearly identical. No doubt, tire issues rise to the top concern of passenger car crashes. Brake defects are a distant second priority, albeit with a much higher overall frequency (5,764 for brakes as compared to the tire issues of 3,934 for blowouts and 1,561 for tread depth).

3.8 C208 CU Model Year

C 2012/2016 Addoms Heighted Gash Das Peersone Types Invived AND Whole Dete (C22 V 12 1/1/2012 1/2012/016 Order Max Gan Descending Suppres Zero-Valued Rows Special Reveal	CAF	RE 10.1.0.19) - [IMP/	ACT Results	- 2012-20	16 Alabar	na Integra	ted Crash	Data - Passe	enger Types	s Inv — 🗖	x
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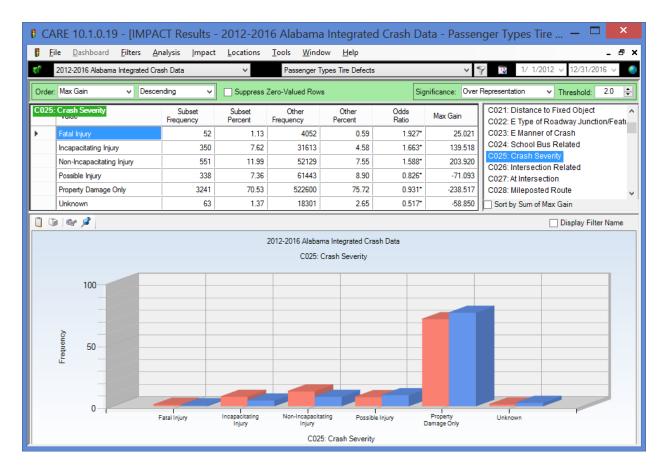
The significant over-represented model years are from 1982 through 2002. It is reasonable to expect that older vehicles would have more problems in this regard.

3.8 Passenger Vehicle Tire Issues Further Analysis

The single vehicle defect highest killer was in tire issues. Over five years there were 3,034 crashes caused by blowouts/tire separation, and 1,561 crashes caused by tread depth issues over the five years of the study (4,595 total for tire issues). While the cross-tabulation in Section 3.7 indicates that tread depth was a slightly higher cause of death with 28, as opposed to blowouts, which has 24, there is no implication that the difference between these two numbers is statistically significant. The 52 tire defect fatal crashes resulted in a total of 60 fatalities (12 fatalities per year).

These two tire issues account for almost 80% of the fatalities, and the next highest (brakes) had only about 13%, with the remaining being distributed one-each among the other attribute values. It is clear that tire issues are head and shoulders over all other vehicle defect issues when it comes to passenger car fatalities.

This being the case, a subset was formed of the 4,595 defective tire cases in an effort to flush out the demographics and focus in on the source of these problems. The following gives a summary by severity as compared to all other crashes that occurred in the five year period.

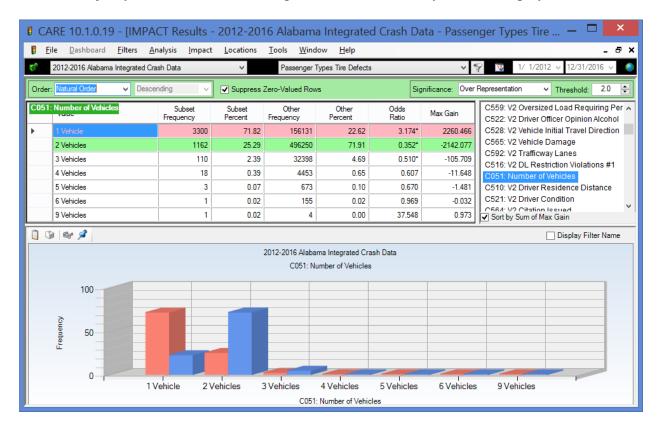


Notice that the proportion of Fatal Injury for these crashes is close to double what it is for all other crashes. The two highest injury categories are also over-represented by about 60% higher than expectation (58.8% and 66.3%). Thus, we can conclude that these are not minor problems, and something should probably be done to address them, if nothing other than a PSA.

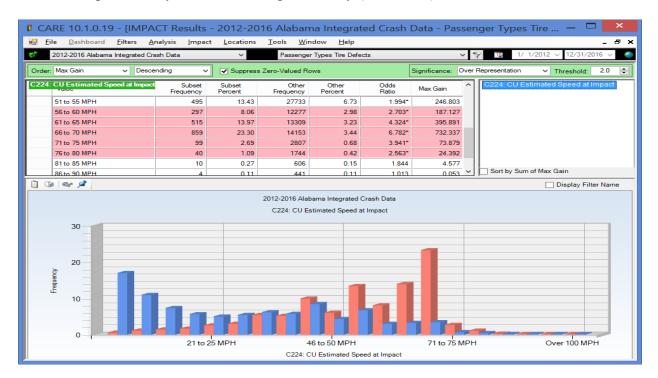
The following comparison for Primary Contributing Circumstances indicates that tire problems are usually coupled with speed in order to create the crash problem.

