Panel 2: Engineering Realities
Structural Crashworthiness,
Occupant Injury and Advanced Vehicle Design

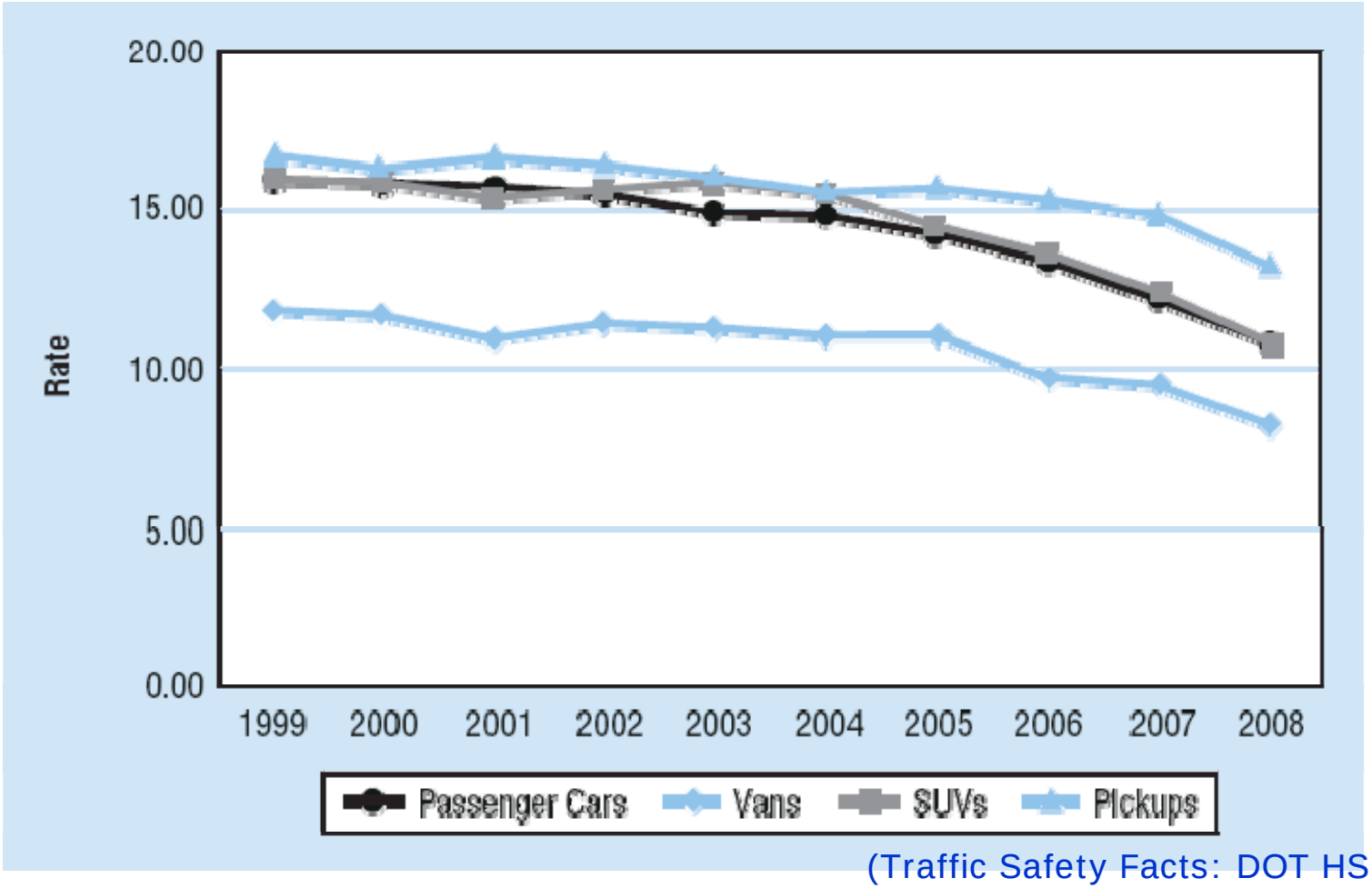
Honda's Thinking About Size, Weight and Safety

Fatality Rates
Weight Reduction & Downsizing
Compatibility Issues
Unnecessary Testing Increases Weight

Honda R&D
Koichi Kamiji
Senior Chief Engineer
2011.2.25

Occupant Fatality Rate Are Declining

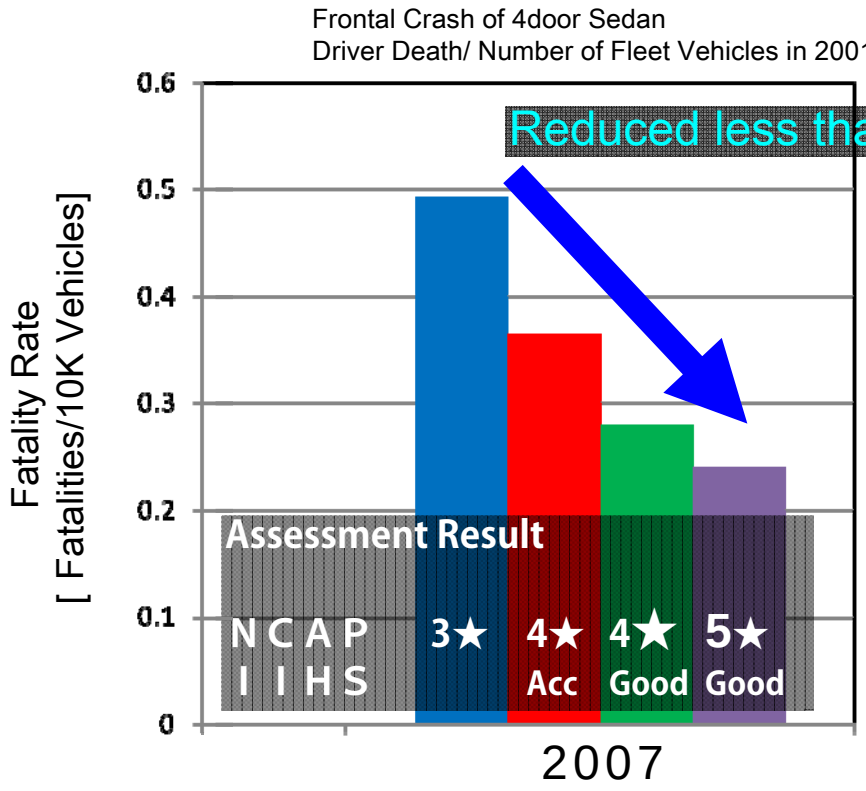
Passenger Vehicle Occupant Fatality Rate per 100,000 Registered Vehicles, by Type of Vehicle and Year, 1999–2008



(Traffic Safety Facts: DOT HS 811 368)

Crashworthiness Improvements and Fatality Rates

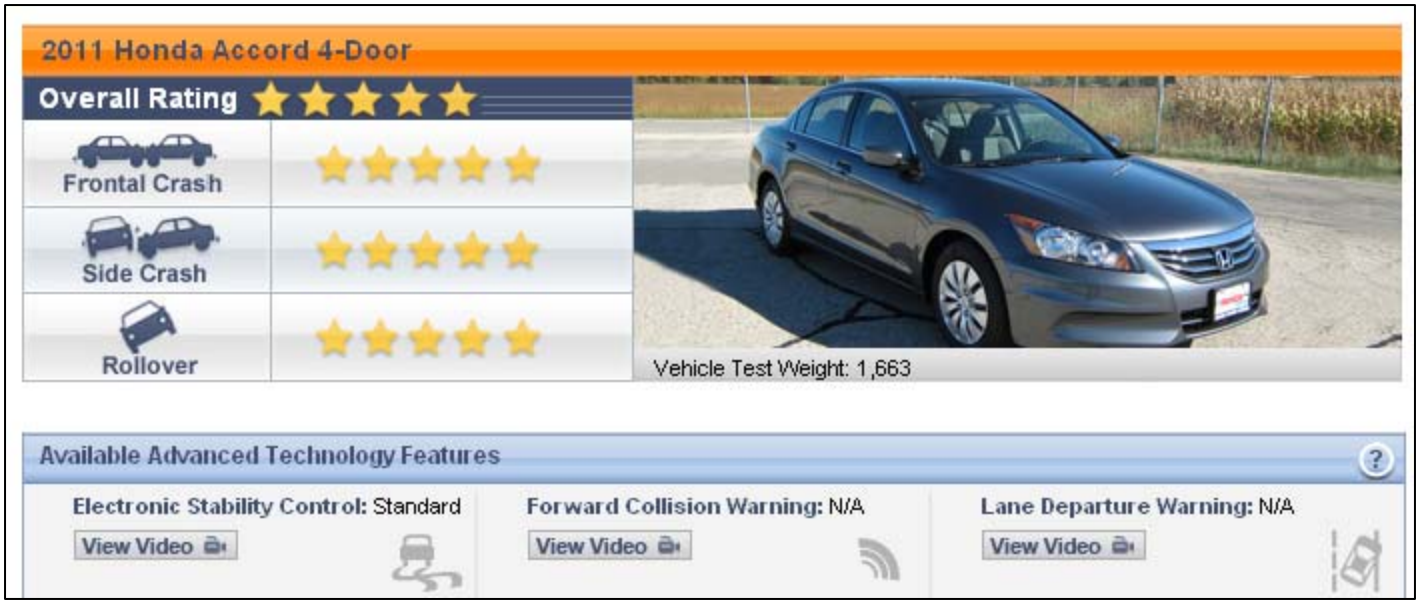
NCAP/IIHS Rating and Fatality Rate



	NCAP	IIHS	Models
■	3★	-	92-95 Civic 93-97 Corolla
■	4★	A	94-97 Accord,98-02 Accord 96-00 Civic 92-96 Camry 98-02 Corolla
■	4★	G	97-01 Camry
■	5★	G	03-07 Accord 01-05 Civic 02-06 Camry 03-07 Corolla

