



DUCKER WORLDWIDE

**ALUMINUM ASSOCIATION
AUTO AND LIGHT TRUCK GROUP
2009 UPDATE
ON ALUMINUM CONTENT
IN NORTH AMERICAN LIGHT VEHICLES
PHASE I**

OCTOBER 31, 2008

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INTRODUCTION AND METHODOLOGY

Introduction and Methodology

Background

- Ducker Worldwide has collected data on the growth and development of aluminum content in automotive light vehicle applications on an annual basis since 1991
- Ducker started its systematic efforts in North America in 1991, expanded into Europe and Japan in 2000 and the remainder of the world in 2007
- Data are collected on a “bottom-up” basis, meaning the market has been tracked on an OEM, platform-by-platform and product-by-product basis. With metallurgists, engineers, and component specialists on staff, Ducker has become a leading subject-matter-expert for the global automotive industry on aluminum content and aluminum applications across all vehicle systems



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PROVIDE CLIENTS WITH GLOBAL PERSPECTIVE

Introduction and Methodology

Study Methodology

- Ducker conducts direct interviews with the purchasing and engineering personnel at the OEM, tier suppliers and aluminum companies that are directly involved in making decisions to utilize aluminum for each component. Over the past 18 years, Ducker has developed an extensive industry network and is well positioned to gather any data point related to aluminum and automotive
- Ducker uses primary research to gather data on the topic. Ducker always begins with material supplier interviews. The next step is component supplier interviews, and the final step is OEM interviews to confirm our findings. Secondary research from published sources only plays a minor role in our work
- The nearly 100 light vehicle aluminum components for which Ducker collects data are shown in the Appendix. The aluminum penetration for every component can be different for every vehicle in every region. The principal objective of our studies is to determine the average pounds of aluminum for each of the components and systems shown in the Appendix, and to use these system average weights to determine the average aluminum content for the vehicles forecast for production in each region of the world. Finally, the average aluminum content in each region is separated into the various aluminum product forms i.e. high pressure die castings, low pressure permanent mold and other castings, rolled products, extruded products and forgings and impacts

Introduction and Methodology

Study Methodology

- The two most important data points for project success are the penetration of aluminum by component by region and the average aluminum weight for these components. We believe we have been successful in obtaining these data points for all the critical components under study, and we believe the results of this effort provide the most reliable and accurate estimates of auto aluminum use that have ever been developed
- **In order to finish the project on schedule, Ducker fixed vehicle production at 12.94 million vehicles for the year 2009. Production forecasts for 2009 have declined for seven straight months in 2008 and as of October 31 the latest CSM forecast is 11.8 million units for 2009. The lower estimate does not have a significant effect on any of the key observations or conclusions of the report**
- In **Phase I**, we will present aluminum data on the past, present and the expected future production of light vehicles in North America. In **Phase II**, to be sent under separate cover in December, we will present data comparing aluminum content in North America in 2009 with light vehicle aluminum content in Europe, Japan and the remainder of the world for 2009



EXECUTIVE SUMMARY

Executive Summary

- The North American auto industry is in the midst of the greatest turmoil and need for change in recent history. The 25% decline in production from 2001 to 2009, although not unprecedented, has put the industry under extreme financial pressure. For the Big 3 in particular, these are desperate times. This sad state of affairs is additionally compounded by the shift in market share from the Big 3 to the foreign domestics, the shift in mix away from high profit full frame vehicles and finally the government mandate to improve fuel economy by 40% in the face of extremely volatile oil prices. We will attempt in this report to address the effect all these factors may have on aluminum use for light vehicles between now and 2020
- Most of the comparisons in this report will be between the recently **revised data** we collected on this topic **for 2006** North American vehicles with our **best estimates** of what will we and other experts believe will happen in **2009 and 2020**
- The next twenty one pages provide a summary of our findings and a forecast for 2009 and 2020. The remainder of the document provides details by component, details by OEM and details about the most likely uses of aluminum in future light vehicles that were compiled through OEM interviews
- Some key observations on 2008 and 2009 are shown on the next page

Executive Summary

- The Big 3 have lost nearly 10 market share points to the foreign domestics over three years
- Production at GM, Ford, Chrysler and Nissan will decline by 2.75 million vehicles from 2006 to 2009 while Honda, Toyota and others are expected to grow production by 400,000 units from 2006 to 2009
- In 2008, fuel economy will be the highest in recorded history at 26.8 MPG according to the EPA
- The decline in curb weight from calendar year 2004 to 2009 will be the largest decline in nearly 30 years and contribute an improvement to fuel economy of at least one MPG
- The shift away from full frame large trucks and SUVs was the largest contributing factor to the decline in curb weight and the resulting fuel economy improvement in 2008
- The shift to more vehicles in the B, C and D unibody vehicle segments will be beneficial to aluminum in the long term, but the size of the shift in 2008 caused a decline in curb weight which negatively affected not only aluminum weight per vehicle, but steel and iron weight as well
- As a result, aluminum will suffer the first decline in pounds (2 lbs.) per vehicle in 35 years in 2008, but 2009 should put aluminum back on a new but slightly slower growth curve
- Even though 2009 vehicle production will be much lower than 2006 production, there will be a need for more aluminum engine blocks, more knuckles, more suspension arms and links, more brake calipers, more hoods and more bumpers than in 2006
- On a pounds per vehicle basis, most 2009 light vehicle systems will increase aluminum content over 2006 with the big exception being subframes, cradles and crossmembers. This segment has declined by 80% over the last three years and will cost aluminum 40 to 50 million pounds of content in 2009. These losses can be attributed to the move to advanced high strength steels for these parts at Chrysler, Nissan and Ford

Executive Summary

- Some of the **highlights** for 2009 are as follows:
 - Over 22% of the vehicles in 2009 will have an aluminum hood, an all time record
 - Nearly 70% of all engine blocks will be aluminum in 2009
 - Nearly one third of all 2009 models will have at least one pair of aluminum control arms or suspension links
 - Nearly one half of all 2009 models will have at least one pair of aluminum knuckles
 - Aluminum ABS housings will be on 85% of the 2009 vehicles
 - Honda and BMW have become the aluminum content leaders over the last three years replacing GM and Nissan
 - Honda has programmed rear aluminum knuckles for all new vehicles
 - The BMW X6 will have an average aluminum content of 443 pounds, and with the V8 engine option and an aluminum full size spare, some X6 models will contain over 500 pounds of aluminum or 10% of the curb weight
 - Vacuum die cast (High Q) aluminum front strut towers on the BMW X6, first aluminum strut towers in North America
 - Aluminum IP Beams for the Honda Pilot and Acura MDX plus aluminum knuckles, hoods and control arms make the aluminum content 423 pounds or 10% of curb weight
 - The MDX/Pilot and BMW X6 are bell weather unibody vehicles which optimize both aluminum and advanced high strength steel use

Executive Summary

- Other highlights that won't go into effect until after 2009 are:
 - Some versions of the very high volume GM Global Epsilon program will have forged aluminum Ball Joint Yokes weighing approximately six pounds each along with aluminum control arms and knuckles with a launch in 2009 in Europe, 2010 in North America and China in 2012
 - GM may merge with Chrysler, and because GM has a more consistent approach to aluminum than Chrysler use this should be beneficial to North American aluminum content going forward. A Chrysler/ Nissan merger would be detrimental to aluminum use, in our opinion they are both inconsistent
 - The Prius will be manufactured in Mississippi with an aluminum hood and deck lid in 2010
 - Chevy Volt will have an aluminum hood and possibly an aluminum front structure in 2011 or late 2010
- As a percent of average curb weight, aluminum will be at an all time high of 8.6% in 2009, and is likely to be greater than 10.0% of curb weight by 2020
- If the full frame share of total production in 2020 falls to 10% from the predicted 20%, aluminum's share of overall curb weight could be as high as 12% in 2020
- The best long term scenario for aluminum in order to optimize aluminum as a percent of curb weight is 100% unibody vehicles with low torque gasoline engines or hybrid engines which insures 100% aluminum block use and the optimum use of aluminum structural parts and aluminum closures. Low torque means under 500 Newton meters

Executive Summary

The results of our interviews of 32 auto material thought leaders are as follows:

- There is a **less than a 15% probability** that there will be a significant number of **mass produced full aluminum bodies** by 2020
- There is a **60% probability** that a significant number of vehicles with **partial aluminum body structures** will be in production by 2020
- There is a **75% probability** that aluminum content will grow to **more than 350 to 360 pounds per vehicle** over the next twelve years and there is only a 25% probability of any decline in aluminum content during this period
- There is a **75% probability** that aluminum content growth will remain in the **four to six pounds per vehicle per year** range through 2020 in addition to what growth there is for aluminum partial and complete body structures. We believe that the 2008 decline in aluminum content is an aberration caused by mix shift and the one time loss of most subframes and cradles to steel
- There is a **very low probability**, less than 10%, that **aluminum will lose any significant share** to steel, iron or magnesium over the next twelve years
- Based on the above, we have concluded that the most likely aluminum content by 2020 is 376 pounds per vehicle with a 20% chance of reaching 395 pounds per vehicle and a 30% chance of aluminum content being as low as 355 pounds per vehicle
- These same experts also said that both aluminum and high strength steel will be **very significant** in their efforts to improve fuel economy by 40% by 2020