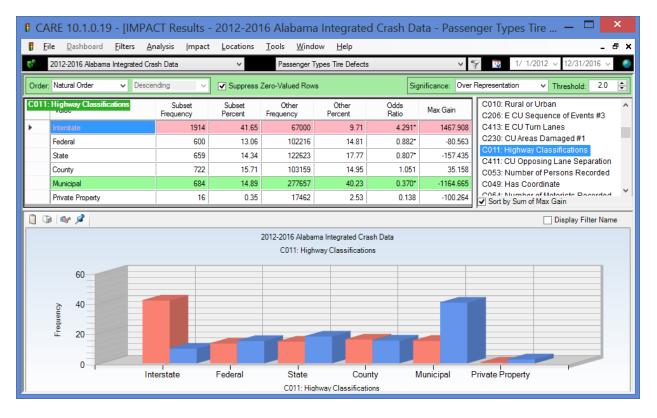
CA	RE 10.1.0.19 - [IMPAC] e Dashboard Filters Anal		2012-201 Locations	16 Alabam Tools Wind	-	ed Crash [Data - Passer	nger Types Tire 🗕 🗖 🗙
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Order:	Max Gain 🗸 Descendi	ing v	Suppress	Zero-Valued Rov	vs		Significance: Over	Representation V Threshold: 2.0
C015:	Primary Contributing Circumstanc	Content Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 🔻 ^	C222: CU Contributing Vehicle Defect C015: Primary Contributing Circumstand
▶	Defective Equipment	2667	58.04	9047	1.31	44.276*	2606.764	C202: CU Contributing Circumstance
	Driving too Fast for Conditions	637	13.86	25063	3.63	3.817*	470.128	C204: E CU Sequence of Events #1 C017: First Harmful Event
	E Over Correcting/Over Steering	132	2.87	5996	0.87	3.306*	92.078	C201: CU Vehicle Most Harmful Event
	E Other - No Improper Driving	115	2.50	7999	1.16	2.159*	61.742	C019: E Most Harmful Event
	Over Speed Limit	135	2.94	11167	1.62	1.816*	60.649	C541: V2 Vehicle Most Harmful Event 🗸
	E Ran off Road	147	3.20	15595	2.26	1.416*	43.167 🗸	Sort by Sum of Max Gain
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The vast majority of these crashes are single vehicle, as shown by the next display.



Impact speed for these crashes is relatively high, further reinforcing the speed cofactor, and as would be expected, they occur more in open country (rural areas).





County roads are about as expected perhaps because it is difficult to travel these roads at too high a rate of speed. Federal and State roads are under-represented in favor of Interstates.

The causal unit model year follows about the same as given above, with the older vehicles (up to 2004 for this subset) being over-represented. Driver ages that are over-represented are those from 18-30 years if age. Wet roadways have about twice their expected number of crashes (we suspect that further analysis will show this coming from the low tread tires as opposed to the blowouts). Males are over-represented by about 24% higher proportion than expected. While day of the week is close to the DUI pattern (over-representations on weekend days), the time of day favors the two or three hours before the typical rush hours.

4.0 Discussion on Potential Inspection System for Alabama

Most of the promotion of vehicle inspection systems within the states has been conducted in isolation. If you consider the loss of one life and multiply it over the five year death toll of 68 fatal crashes (about 14 per year), the cost of implementing a vehicle inspection system is indeed costbeneficial. What is not considered, however, is the downside of such an expenditure. Please see general considerations for traffic safety investments that is given here in the left panel under the title of "Optimal Traffic Safety Allocation" linked to here:

http://www.safehomealabama.gov/SafetyTopics/GeneralTrafficSafety.aspx

The failure is one of not seeing the effect that saving these 14 lives per year is going to have on failing to save even more of the average of 895 fatalities per year over the last five years. Advocates (in all areas) often fail to see the downside of their actions, and as a result, traffic safety resources will not produce the maximum savings of fatalities. Most traffic safety countermeasures have several downsides, but one that is always present is the zero sum game of the total safety budget, which any given program must deplete.

So, for example, if a given countermeasure costs \$100,000 per year (for example) these dollars will have to come from other traffic safety programs. It is not a matter of going to the general fund; and even if it were, the same argument could be made, that this \$100k should go to a countermeasure that has a higher benefit to cost ratio.

The cost of most countermeasures is fairly easy to obtain; however, the benefits that any one of them will produce is highly speculative, and we must turn to the traffic safety professionals to estimate these benefits. There are a number of resources to this effect available from NHTSA (e.g., *Countermeasure that Work;* <u>https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812239_countermeasures_8thed_tt.pdf</u>).

Few studies of effectiveness have been performed for vehicle inspection systems for a variety of reasons. But the major issue is in isolating the number of crashes that will be reduced by implementing the program. "The program" itself is not at all defined, since there are variations in every state that has implemented a program. So it is impossible to aggregate the results.

Please review the findings above. Recognize that large truck inspections are handled already by FMCSA mandates. In essence, they already have an inspection system. So, we are mainly talking about the second half of the findings given above – those for passenger cars. The major problem with passenger cars was found to be tires. Further analyses can and should be done if programs to address this problem are to be developed. This can easily generate the target groups and the demographics that should be employed to develop the most effective program.

The big question that must be answered: is a full scale inspection system necessary to deal with the issue of car tires. Could one be developed that just concentrated on these issues and perhaps the third item, which was brakes? Would a PI&E program be just as (perhaps more) effective, but at a fraction of the cost? Could tire providers be involved in not repairing tires that are prone to be defective?

We are not prepared to answer these questions at this point; we feel that raising them is sufficient to getting decision-makers thinking in the right direction. We urge decision-makers to consider how many lives might be saved if the cost of implementing an inspection program were to be invested in other more cost-effective countermeasures. We stand ready to provide additional information to help them if they feel that such an effort would be warranted.

For more information on this subject from NHTSA and other sources, please see: <u>http://www.safehomealabama.gov/tag/defects-recalls/</u>