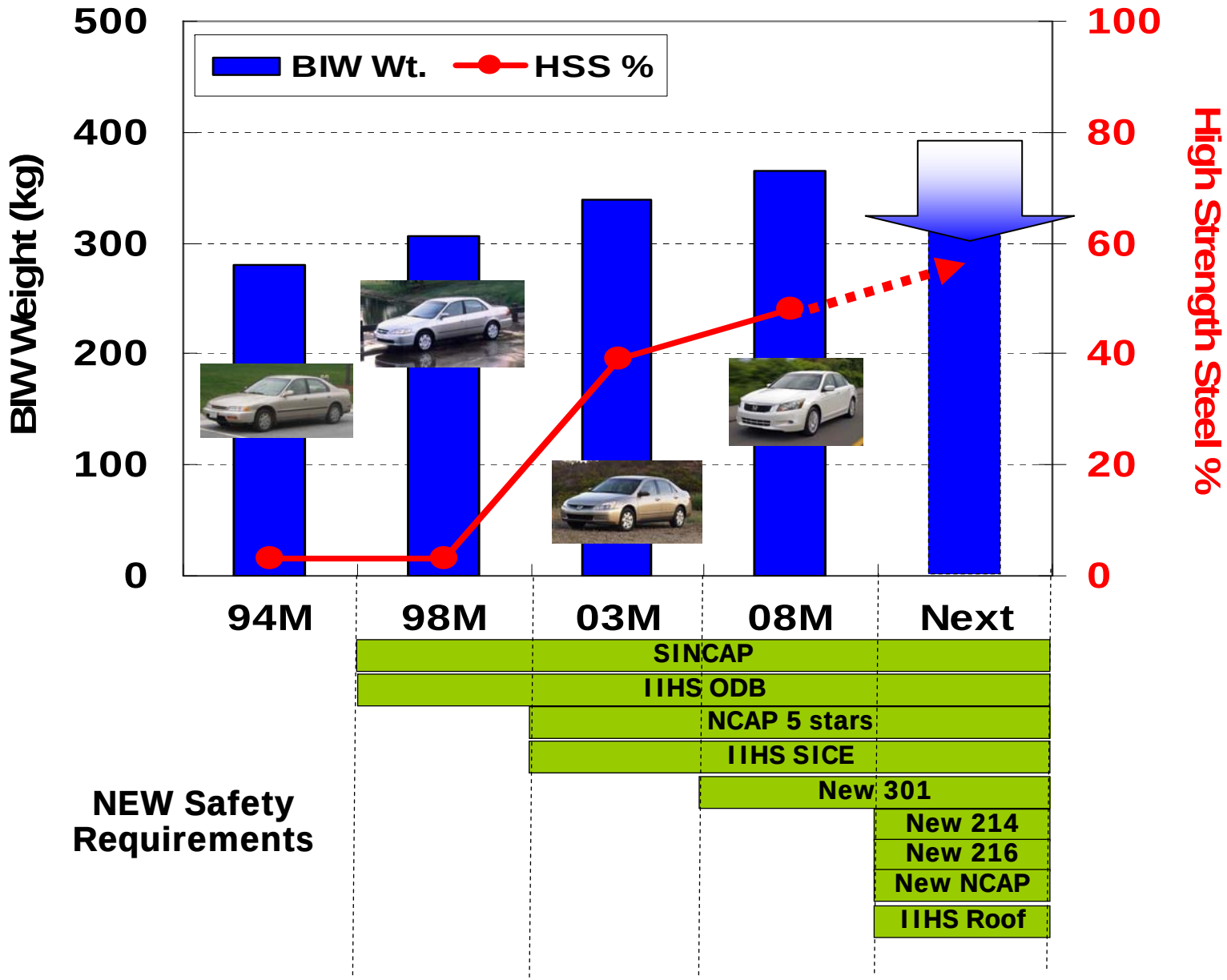
Better Crashworthiness leads to lower fatality rates

Enhanced Safety Performance

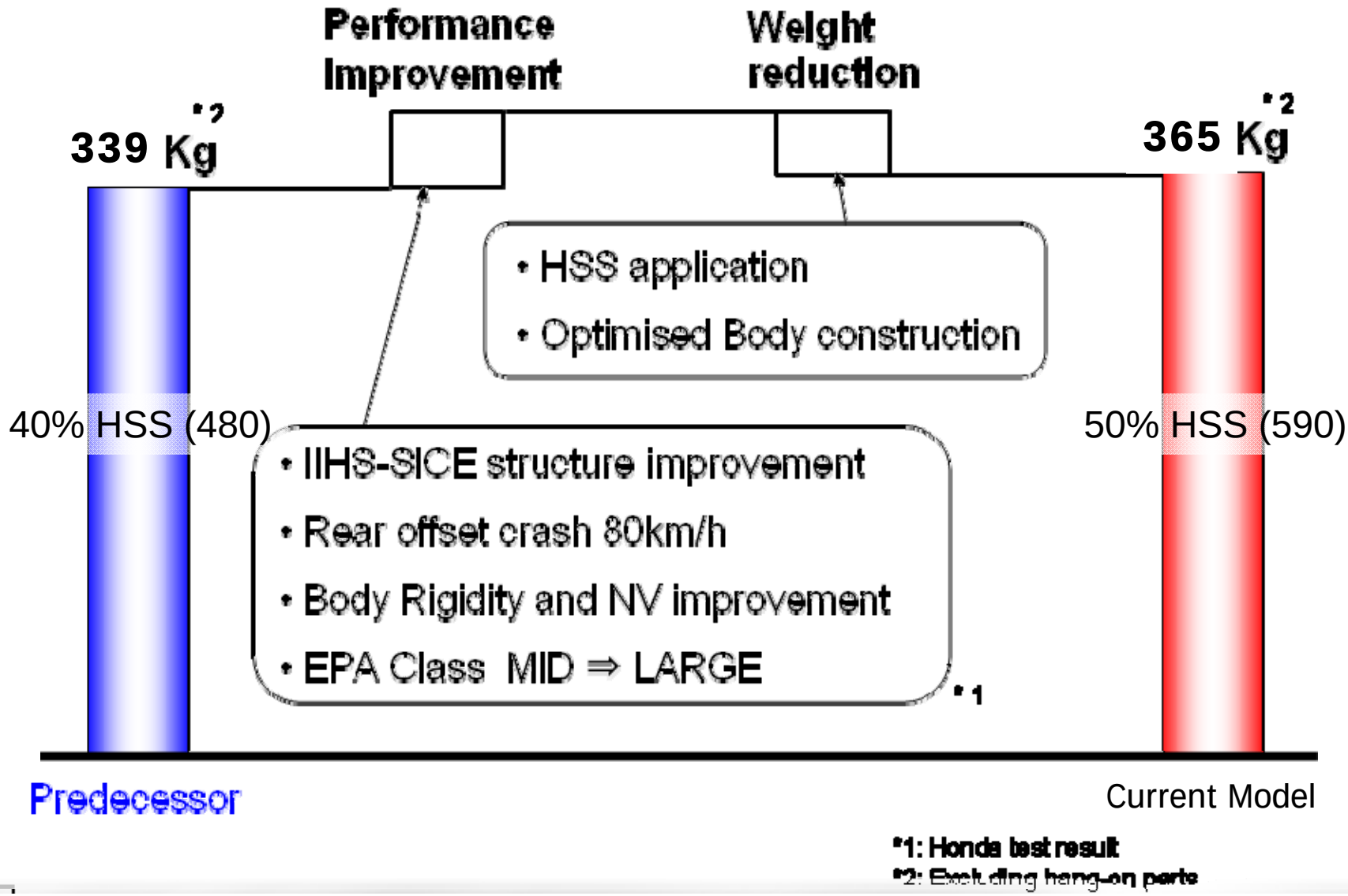


New safety requirements will emphasize this trend, and crash avoidance technologies (e.g. crash mitigation brake) are getting popular.