Executive Summary

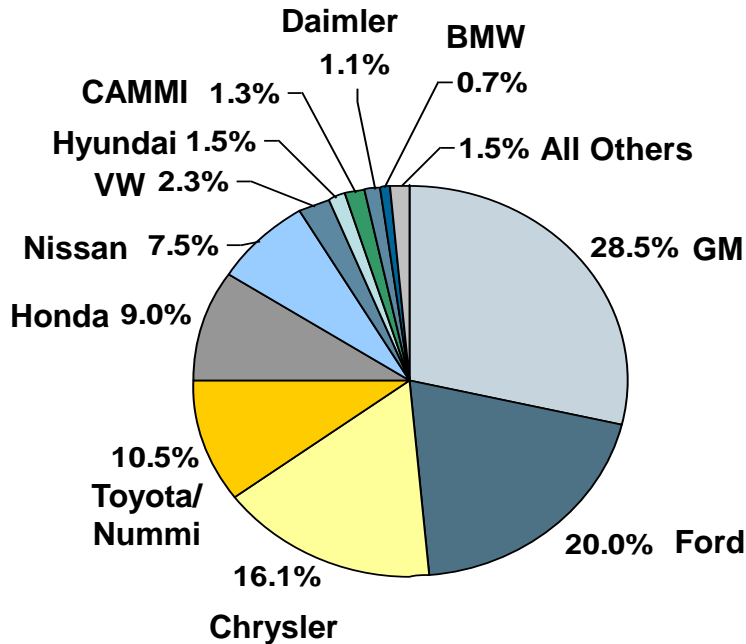
North American Light Vehicle Production

- Segmented by OEM -

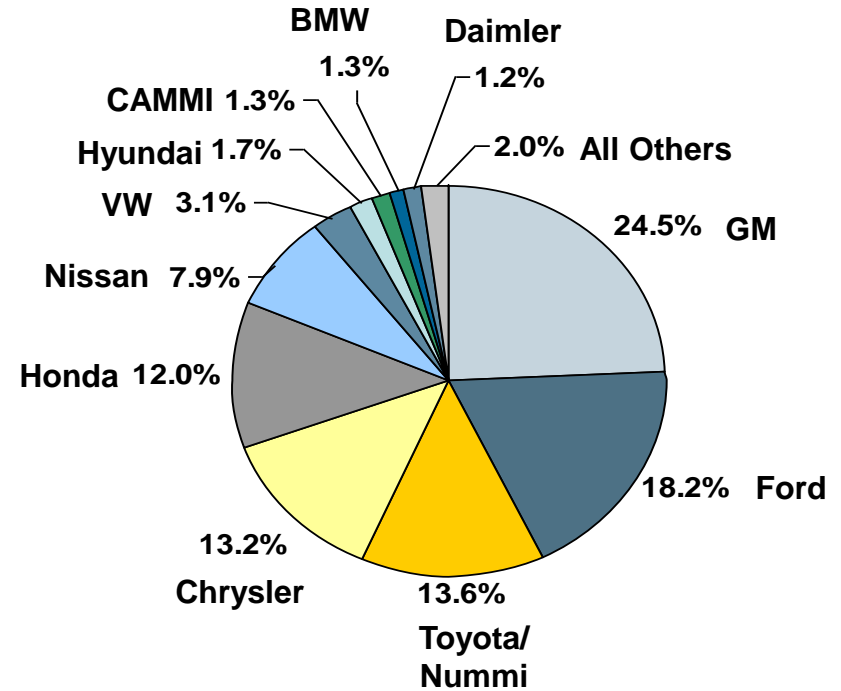
2006

2009

The Big 3 have lost nearly 10 production share points over three years



15.3 Million Vehicles



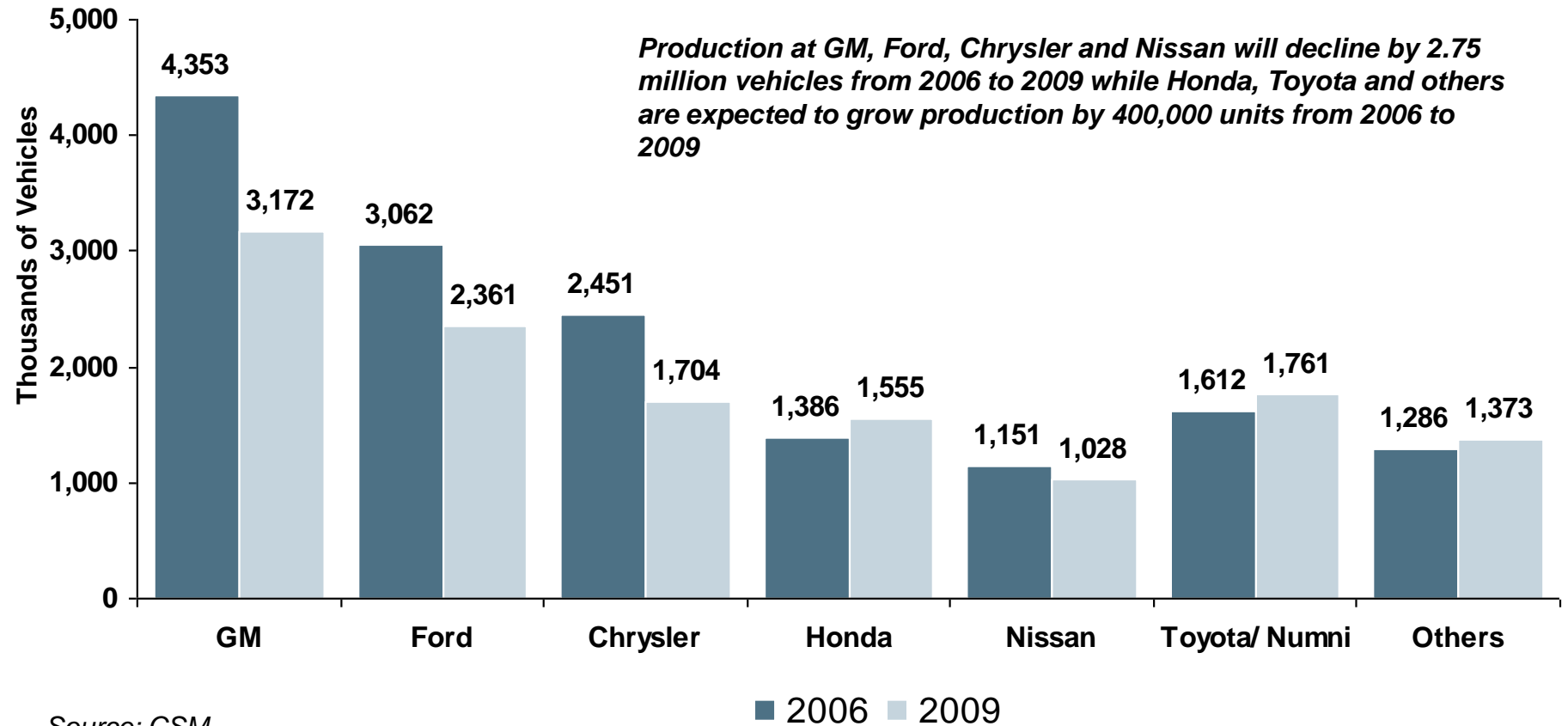
**12.954 Million Vehicles
(could be as low as 11.8 Million)**

Source : CSM

Executive Summary

North American Light Vehicle Production

*- Segmented by OEM -
2006 Versus 2009*

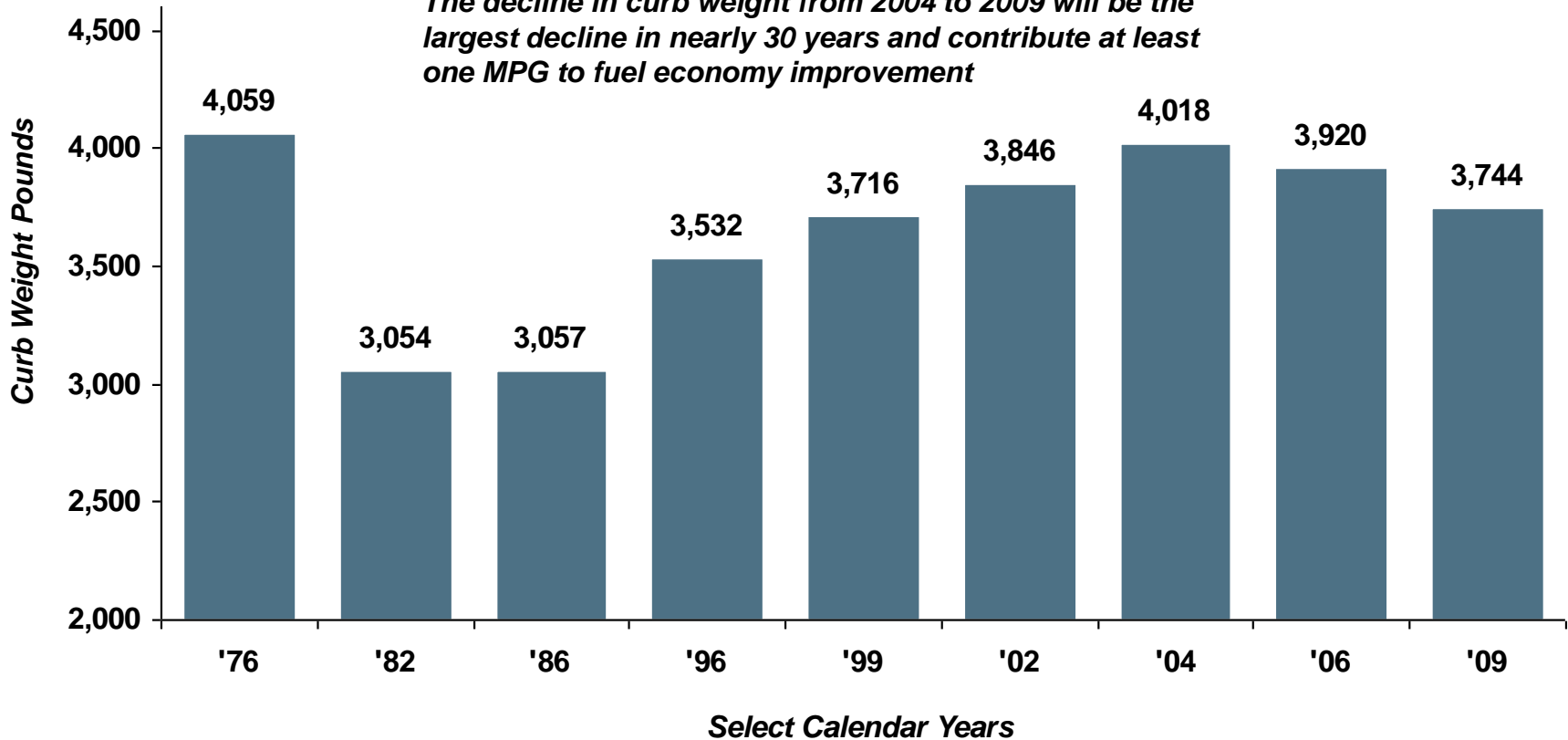


Executive Summary

North American Light Vehicle Curb Weight *- History and Forecast -*

Unibody vehicles are expected to average **3,469 pounds** and full frame vehicles will average **4,668 pounds** in 2009

The decline in curb weight from 2004 to 2009 will be the largest decline in nearly 30 years and contribute at least one MPG to fuel economy improvement

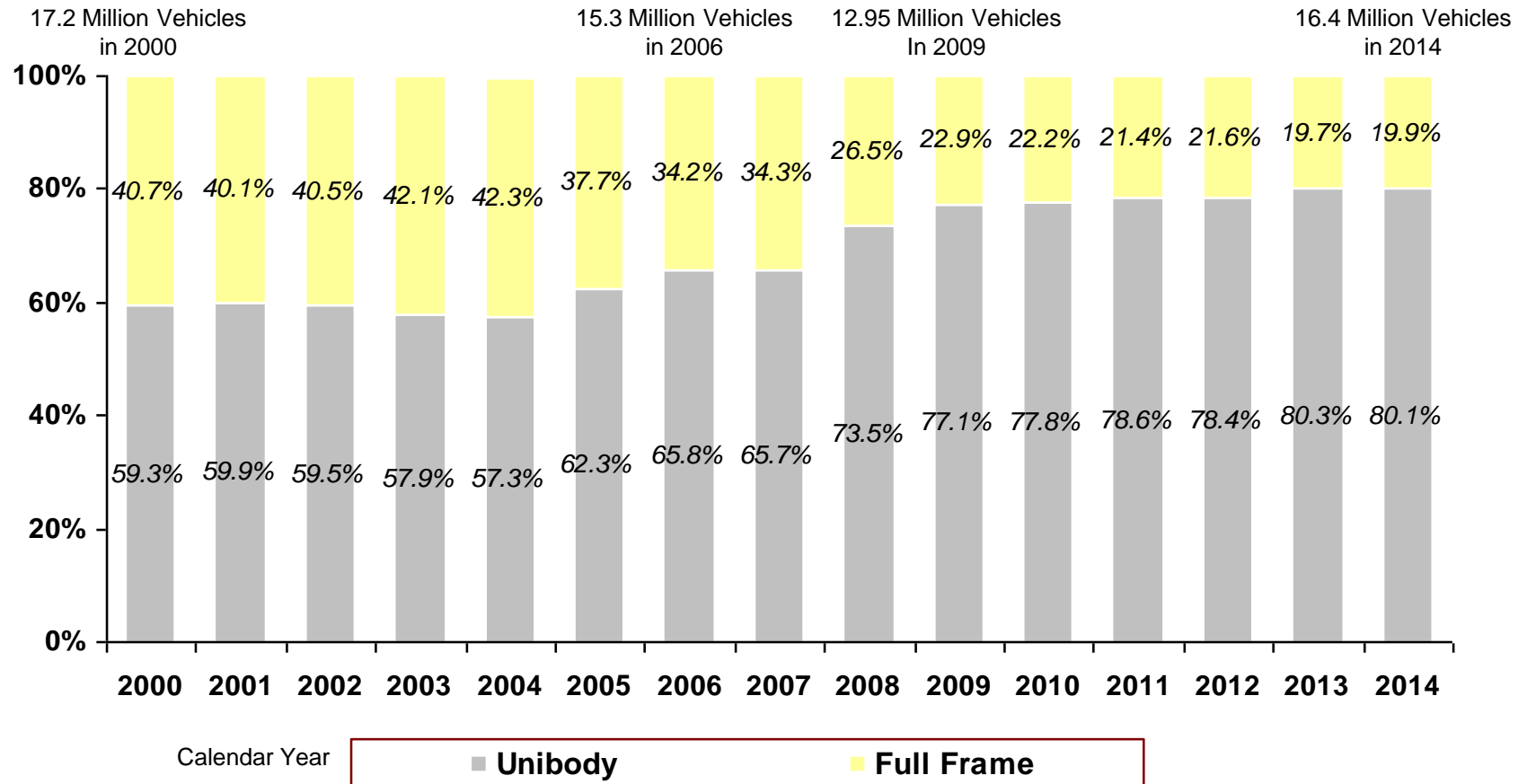


Executive Summary

- The shift away from full frame large trucks and SUVs was the largest contributing factor to the decline in curb weight and the improvement in fuel economy in 2008

North American Light Vehicle Production

- History and Forecast -



Source : CSM

Executive Summary

North American Light Vehicle Production

- Millions of Aluminum Units or Pounds/Vehicle -

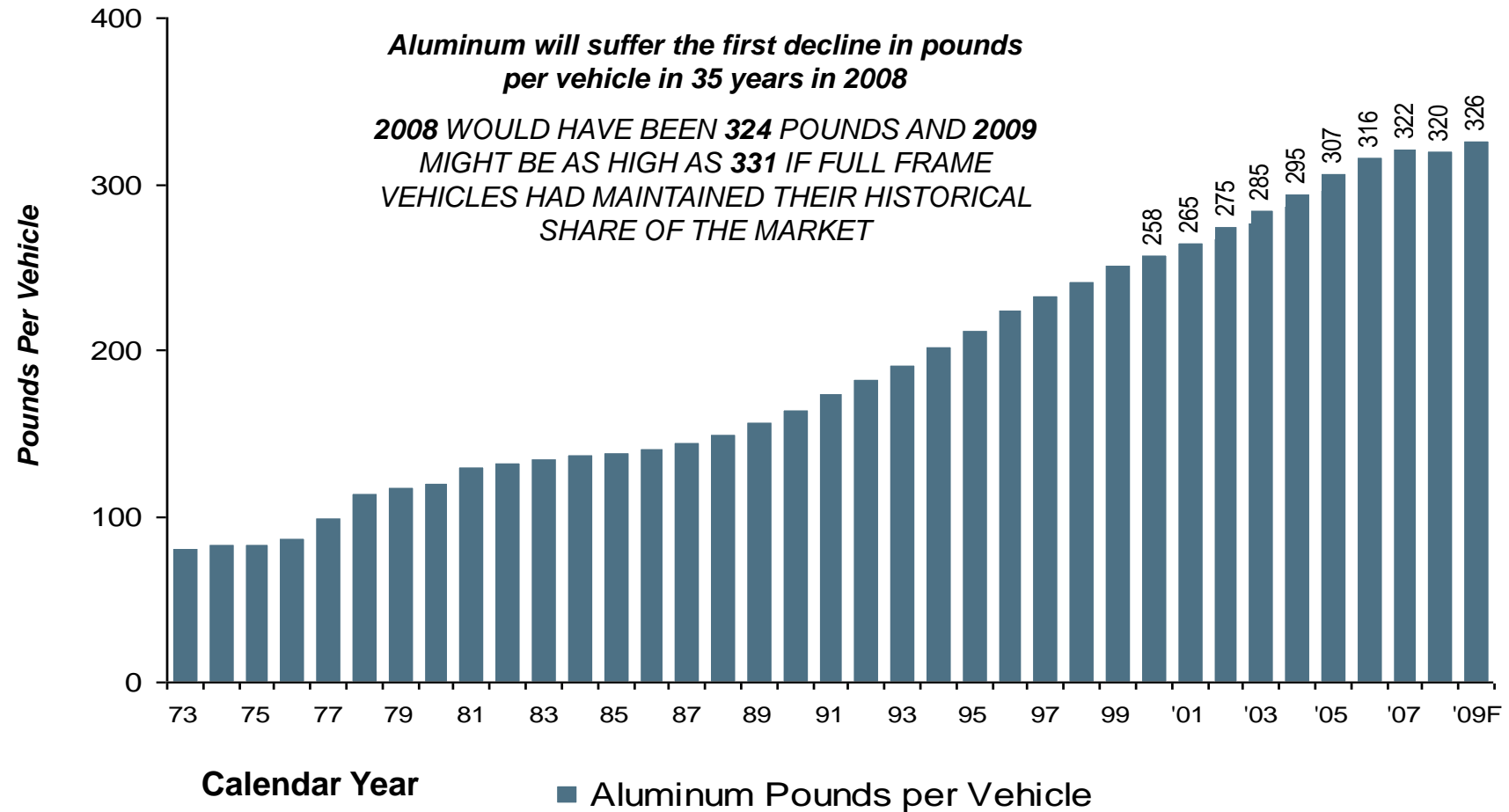
These systems and components represent over 95% of all the aluminum weight in the vehicle

	Calendar Year						Calendar Year				
	1996	1999	2002	2006	2009		1996	1999	2002	2006	2009
Vehicles (Millions)	15.10	17.00	16.40	15.30	12.95	Hoods	0.9	1.7	2.4	2.85	2.89
Engine Blocks	2.72	3.91	5.74	7.99	8.95	Other Closures	0.1	0.5	1.4	0.94	0.14
Cylinder Heads	14.20	18.42	21.63	24.06	20.08	Bumper Beams	2.0	1.7	1.7	2.6	2.85
Intake Manifolds	12.38	9.86	8.96	8.86	7.53	Heat Shield lbs.	2.1	3.1	3.82	4.05	4.2
Oil Pans	7.25	8.84	9.02	9.74	8.64	Control Arms/Links	0.5	4.3	6.7	9.0/1.6	10.8/2.1
Other Engine lbs.	20.0	20.5	20.5	21.6	21.8	Knuckles	0.6	9.6	10.4	15.0	16.8
Automatic Transmissions	13.44	15.13	14.92	13.86	11.48	Subframes/Cradles & Crossmembers	1.0	1.3	1.5	2.0	0.568
Manual Transmissions	1.66	1.87	1.48	1.44	1.52	Driveline Yokes	1.4	3.0	4.0	6.0	4.0
Transfer Cases	2.3	3.0	2.45	3.0	2.18	Front Structures	--	0.5	0.9	0.6	0.4
Differential Carriers	1.7	2.0	2.1	3.3	2.3	Complete Structures including IP	--	--	0.01	0.01	0.21
Wheels	27.2	39.4	40.7	41.0	35.9	Heat Exchangers	32lbs.	32lbs.	32lbs.	31.5lb.	31.5lbs
ABS Housings	10.57	12.41	12.30	11.93	11.05	Curb Weight lbs.	3,532	3,716	3,846	3,920	3,744
Drive Shafts	0.7	1.5	2.0	3.0	2.0	Aluminum % of CW	6.3%	6.8%	7.2%	8.1%	8.6%
Brake Calipers	0.5	1.8	3.9	12.0	12.1						

Executive Summary

North American Light Vehicle Aluminum Content

- History and Forecast -



Executive Summary

North American Light Vehicle Aluminum Content

- Pounds per Vehicle -

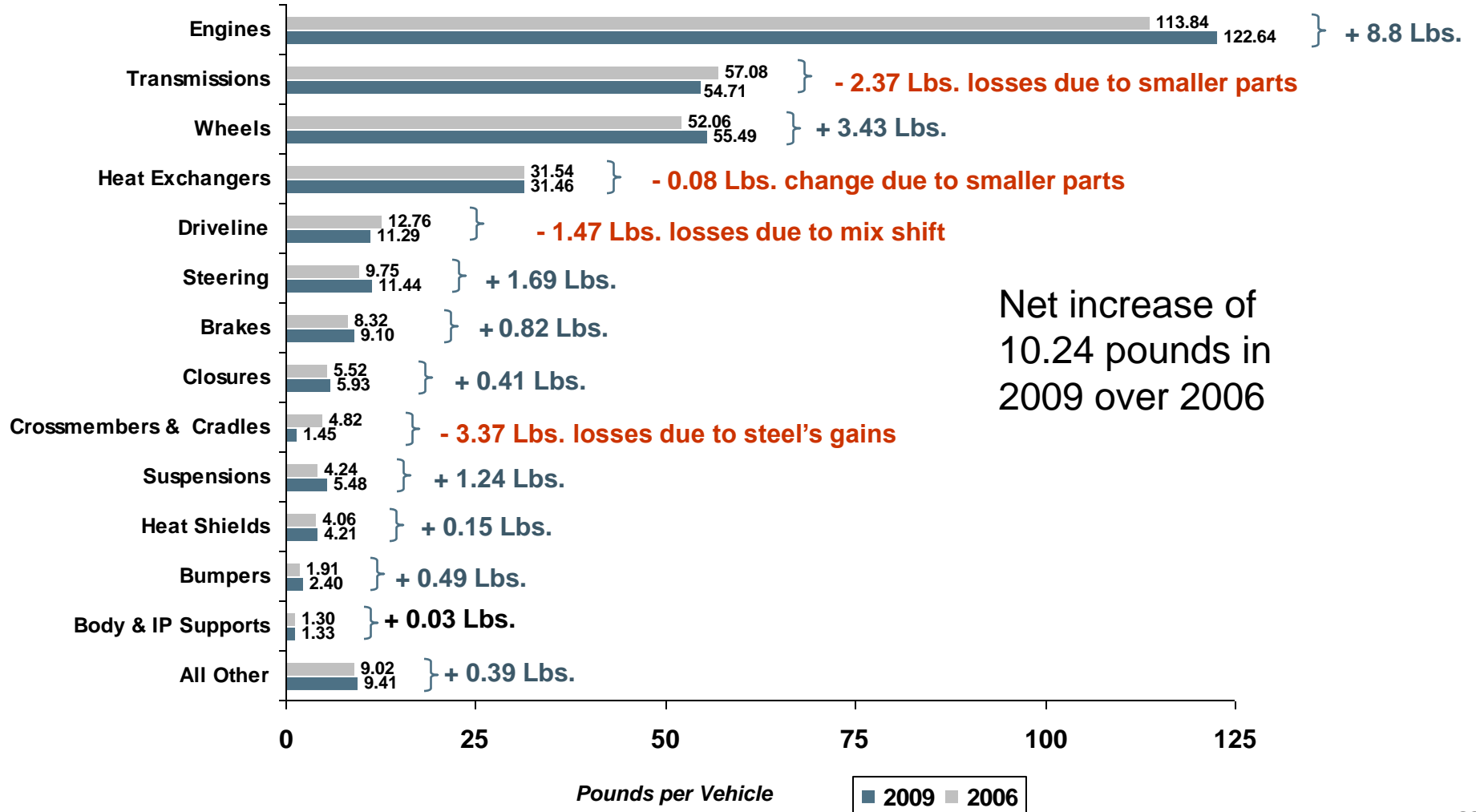
<i>System/Component</i>	<i>Actual 1996</i>	<i>Actual 1999</i>	<i>Actual 2002</i>	<i>Actual 2006</i>	<i>Estimate 2009</i>
Engines	76.85	81.04	92.66	113.84	122.64
Transmissions	55.17	56.63	56.69	57.08	54.71
Driveline Components	4.00	4.86	5.35	12.76	11.29
Wheels	33.00	42.92	49.32	52.06	55.49
Heat Exchangers	32.00	32.00	32.00	31.56	31.46
Suspensions	0.25	1.40	2.18	4.15	5.48
Steering Components	3.00	8.00	8.17	9.75	11.44
Cradles and Subframes	2.00	2.30	3.41	4.83	1.45
Brakes	3.25	3.83	5.48	8.32	9.10
Closures	1.65	2.60	4.32	5.52	5.93
Heat Shields	2.10	3.10	3.82	4.06	4.21
Bumpers and Bumper Beams	1.00	1.25	1.35	1.91	2.40
Body and IP Structures	--	1.77	1.26	1.30	1.33
All Other Components	9.23	9.30	9.03	9.02	9.41
Total	223.5	251.00	274.94	316.16	326.34