Honda Accord BIW Weight History

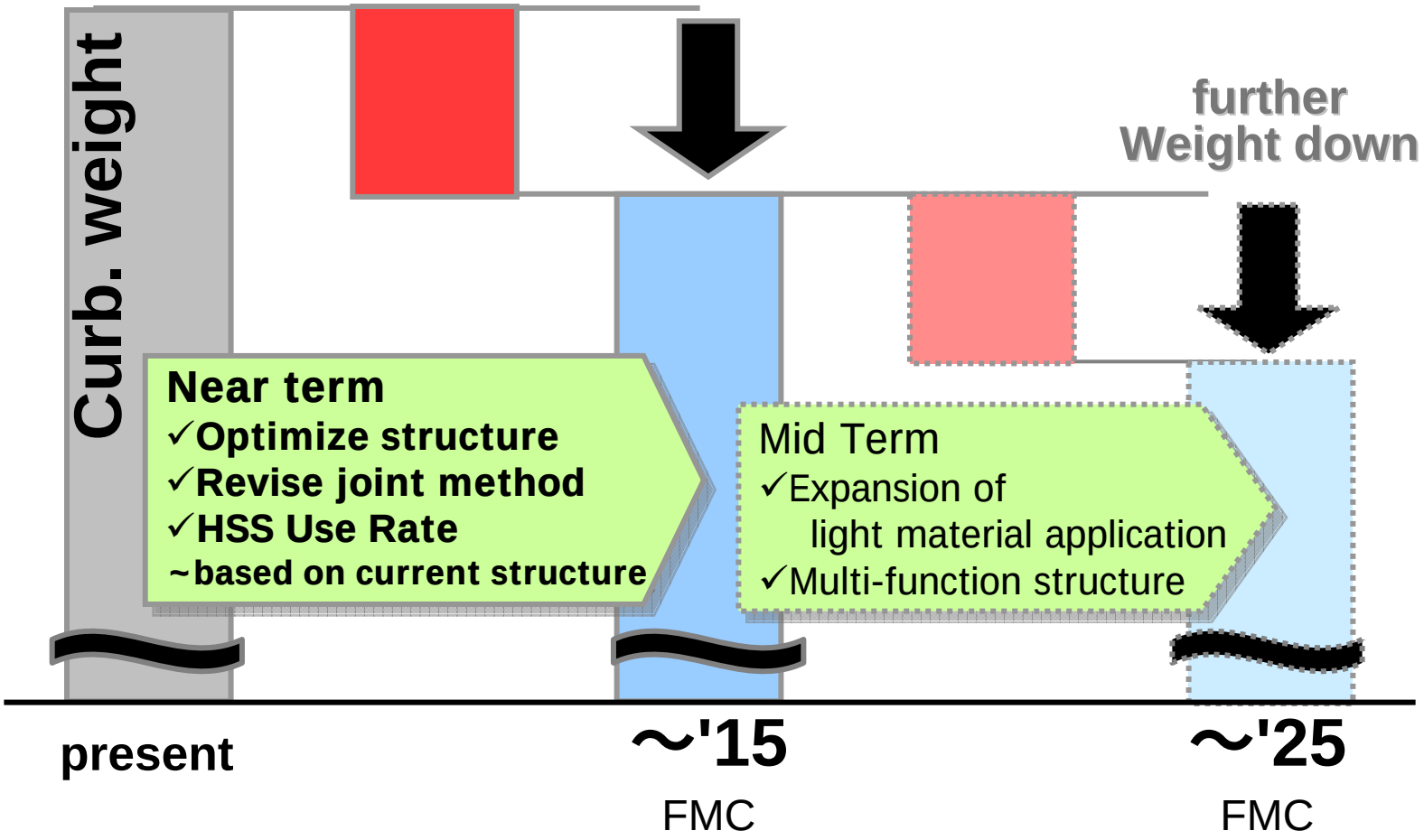


Honda Accord BIW Weight



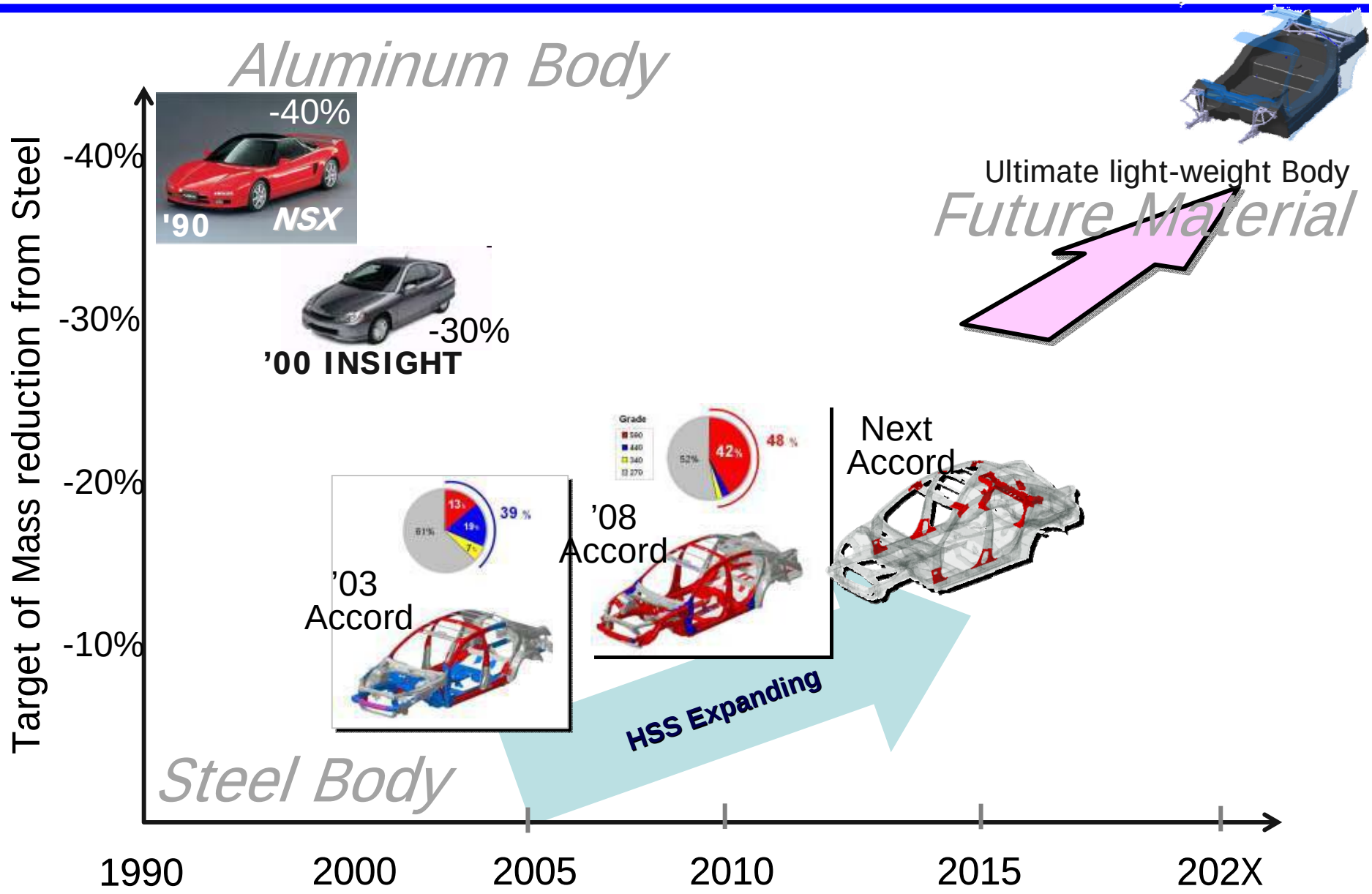
Target of Weight Reduction※

in case of mid-size vehicle



※Require the countermeasure for performance, cost, etc.

Technology Direction of BIW



Down Sizing can reduced fuel consumption

Customer Role:

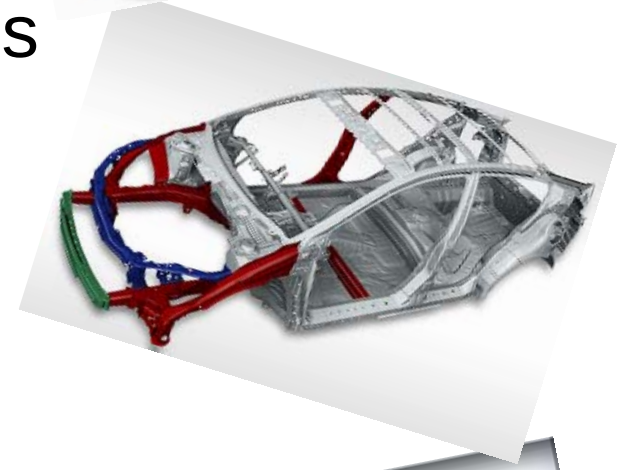
- Consider smaller vehicles

Regulatory Role:

- Do not discourage smaller vehicles

OEM Role:

- Make attractive small vehicles:
  - Advanced Safety
  - Fun-to-drive
  - Functional
  - More fuel efficient
    → Downsizing can reduce CO2 by ~20%