Executive Summary

North American Light Vehicle Aluminum Content

2009 Compared to 2006

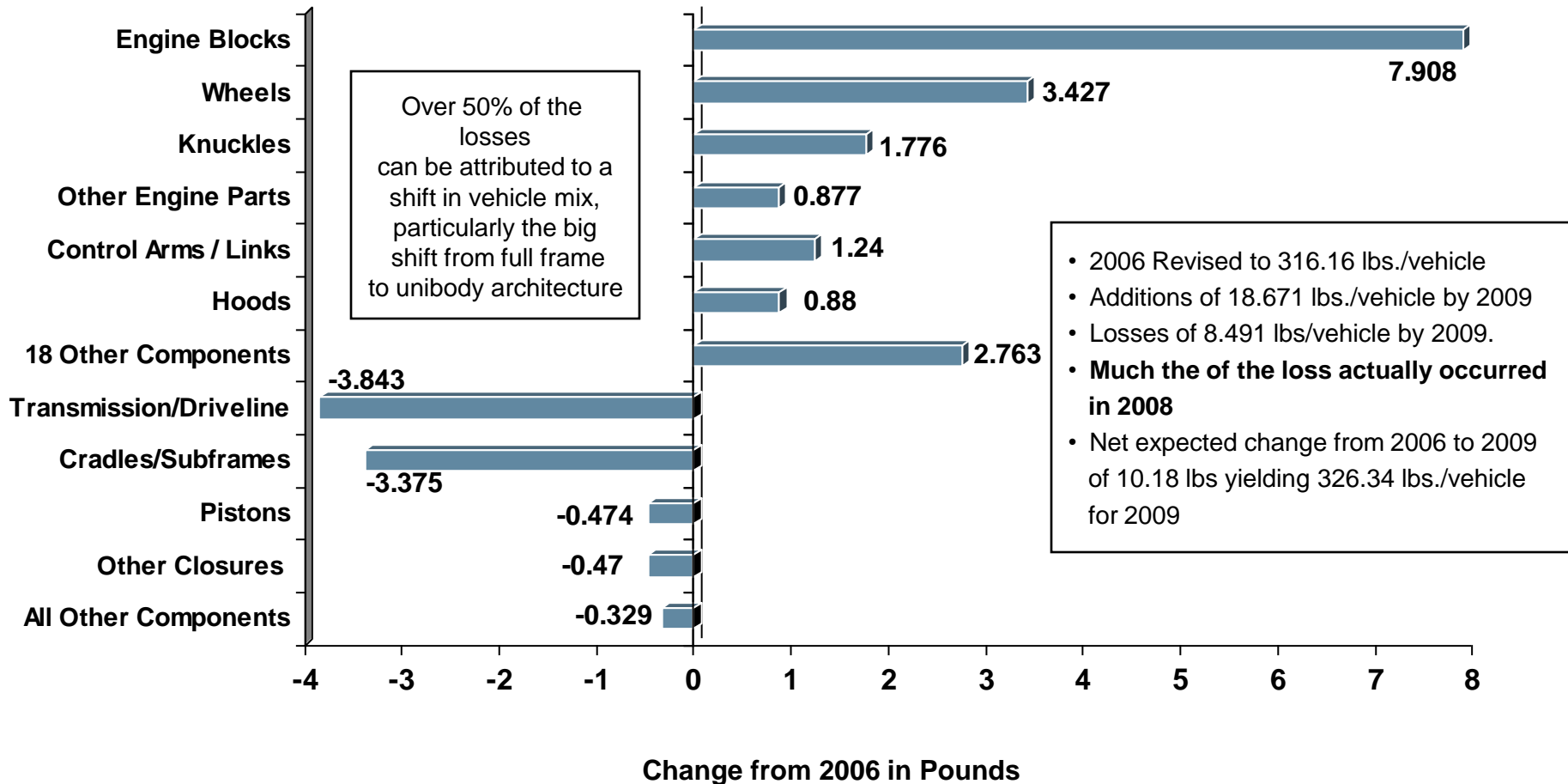
Net Change



Executive Summary

North American Light Vehicle Aluminum Content

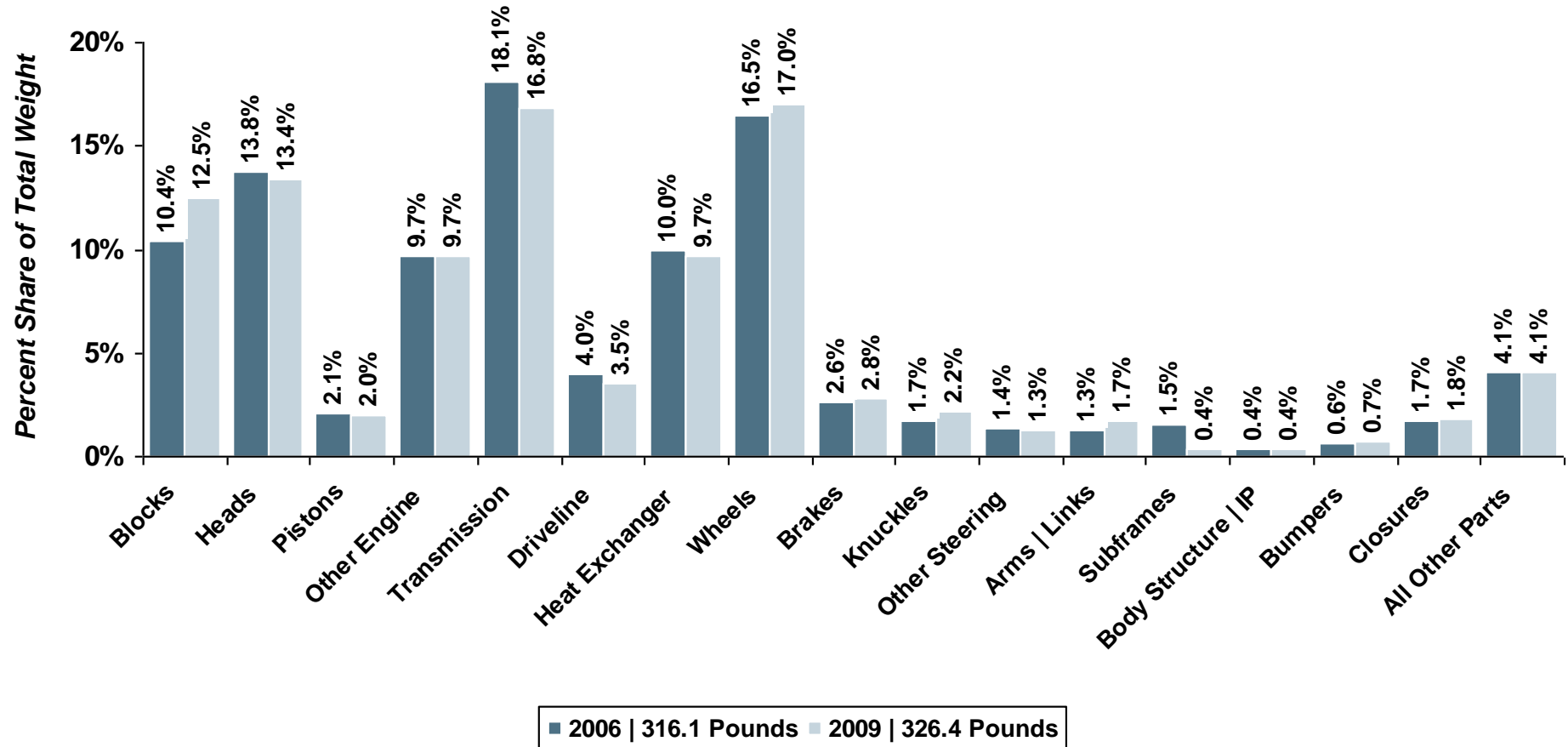
- 2009 versus Revised 2006 -



Executive Summary

2009 North American Light Vehicle Aluminum Content

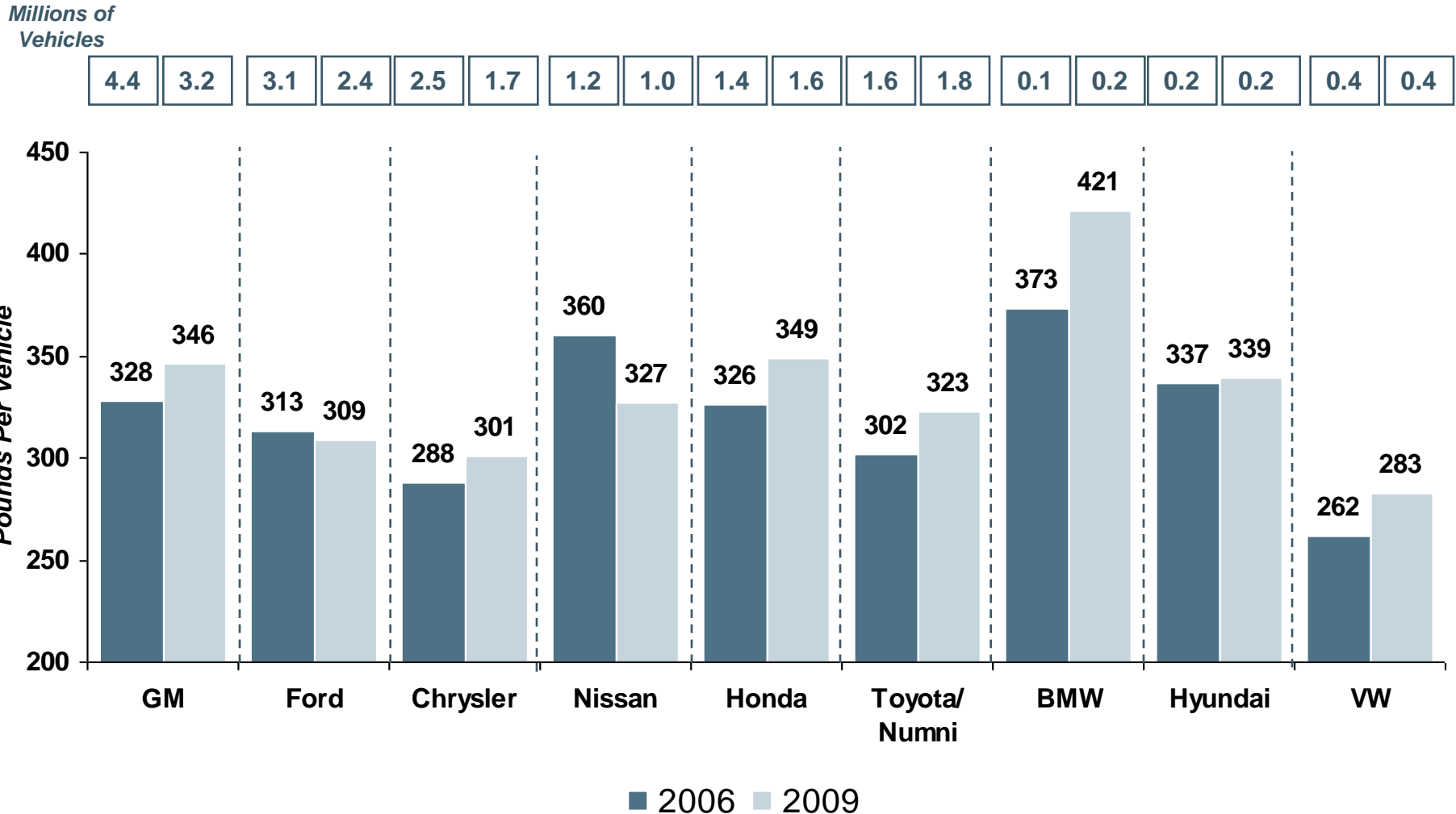
- Segmented by System or Component -



Executive Summary

North American Light Vehicle Aluminum Content

**- Segmented by OEM -
2006 Versus 2009**



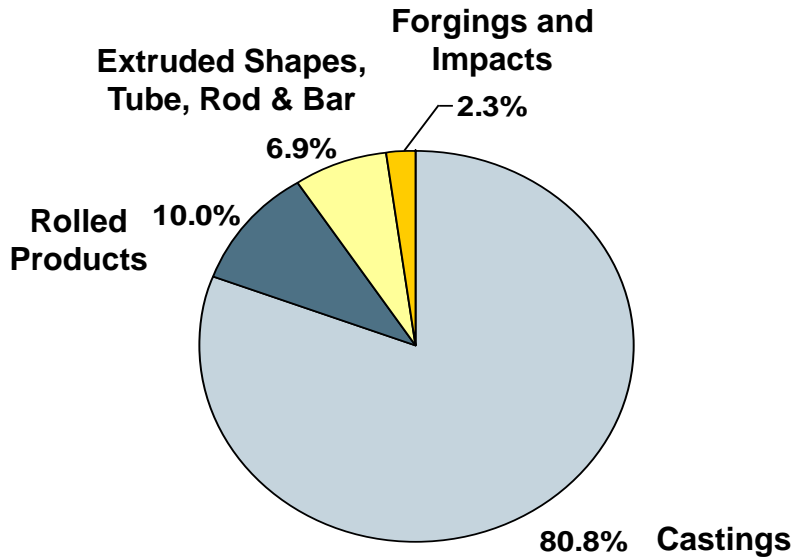
Executive Summary

North American Light Vehicle Aluminum Content

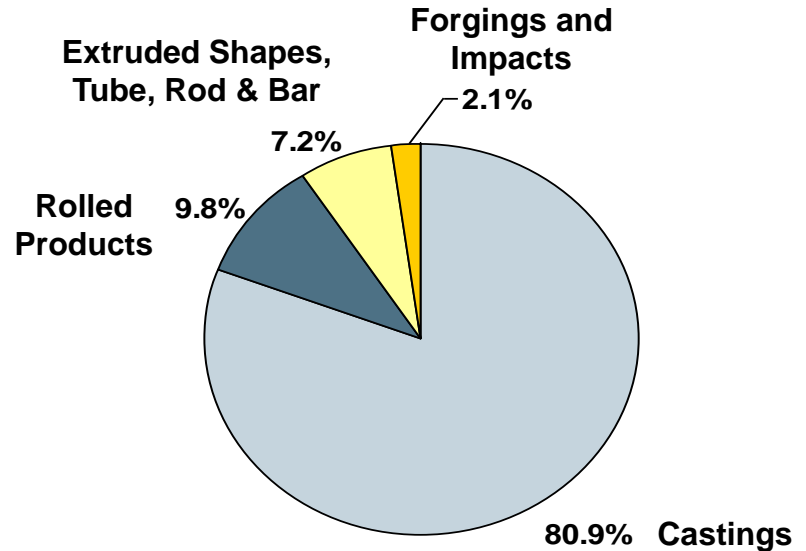
2006

2009

Broad product mix changes from 2006 to 2009 will be minimal



4.837 Billion Pounds



**4.225 Billion Pounds
Based on 12.95 Million Vehicles**

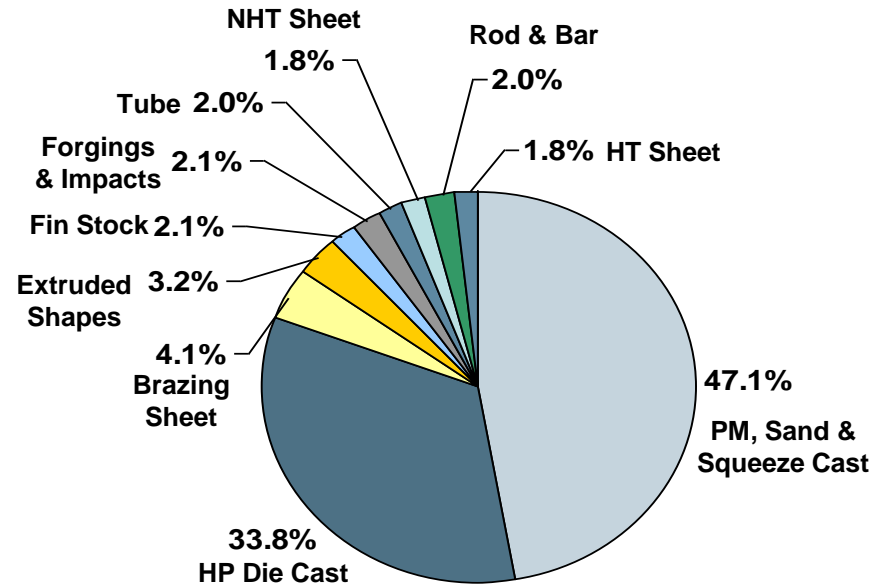
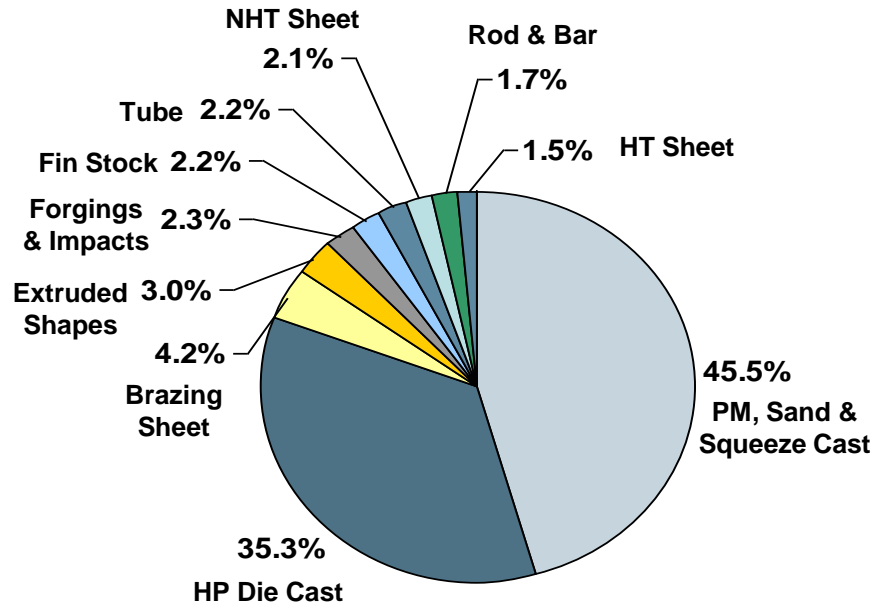
Executive Summary

North American Light Vehicle Aluminum Content

PM castings, squeeze castings, heat treated sheet, extruded shapes and rod and bar will all increase share in 2009

2006

2009



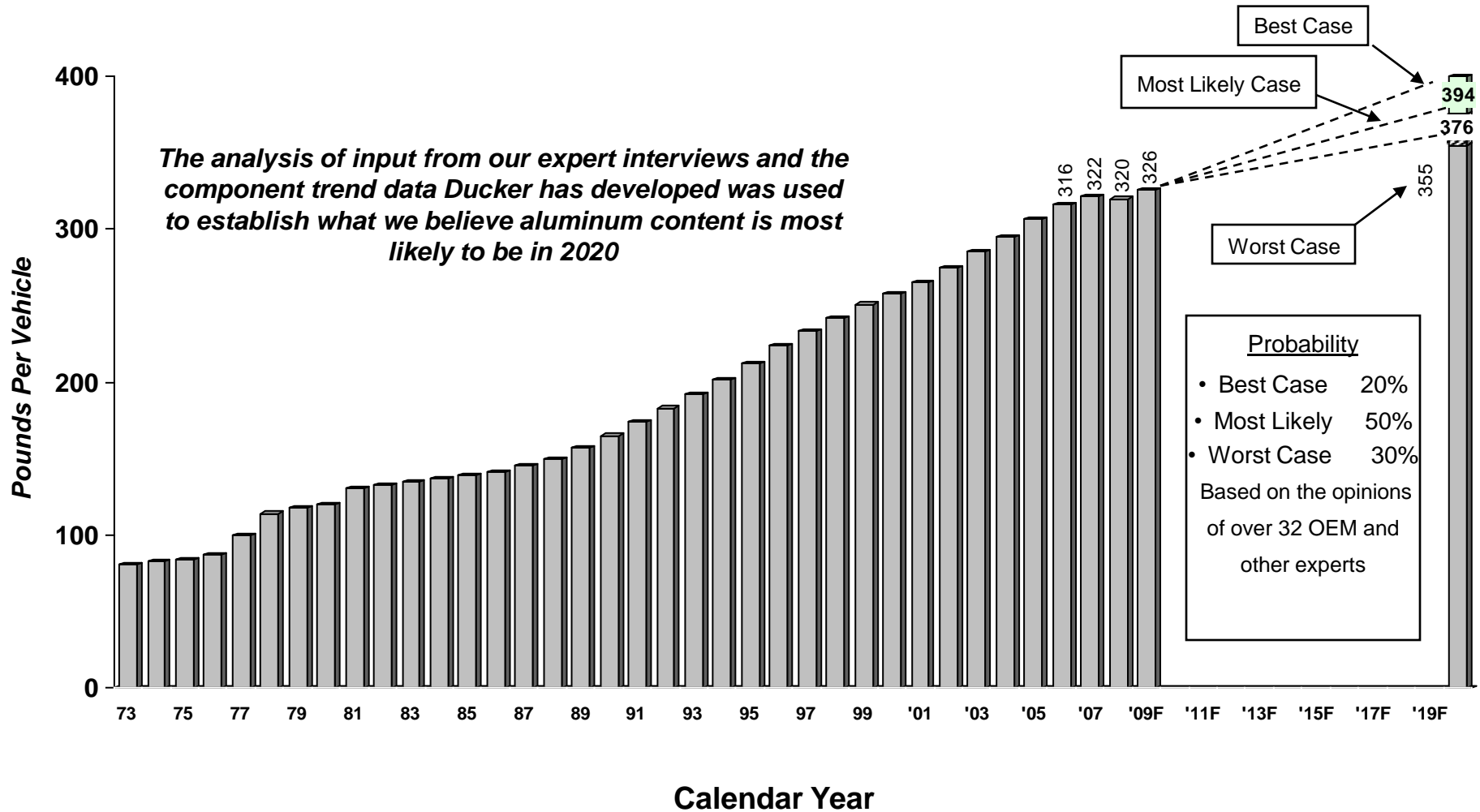
4.837 Billion Pounds

**4.225 Billion Pounds
Based on 12.95 Million Vehicles**

Executive Summary

North American Light Vehicle Aluminum Content

- History and Forecast -



Executive Summary

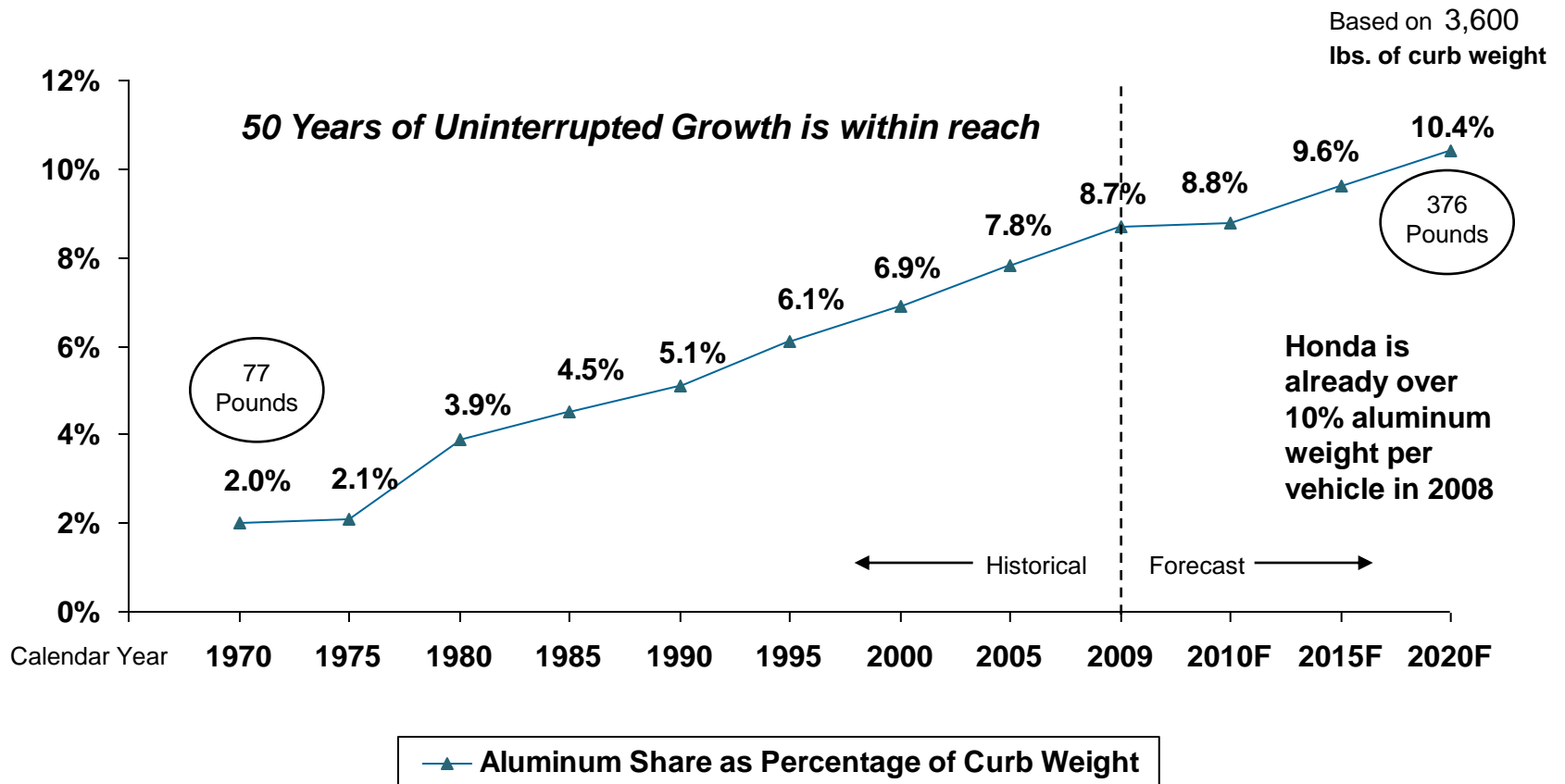
What Will it Take to Get to 376 Pounds of aluminum per Vehicle in 2020?

- The “**Most Likely Case**” will require the following (assuming 16M vehicles are assembled in 2020):
 - 140,000 Complete Aluminum Bodies adds 3 pounds per vehicle
 - 480,000 Partial Aluminum Bodies adds 4.5 pounds per vehicle
 - 9.6 Million Aluminum Hoods or the equivalent in roofs and other body panels adds 10 pounds per vehicle
 - 13.6 Million Aluminum Engine Blocks adds 10 pounds per vehicle, but hybrid blocks will be lower in weight
 - Less than one Million Diesel Engines with Iron Blocks, but one million diesels with aluminum blocks are included in the 13.6 million aluminum total
 - 48 Million Aluminum Wheels adds 5 pounds per vehicle
 - 30 Million Aluminum Knuckles adds 4 pounds per vehicle
 - 25 Million Aluminum Control Arms and Links adds 4.5 pounds per vehicle
 - 10 new pounds per vehicle of aluminum growth from other parts such as bumpers, heat shields, brake calipers, ABS and driveline components, cylinder heads, bed plates and a few other components
 - Average Curb Weight of at least 3,600 pounds. A larger drop in curb weight will hurt aluminum part size and weight per vehicle. Hybrids can hurt overall aluminum weight do to the small size of the internal combustion engine, but hybrids can help increase the use of aluminum structural parts and closures

Executive Summary

North American Light Vehicle Aluminum Content as a Percent of Curb Weight

- History and Forecast -





2009 COMPONENT ANALYSIS

2009 Component Analysis

- Aluminum blocks will grow from only 52% penetration in 2006 to 69% penetration in 2009. Aluminum blocks have been the largest driver of aluminum growth during this decade. Aluminum cylinder head growth, intake manifold growth and bed plate growth have been minor contributors to the 8.8 pounds added to aluminum engine parts since 2006
- Weight changes for aluminum transmission and driveline parts such as housings, transfer cases, differential carriers and drive shafts will reduce aluminum content by nearly four pounds in 2009. Essentially all of this decline is due to the non proportional shift to smaller vehicles with smaller parts, fewer pick up trucks and fewer four by four wheel drive vehicles in our 2009 forecast compared to 2006
- Aluminum wheels, which were the biggest contributor to aluminum growth in the 1990's, continue to contribute to aluminum content growth in spite of the large decline in non captive North American wheel production. Over half the OEM wheels required in 2009 will be imported from Asia or self manufactured. Aluminum wheel penetration growth at Toyota has been the principal reason for aluminum wheel content growth over the last few years in North America

2009 Component Analysis

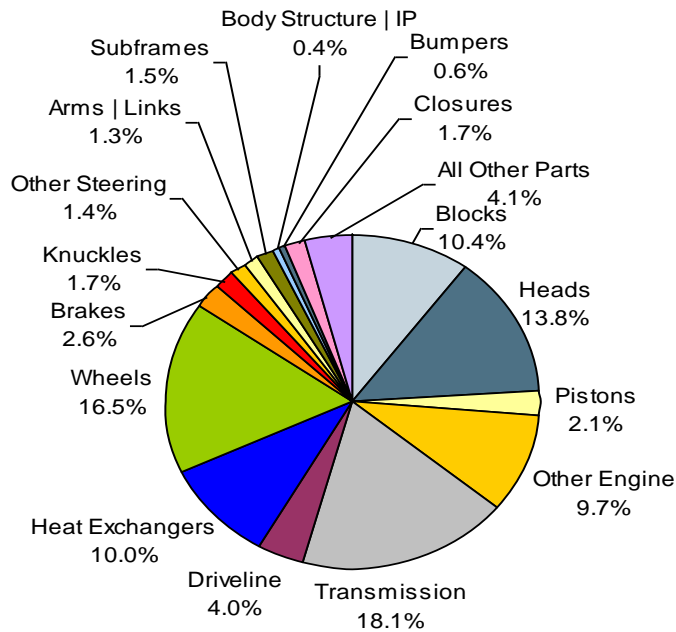
- Other significant component changes in 2009 will be more aluminum weight from penetration increases for knuckles, suspension arms and links, brake calipers, hoods and bumper beams. Decreases will come primarily from an 80% decline in the aluminum content for subframes, cradles and crossmembers and the decline in the use of aluminum sheet for deck lids and liftgates
- Aluminum knuckles are now in use in part or in full for half the models to be manufactured in 2009. Knuckles are currently the most significant cast aluminum structural component
- Aluminum suspension arms and links will be used on one third of the 2009 models. Over half of these parts will be die forged. These components are being challenged by stamped advanced high strength steels at OEMs such as Ford
- Aluminum hoods continue to take one share point per year away from steel. More OEMs are getting comfortable with aluminum for this application, and over 22% of all the hoods in 2009 are expected to be aluminum. The new steels; however, are a much larger threat to other closures such deck lids, liftgates and doors. Roofs are more like hoods
- Aluminum bumper beams have experienced a bit of a growth spurt do to new programs at Honda and Toyota, but the recent losses to martensitic and boron steels at Ford, Chrysler and Subaru are symptomatic of a long term problem for aluminum bumpers