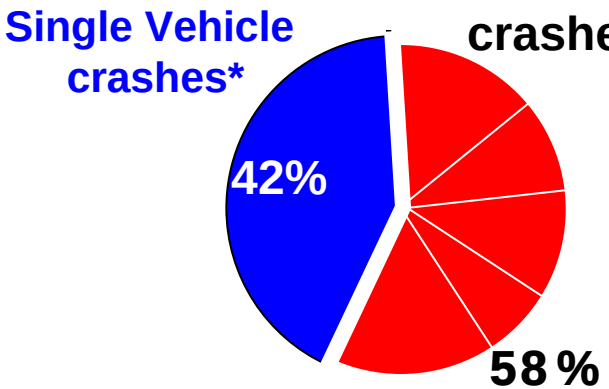
Consumer Downsizing Examples

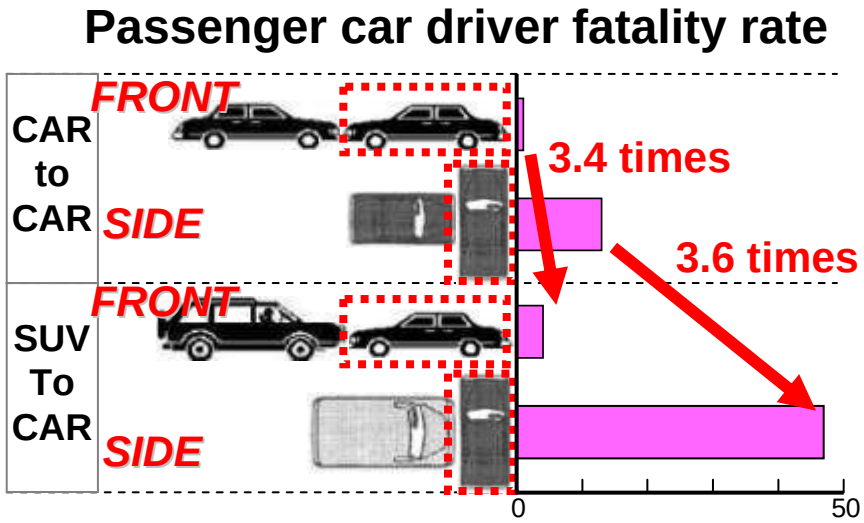
Downsize	Example	FE	GHG	Savings
Car to Car	Accord L4	32.6	273	
	Civic	39.3	226	-17%
Truck to Truck	Pilot 4WD	23.6	377	
	CR-V 4WD	30.5	291	-23%
Truck to Car	Pilot 2WD	23.6	377	
	Accord V6	29.4	302	-20%
Truck to Car	CR-V 2WD	31.2	285	
	Civic	39.3	226	-21%

Downsizing is a major consumer response to high fuel prices… This also results in reduced vehicle mass and potential compatibility concerns

Vehicle Compatibility Challenges

Mass reduction is clearly a benefit for 42% of all fatal crashes because absolute energy is reduced.

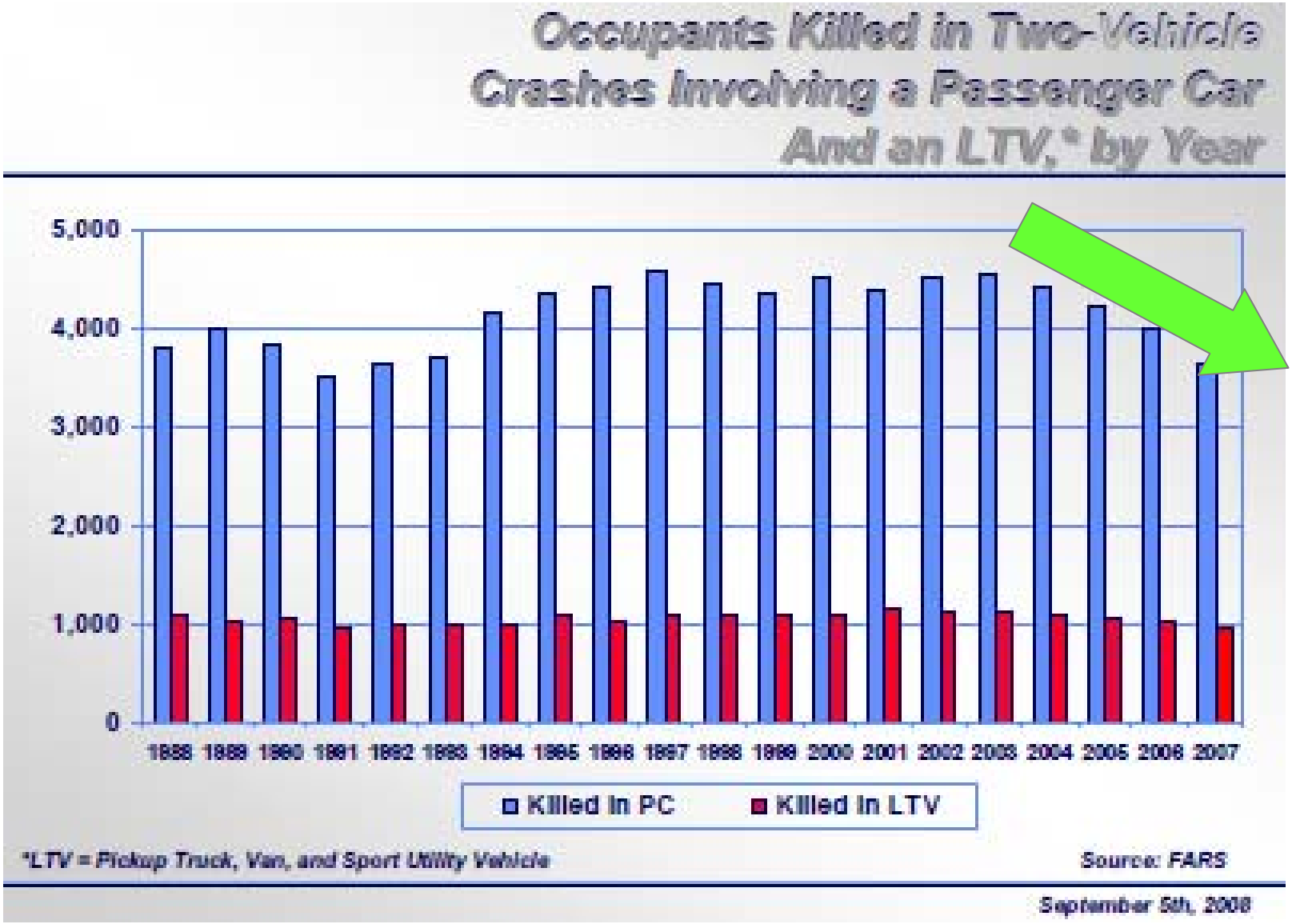




Vehicle compatibility (e.g. Car to SUV) represents a key opportunity to reduce fatalities

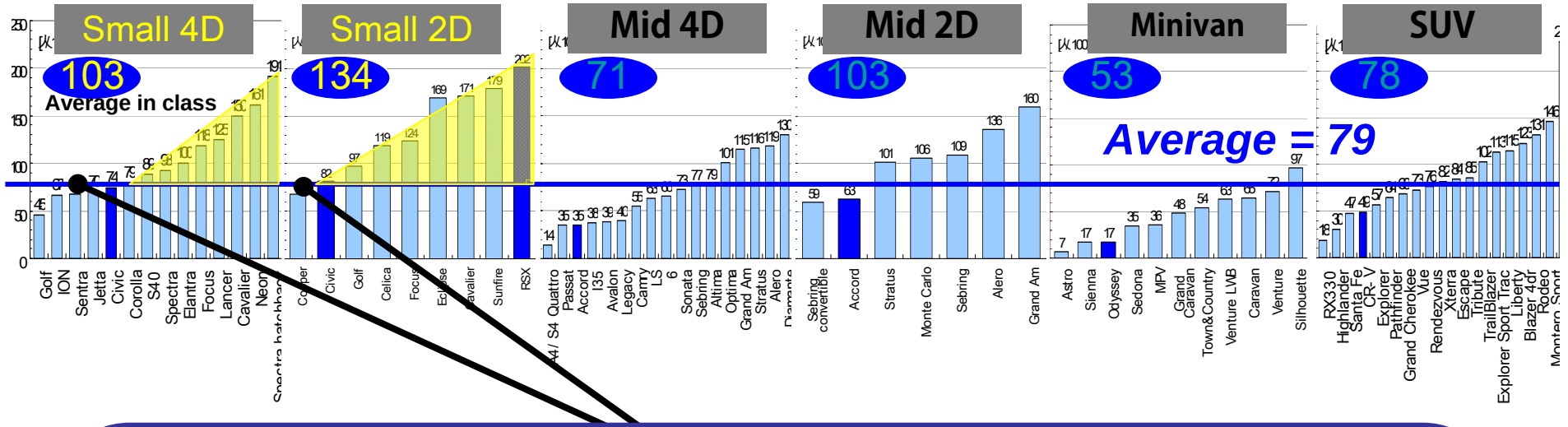
*** Distribution of Car Occupant Deaths 1999-2002 models during 2000-01**

Fatality Trend for Compatibility is Improving



Fatality Rate by Segment & Model

Fatality Rate [Persons /1mil. Vehicles]
2000-2004



Technologies exist to make small cars safe!