2009 Component Analysis

2009 North American Light Vehicle Aluminum Content

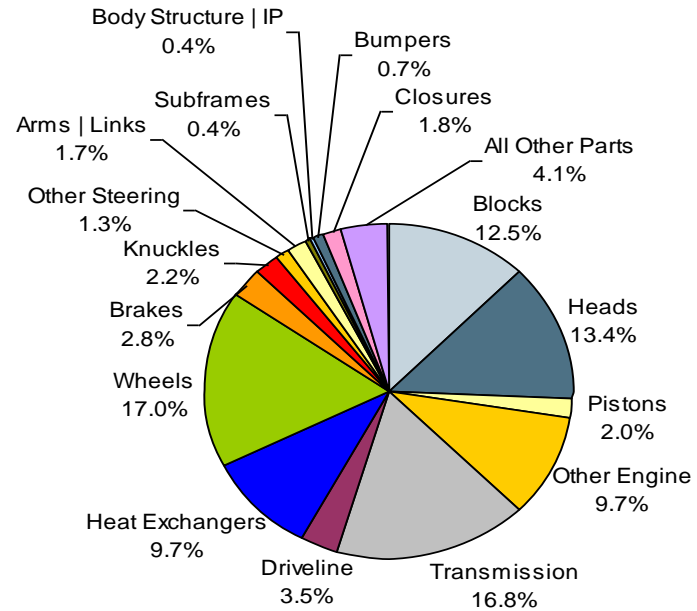
- Segmented by System or Component -

2006



316.1 Pounds

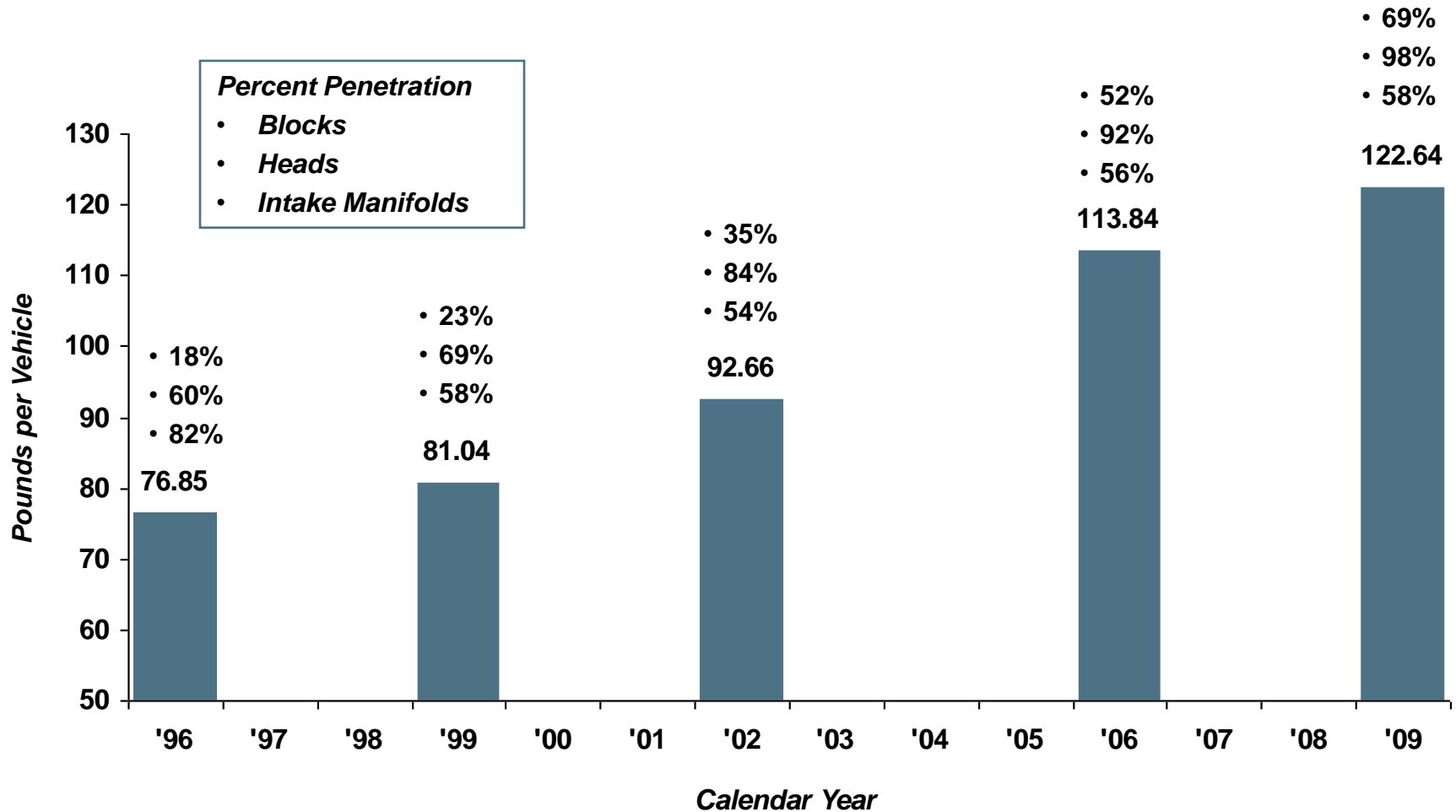
2009



326.4 Pounds

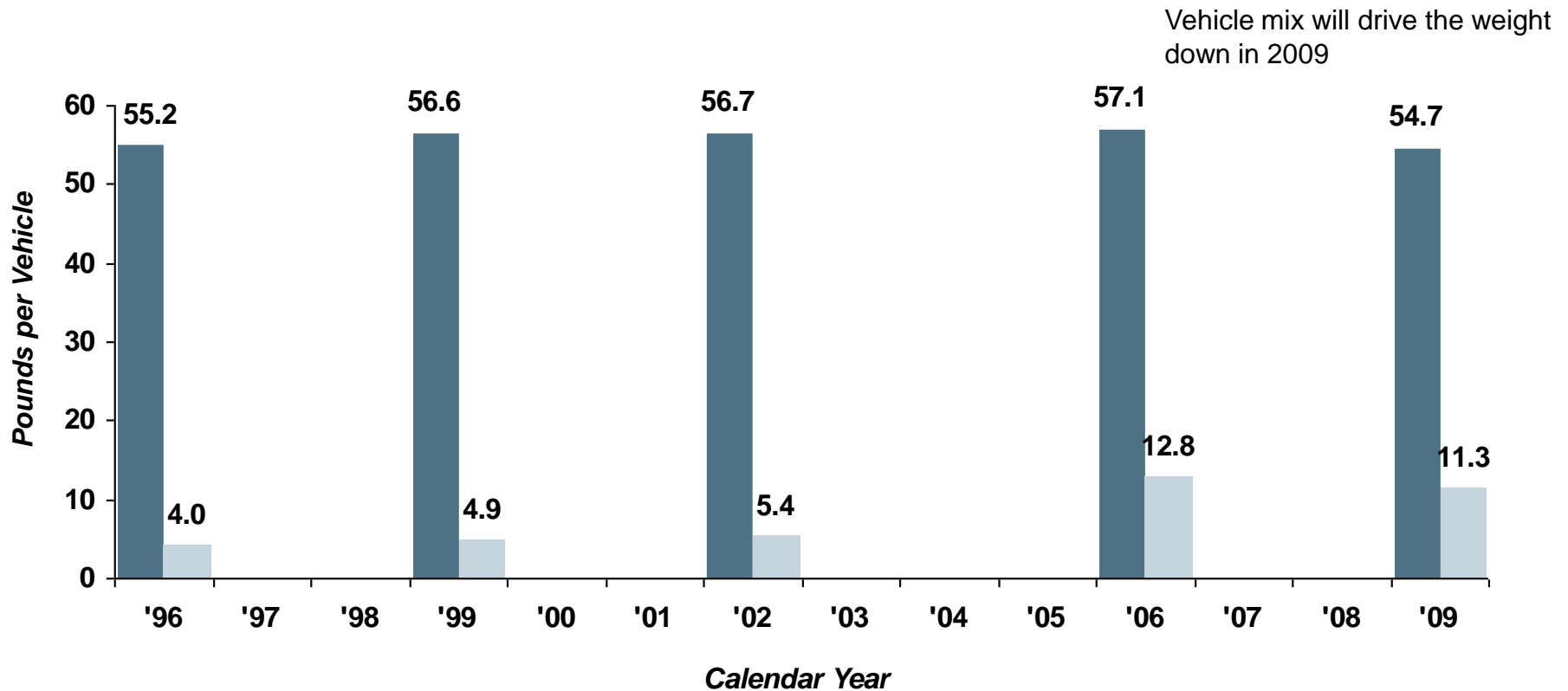
2009 Component Analysis

North American Light Vehicle Aluminum Engine Content (1996 – 2009)



2009 Component Analysis

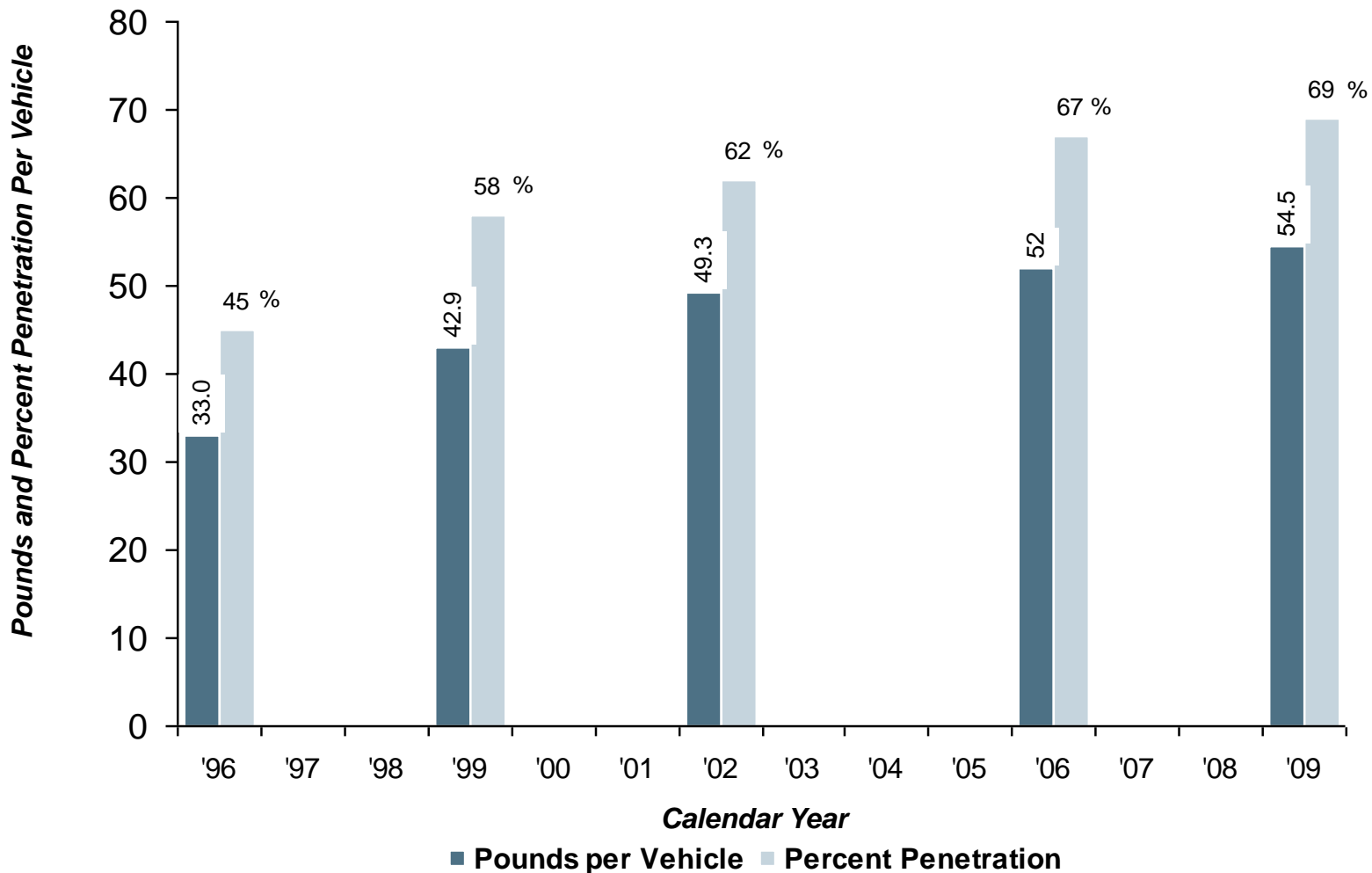
North American Light Vehicle Aluminum Transmission and Driveline Content (1996 – 2009)



■ Transmissions (Automatic, Manual and CVTs) ■ Transfer Cases, Differential Cases, Driveshafts and Yokes