Compatibility Discussion Overview

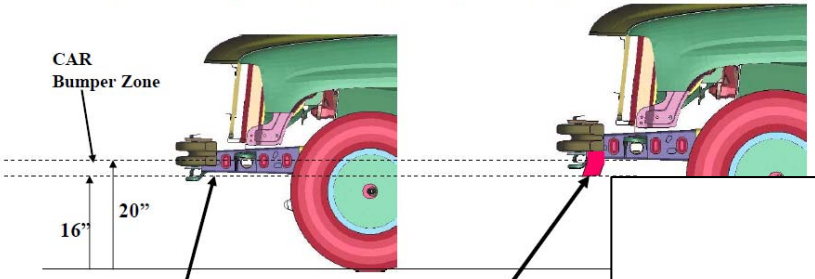
- **We learned compatibility issues from *real world* accidents and crash test studies**

Issue
Override / Underride
Horizontal Misalignment
Fork Effect
Stiffness Mismatch

Current Industry/NHTSA MOU for Compatibility

Phase 1 Recommendation of EVC TWG

- *Adopted in December 2003 as voluntary industry commitment - all vehicles sold on or after September 1, 2009.*
- *Criteria for geometrical compatibility*



At least, 50% of primary structure must be in FMVSS581 Zone and 50% of the zone be covered by the primary structure

OR

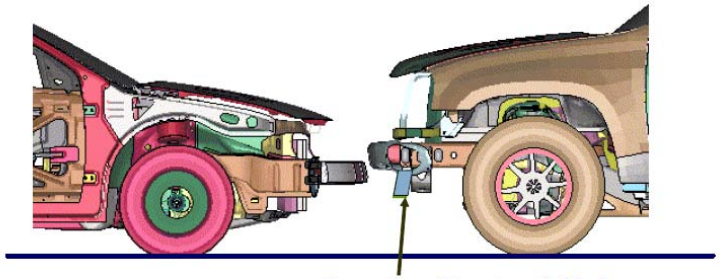
Secondar be added reduce ov passenger

Page 5

Phase 2 Recommendation of EVC TWG

- *Adopted in November 2005 as voluntary industry commitment*
- *Performance criteria for effective secondary structures*

"Effectiveness is measured by reduced intrusion in the car when a Secondary EA structure (SEAS) is added to the LTV."



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Compatibility Discussion Overview

- **We learned compatibility issues from *real world* accidents and crash test studies**

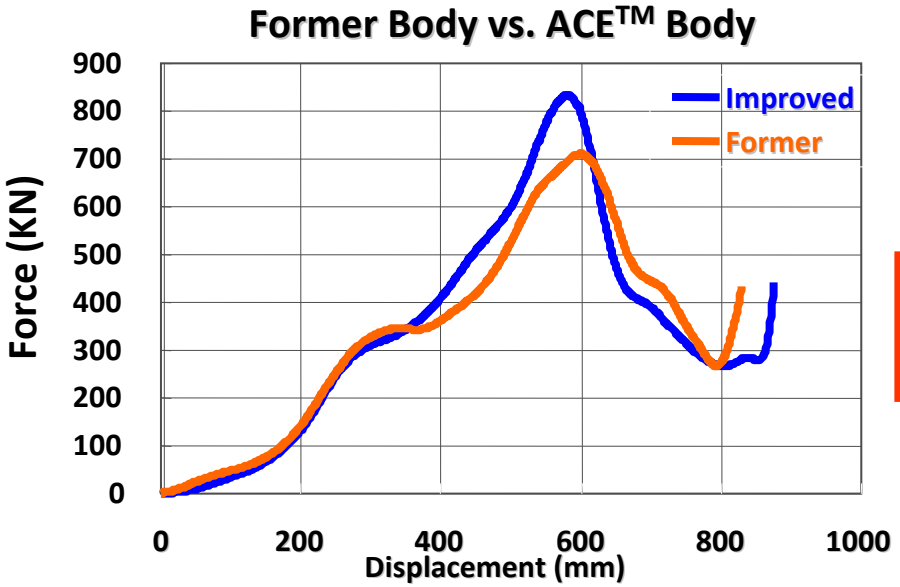
Issue	Industry
Override / Underride	MOU
Horizontal Misalignment	
Fork Effect	
Stiffness Mismatch	

Compatibility Discussion Overview

- **We learned compatibility issues from *real world* accidents and crash test studies**

Issue	Industry	Honda
Override / Underride	MOU	ACE
Horizontal Misalignment		ACE
Fork Effect		ACE
Stiffness Mismatch		ACE

ACE™ (Advanced Compatibility Engineering) Body Structure

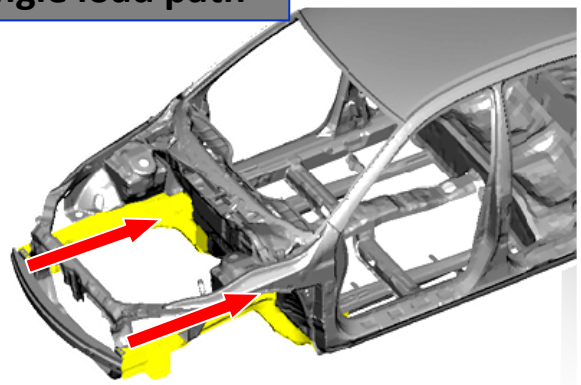


Achieving Highly Efficient Energy Absorption

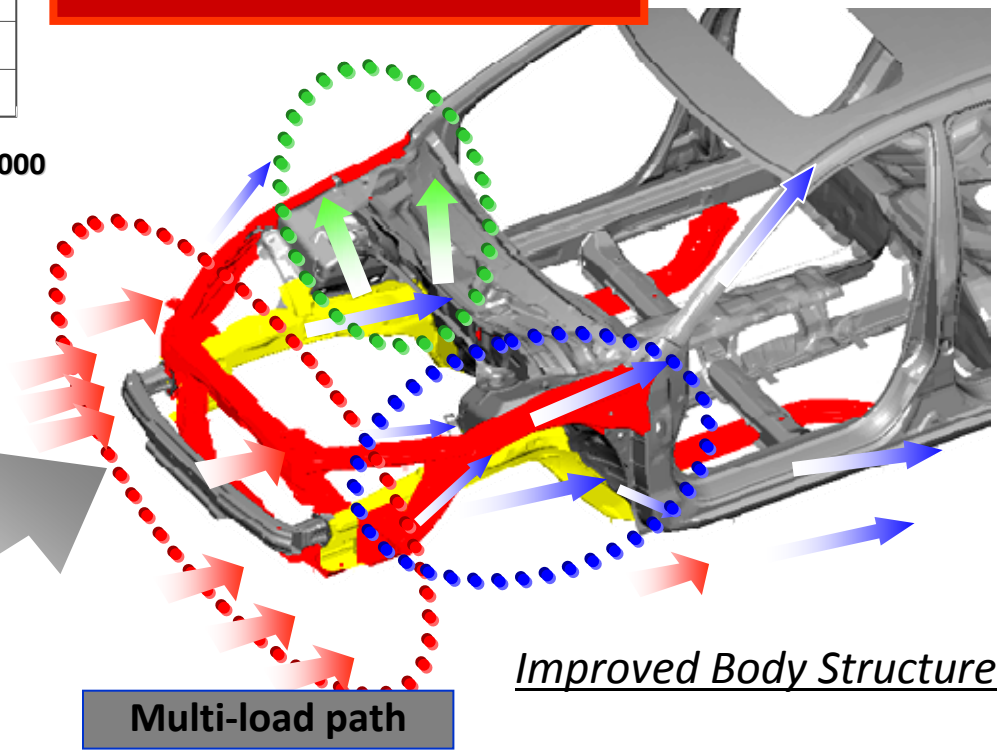
Load Dispersion

Preventing Misalignment with other Vehicle Bodies

Single load path



Former Body Structure

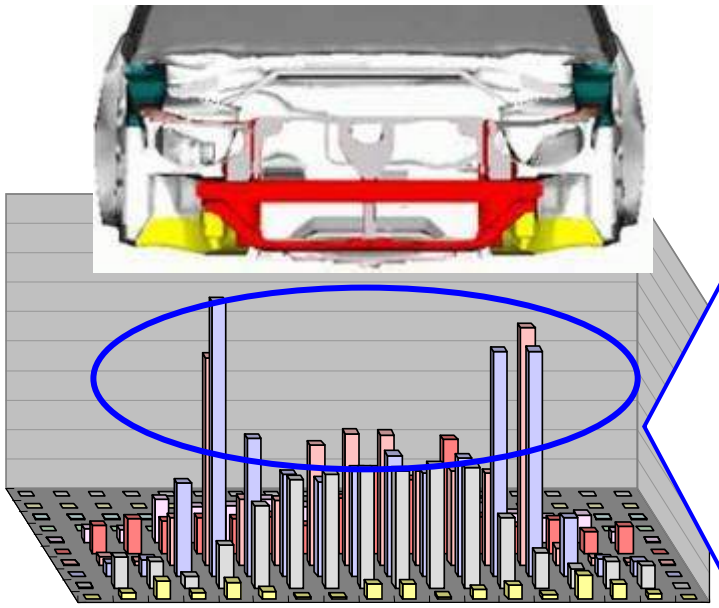


Multi-load path

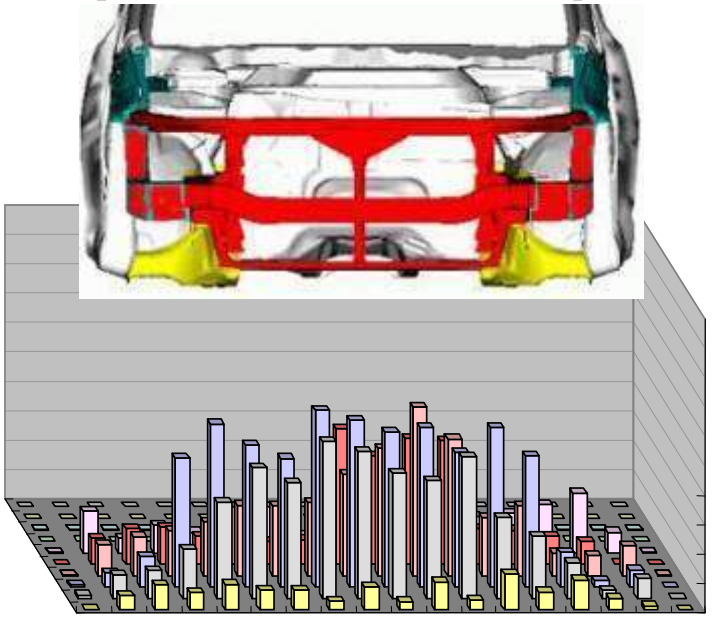
Improved Body Structure

Load Distribution of Body Structure in Frontal Collision (FWDB test)