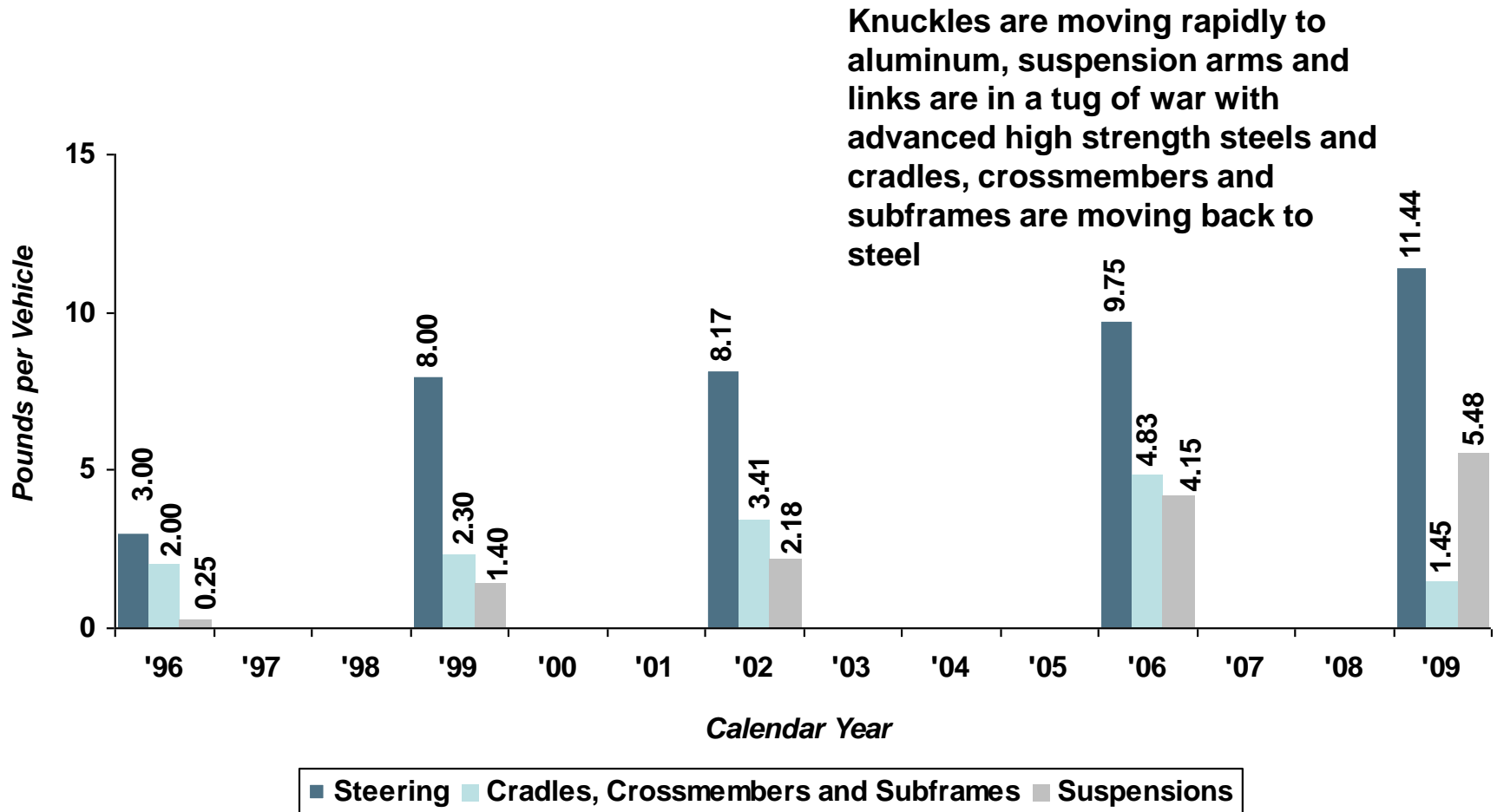
2009 Component Analysis

North American Light Vehicle Aluminum Wheels Pounds of Aluminum per Vehicle *- Percent Penetration (Excludes Spares) -*



2009 Component Analysis

North American Light Vehicle Aluminum Content for Steering, Chassis and Suspension (1996 – 2009)

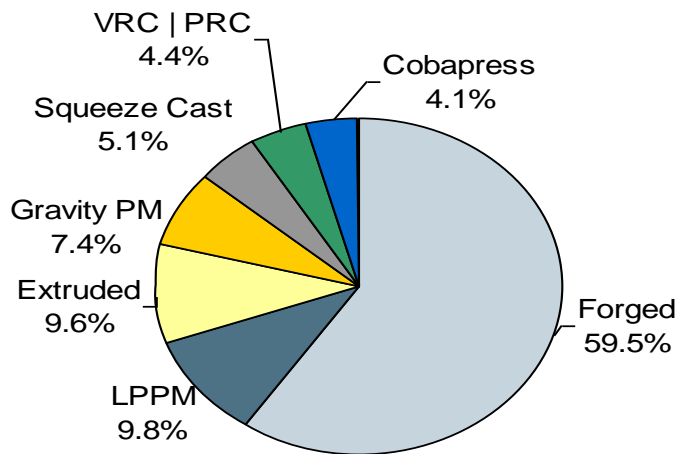


2009 Component Analysis

2009 North American Light Vehicle Aluminum Control Arms and Suspension Links

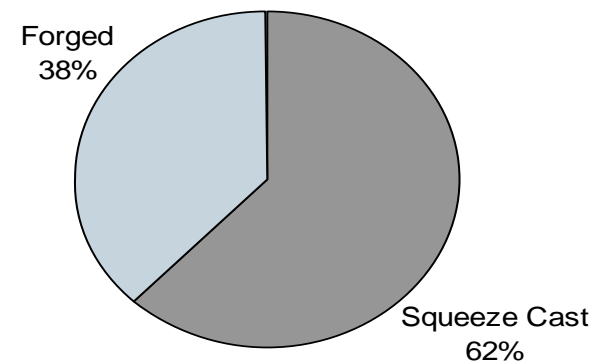
- Segmented by Process -

Control Arms



10.8 Million Units (6 Pounds per Unit)

Suspension Links



2.1 Million Units (3 Pounds per Unit)

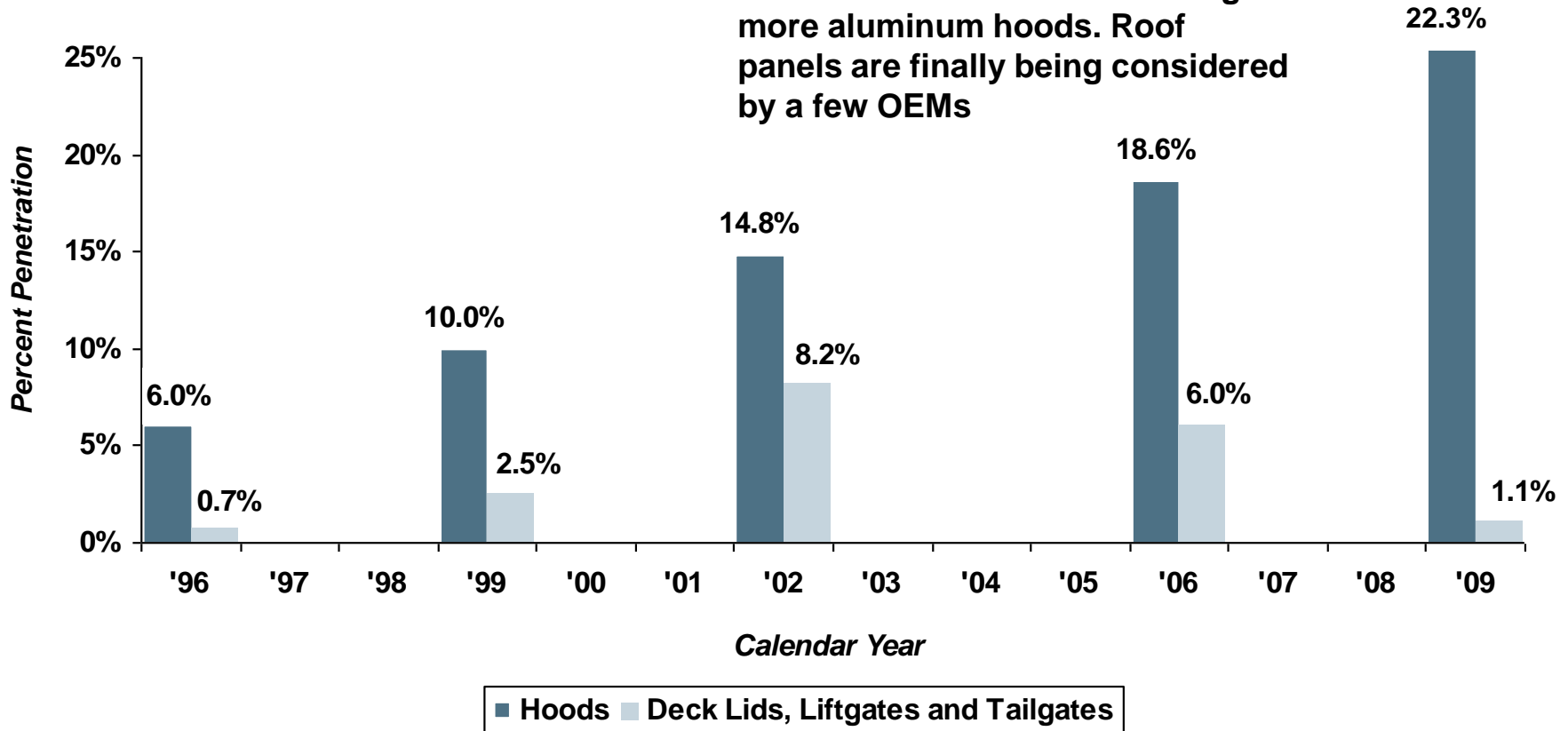
Forgings have become the predominant aluminum product form for control arms. The foreign domestic auto companies are partial to forgings over castings for arms and links.

2009 Component Analysis

North American Light Vehicle Aluminum Closures

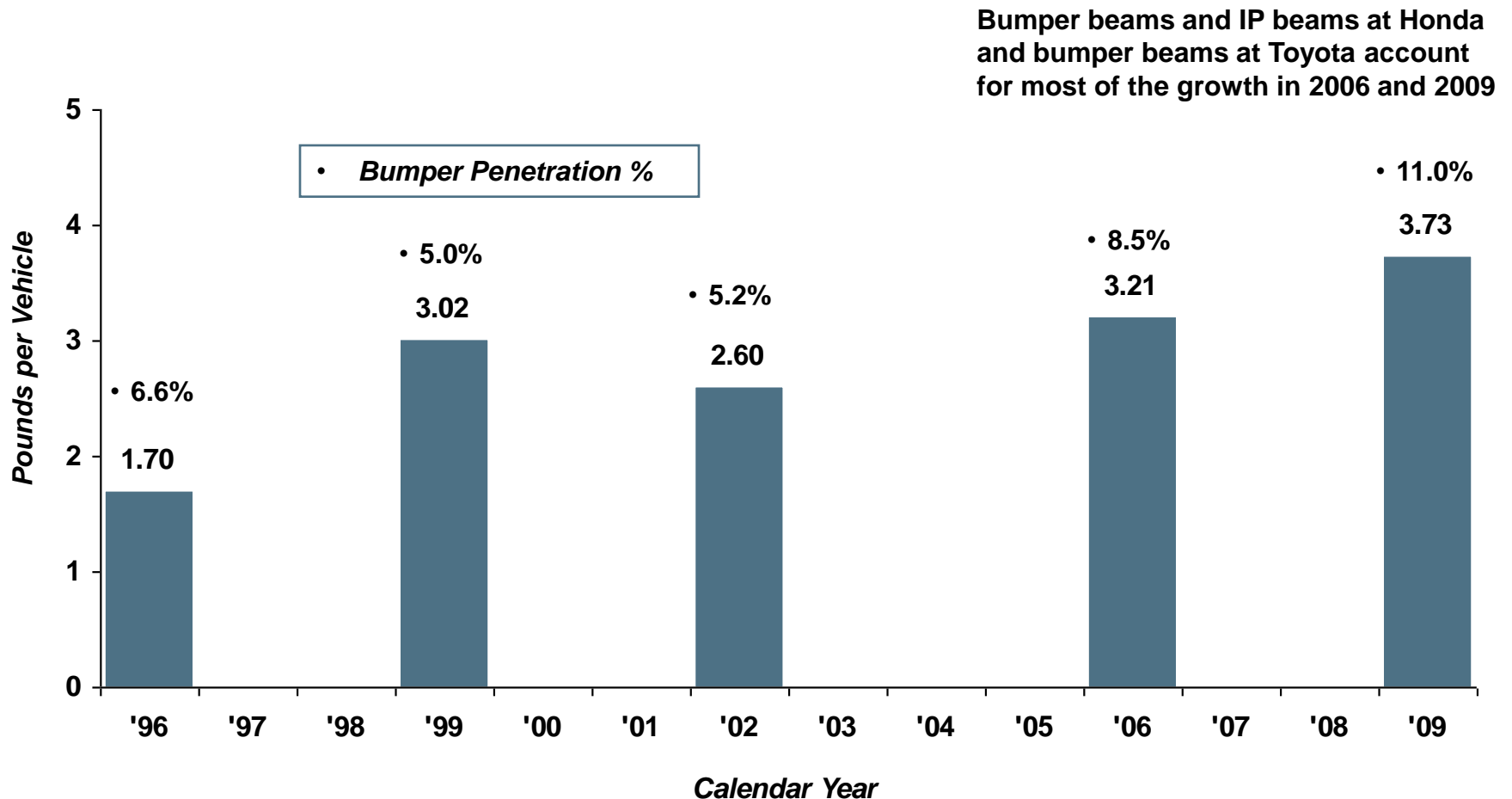
- Percent Penetration -

Several OEMs have removed aluminum deck lids and liftgates from their vehicles while adding more aluminum hoods. Roof panels are finally being considered by a few OEMs