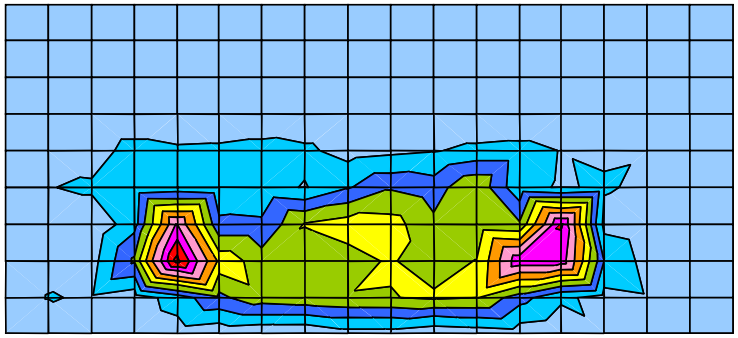
Conventional Structure

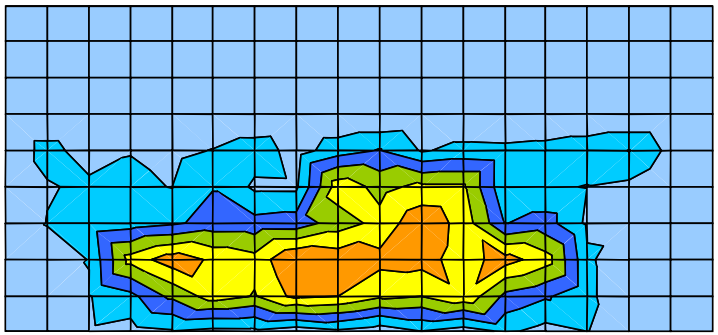


Advanced Structure (Honda's ACE™)



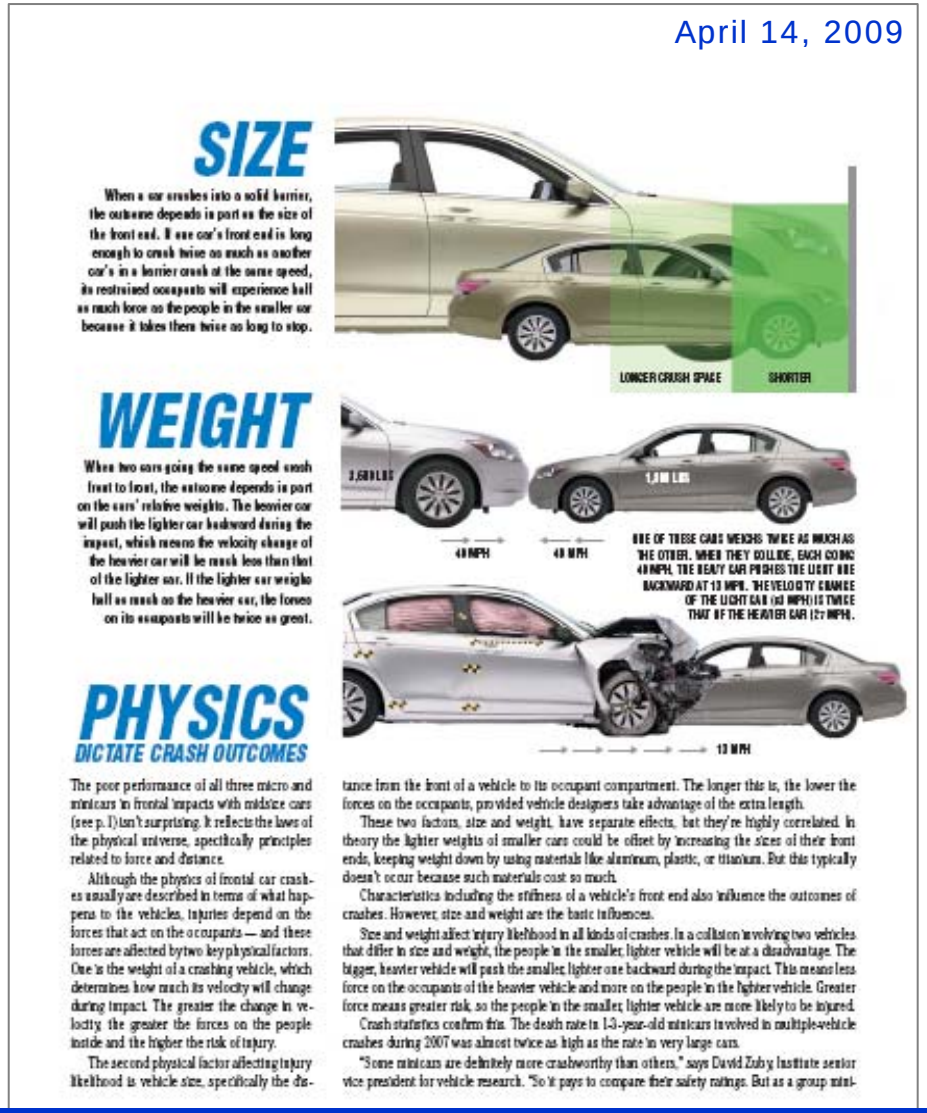
High Aggressivity from Frame Rail





Improved structure showed more homogeneous in barrier force distribution.
Peak force can be reduced to improve partner protection.

Car size and weight



Investigate quantitative evidence technically, not a hypothesis.

Crash Performance & Real World Insurance Losses

	Fit	Accord
POST TEST CABIN		
POST TEST A-PILLAR		
STRUCTURE	M	G
Personal injury protection	90	102
Medical payment	93	92
Body injury liability	84	84

	Fit	Accord
dummy dashboard		
I/P		
Head/Neck	A	G
Chest	G	G
Leg/Foot L	P	G
Leg/Foot R	P	G
Restraint	G	G
*test weight	1330kg	1630kg
*mass ratio	1:1.23	

average | worse than average | substantially worse than average

Fit performed well in the real world too.

Insurance Losses of Small Cars

2007-09 models

Size: Mini | Small | Midsize | Large | Very large

Vehicle	ALL COVERAGES	Collision	Property damage liability	Compre-hensive	Personal injury protection	Medical payment	Bodily injury liability
Chevrolet Aveo	**132**	126	114	108	173	201	146
Hyundai Accent	**129**	124	124	74	172	170	151
Kia Rio	**134**	120	131	80	177	215	159
Toyota Yaris	**124**	130	107	96	183	177	121
Toyota Yaris hatchback	—	51	—	75	—	—	—
Chevrolet Aveo	—	86	70	96	—	—	—
Honda Fit	**84**	81	67	108	90	93	84
Kia Rio	**117**	114	92	73	149	161	149

Compatibility Discussion Overview

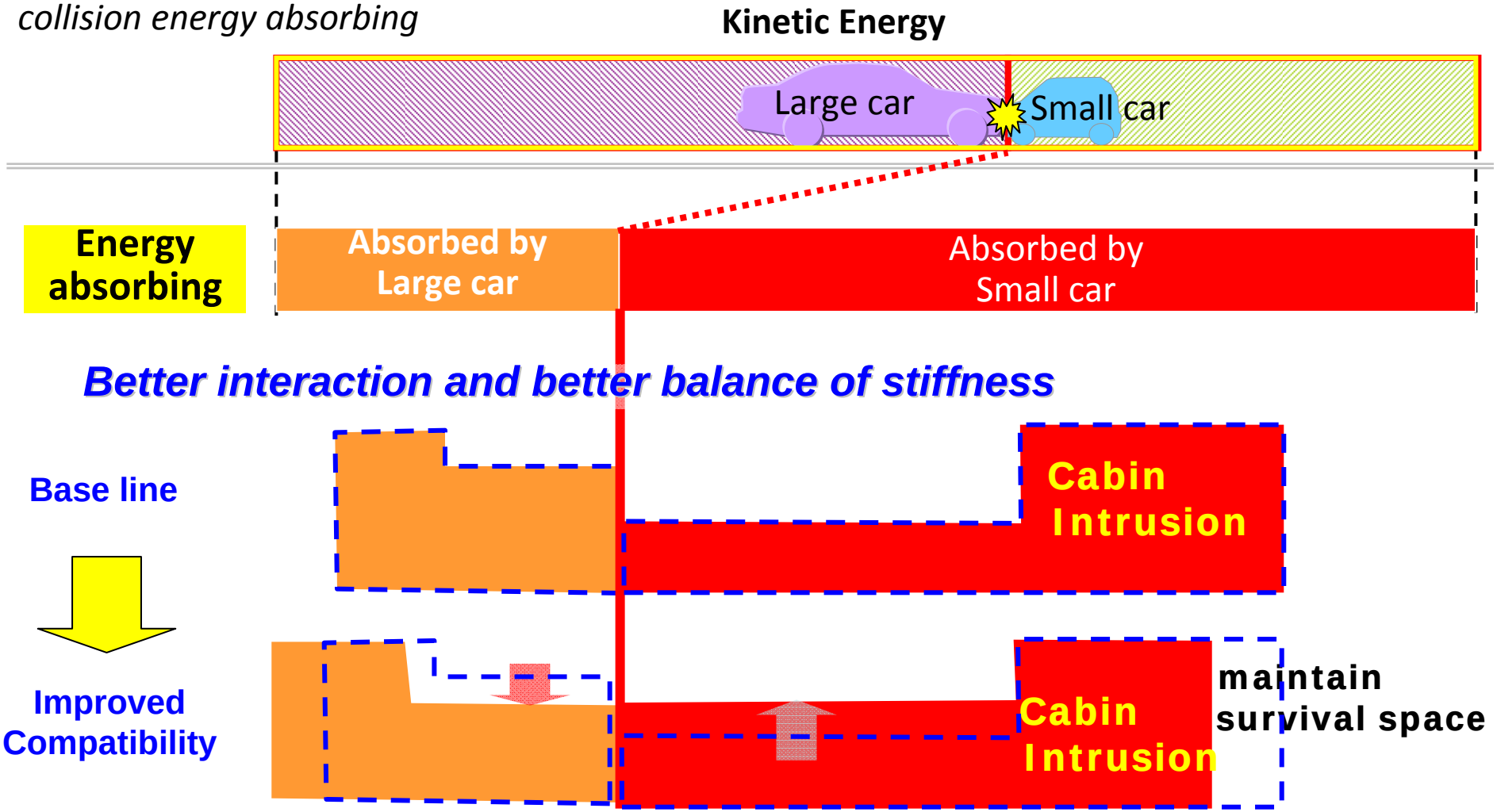
- **We learned compatibility issues from *real world* accidents and crash test studies**

Issue	Industry	Honda	Comment
Override / Underride	MOU	ACE	
Horizontal Misalignment		ACE	
Fork Effect		ACE	
Stiffness Mismatch		ACE	Need Additional Research & Industry MOU?

Weight Reduction & Vehicle Safety

Does Weight reduction also reduce vehicle safety?

Conceptual diagram of collision energy absorbing



Compatibility Test Procedure Research is Needed

Honda recommends FWDB & PDB to develop compatibility standards

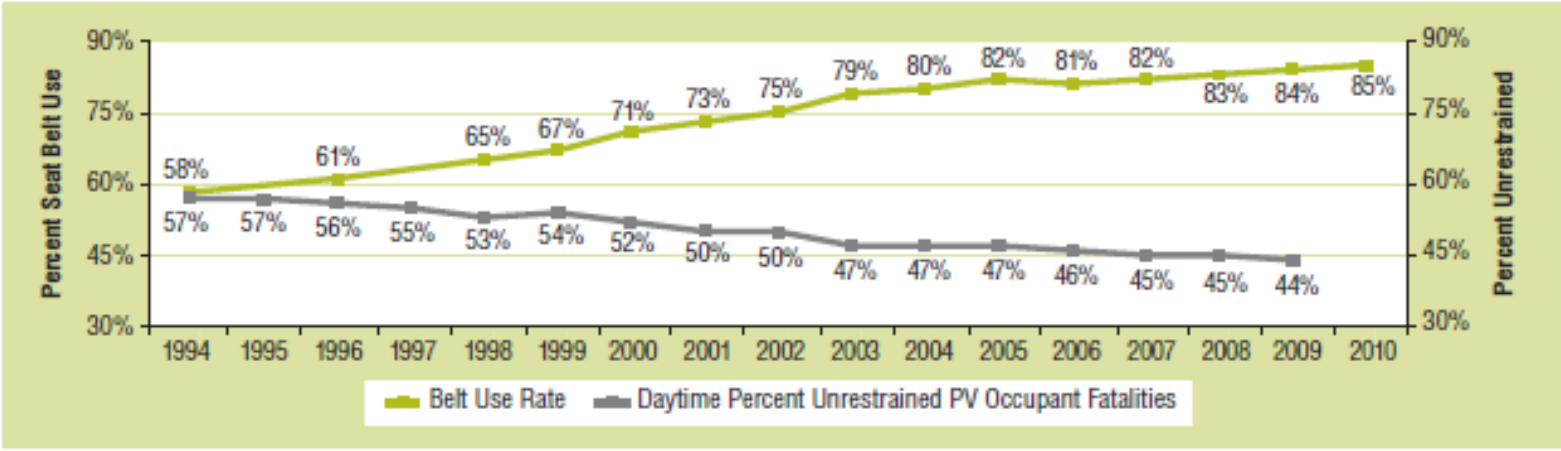
		Interaction	Stiffness Matching With Geometry		Compartment stiffness (Strength)
		With Geometry	Local	Global	
FWDB		**Good**	**Good**	**Acceptable**	**Poor**
FWRB		**Limited**	**Limited**	**Acceptable**	**Poor**
Offset	**PDB** 56-60kmh 	**Poor**	**Poor**	**Acceptable** No bottoming	**Acceptable** Severe for Small
	ODB 56-64kmh	**Poor**	**Poor**	**Poor** Bottoming	**Acceptable** Severe for Large

Unnecessary Regulations?

- Honda's Hypothesis:
  - Seatbelt usage is growing and effective
    - Seatbelt reminder is effective
    - Seatbelt laws and enforcement are effective
  - Unbelted Occupant testing requires additional vehicle length → causes increase in weight
  - Real crashworthiness is not changed
  - Can we save +20 kg on small cars?

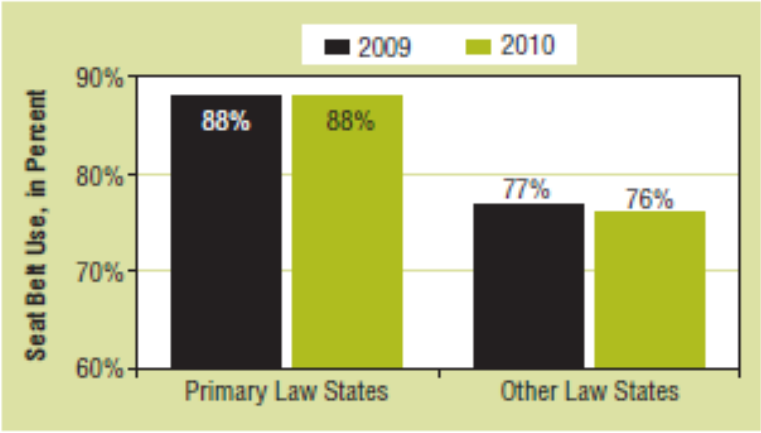
Seat Belt Use

Figure 1
NOPUS Seat Belt Use Rate and Daytime Percent of Unrestrained Passenger Vehicle Occupant Fatalities



(Source: NOPUS and FARS)

Figure 3
Seat Belt Use by Law Type (Source: NOPUS)



Potential to increase from 85% to 88% through wider acceptance of seat belt law enforcement

Effectiveness of Seat Belt Reminder

Table 3
Adjusted Driver Seat Belt Use in Passenger Vehicles With and Without Belt Reminders

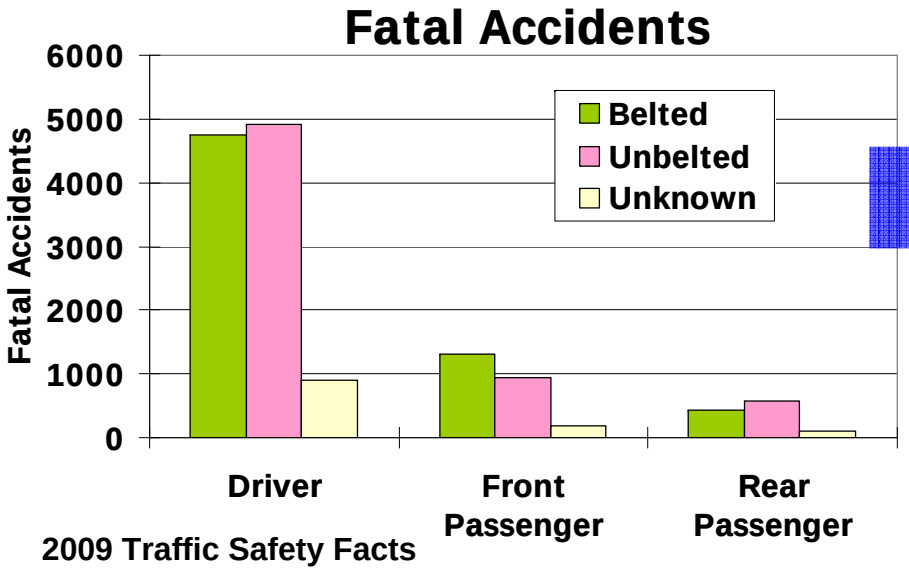
	Seat Belt Use Rates (Percent)			95 Percent Confidence Limits	
	No Reminder	Reminder	Difference	Lower Limit	Upper Limit
Vehicle type					
Car	83.6	88.1	4.5	0.0	9.1
Minivan	88.2	91.9	3.7	-3.6	11.1
Utility vehicle	82.9	92.3	9.4	3.5	15.2
Driver gender					
Male	82.5	88.3	5.8	0.9	10.7
Female	86.0	91.9	5.9	1.7	10.1
Overall	84.3	90.1	5.8	2.6	9.1

Conclusions: "Belt reminders in Honda as well as Ford vehicles are increasing. Although the increase of seatbelt use rate is moderate (5.6 percentage points), on a national level it could have prevented at least 736 driver deaths in 2004."

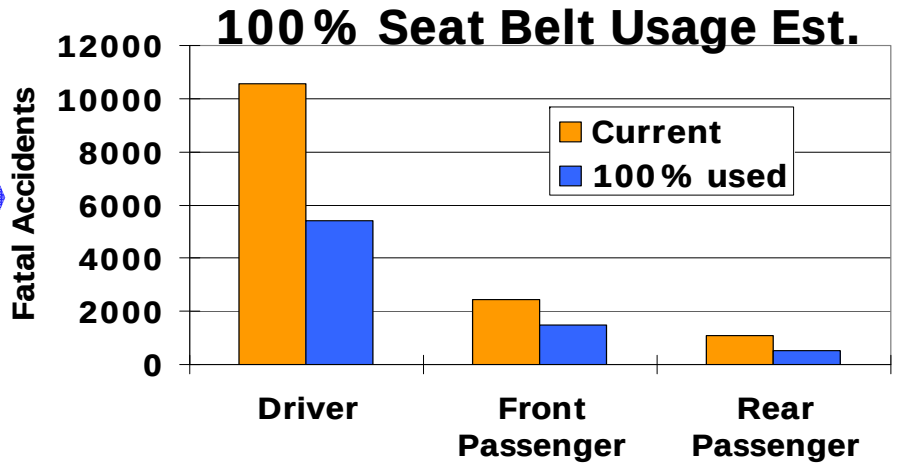
IIHS, 2006, Effectiveness and Driver Acceptance of the Honda Belt Reminder System

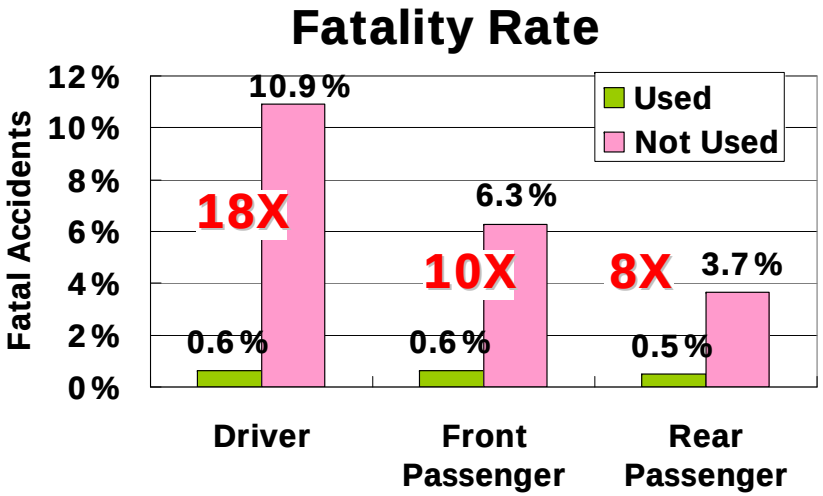
Unbelted Occupants Are Major Portion of Fatality Rates

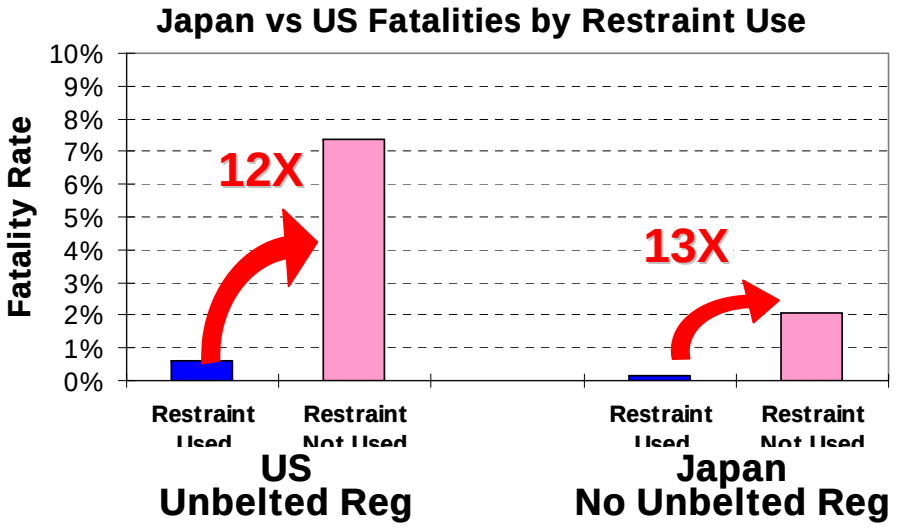
15% of drivers (unbelted) make up 50% of fatalities!



2009 Traffic Safety Facts







FMVSS 208's Unbelted Occupant requirement seems to be ineffective

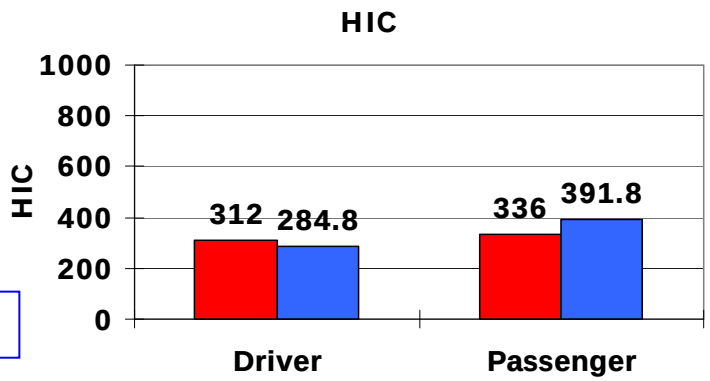
US and Jpn Fit Test Performance Comparison

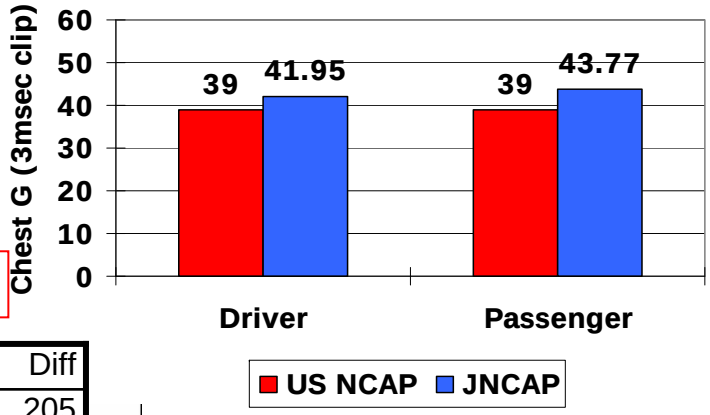
JPN Honda Fit

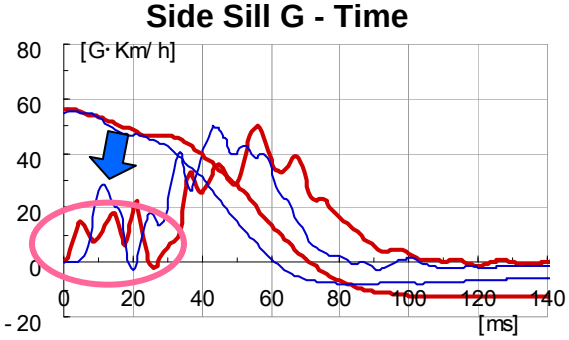
Highest NCAP Test (6 Stars)

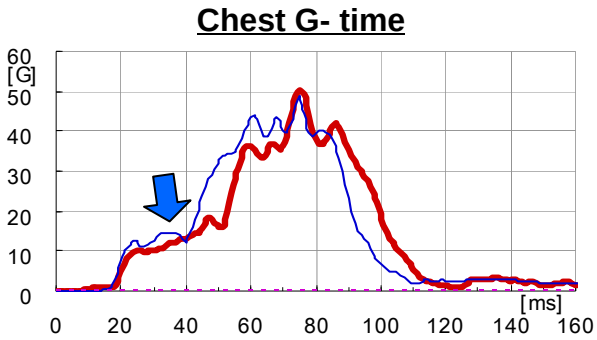
US Honda Fit

Highest NCAP Test (5 Stars)



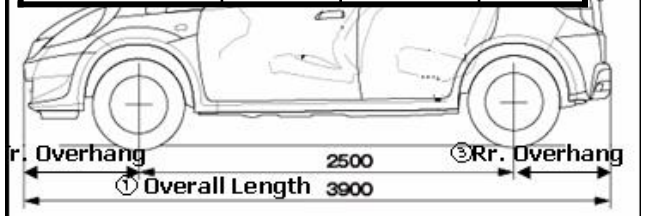






Japanese Model
U.S. Model

	US	Japan	Diff
Length	4105	3900	205
Fr Overhang	910	765	145
Weight	1168	1080	88



US Fit is 88lbs heavier partially due to longer front overhang compared to Jpn Fit. Safety performance is nearly equal. 100 mm of 148mm increase in length is due to unbelted occupant test. **+20kg can be reduced.**

Conclusion

- 42% of fatalities are Single Vehicle Crashes – these will all benefit from light weighting due to decreased energy.
- The application of intelligent design can improve safety even when controlling for weight and size
- Improved compatibility (beyond current MOU) has the potential to further improve safety even as customers downsize and OEMs down weight. (stiffness)
- Unbelted occupant testing seems to be ineffective in reducing fatalities, while adding length and weight to small cars. Rethinking this issue could save +20kg for small cars.

HONDA

The Power of Dreams