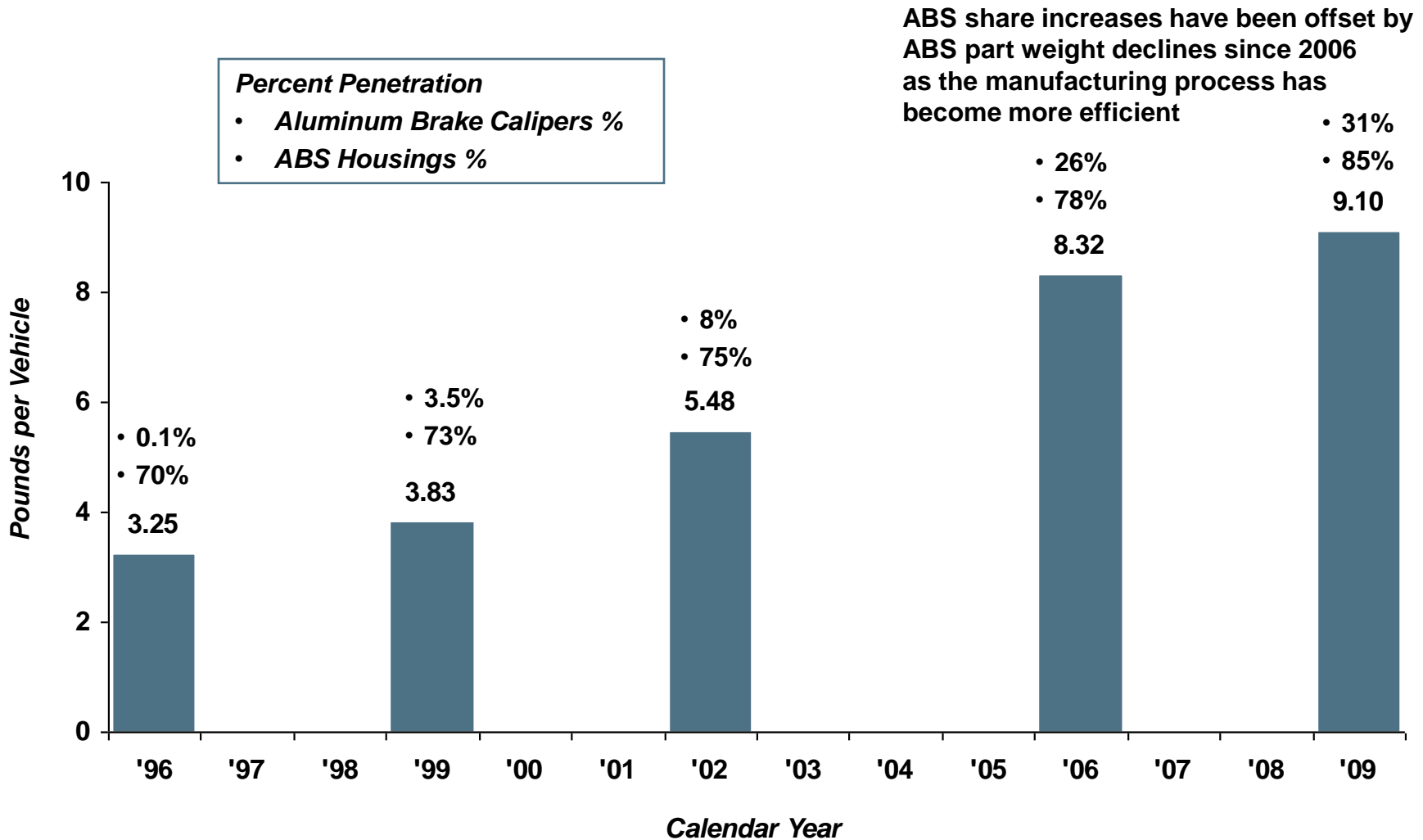
2009 Component Analysis

North American Light Vehicle Aluminum Content for Body, Bumper and IP Beams (Primarily Extruded Shapes)



2009 Component Analysis

North American Light Vehicle Aluminum Content for Brakes





2009 OEM ANALYSIS

2009 OEM Analysis

- In the last three years, Honda and BMW have displaced GM and Nissan as the aluminum content leaders in North America. BMW is the aluminum pounds per vehicle leader and Honda is the aluminum percent of curb weight leader. The shift away from large full frame vehicles at GM, Ford, Chrysler and Nissan has decreased part weight at these OEMs and indirectly reduced aluminum content. In addition, Nissan and Ford have been removing aluminum parts for cost saving reasons
- During this same period, OEMs such as Honda and BMW, who only make unibody vehicles, have been adding aluminum and advanced high strength steel parts at higher than historical rates. Diesel engines with CGI blocks at BMW hurt their aluminum content. If it were not for these iron blocks and some magnesium/aluminum blocks, BMW's aluminum content would average over 500 pounds per vehicle in North America versus the actual BMW aluminum weight of 421 pounds per vehicle
- In the last few years, our OEM and vehicle analysis has concentrated on using the international vehicle segments (shown on the next page) rather than the common breakdown of light passenger car versus light truck. The car versus truck breakdown is essentially meaningless for material analysis. Many light trucks weigh less than large cars. The international segments are based on footprint and engine displacement which do correlate with curb weight and aluminum content when segmented by full frame versus unibody. The comparisons to be made in Phase II require the international vehicle segmentation rather than the car versus truck comparison common in the U.S.

2009 OEM Analysis

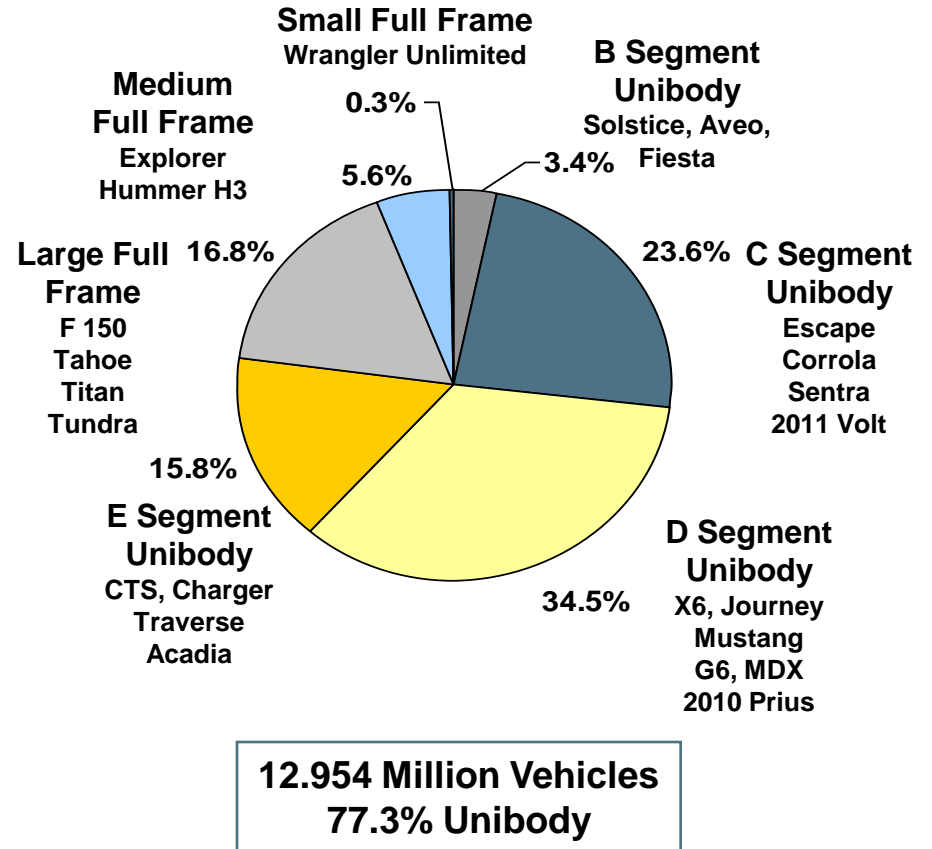
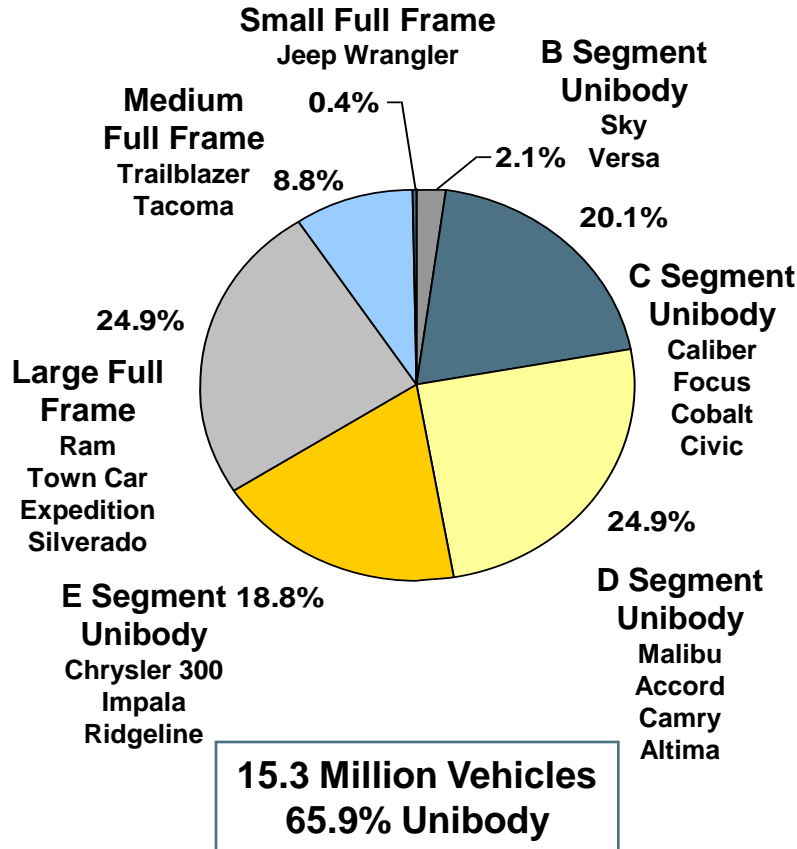
The long term shift to more vehicles in the B, C and D unibody vehicle segments should be beneficial to aluminum.

North American Light Vehicle Production

2006

- By Segment -

2009



2009 OEM Analysis

2006 vs. 2009 North American Full Frame Production by Segment

(000 of Units)

Segment	2006 Full Frame			2009 Full Frame		
	Small	Medium	Large	Small	Medium	Large
AM General	--	--	15.3	--	--	7.5
BMW	--	--	--	--	--	--
CAMI	--	--	--	--	--	--
Chrysler	62.3	105.3	496.6	40.2	85.8	312.9
Daimler	--	--	--	--	--	--
Ford	--	327.9	1,310.6	--	157.4	760.4
General Motors	--	420.1	1,716.0	--	170.2	867.5
Honda	--	--	--	--	--	--
Hyundai	--	--	--	--	--	--
Mitsubishi	--	--	--	--	--	--
Numni	--	170.8	--	--	135.0	--
Nissan	--	288.8	113.6	--	132.4	51.7
Subaru	--	--	--	--	--	--
Toyota	--	34.5	155.5	--	256.9	172.8
VW	--	--	--	--	407.4	--
Total	62.3	1,347.4	3,807.6	40.2	1,345.1	2,172.8

Source : CSM

2009 OEM Analysis

2006 vs. 2009 North American Unibody Production by Segment

(000 of Units)

Segment	2006 Unibody				2009 Unibody			
	- B -	- C -	- D -	- E -	- B -	- C -	- D -	- E -
AM General	--	--	--	--	--	--	--	--
BMW	38.7	--	65.9	--	--	--	163.2	--
CAMI	--	--	196.6	--	--	--	166.3	--
Chrysler	--	543.2	355.2	896.5	--	278.3	476.5	510.0
Daimler	--	--	104.1	69.5	--	--	102.6	56.3
Ford	6.5	479.2	721.9	216.0	2.3	563.4	650.9	227.0
General Motors	97.0	575.6	527.6	1,016.5	164.6	474.3	724.4	771.2
Honda	--	456.7	671.2	257.8	--	680.7	681.2	193.0
Hyundai	--	--	236.6	--	--	--	222.9	--
Mitsubishi	--	--	74.8	17.7	--	--	47.9	5.9
Numni	--	257.9	--	--	--	256.9	--	--
Nissan	177.8	178.5	269.4	122.5	268.8	144.4	345.1	85.0
Subaru	--	--	110.4	--	--	--	193.8	--
Toyota	--	240.5	480.8	272.2	--	256.9	694.5	194.8
VW	--	347.0	--	--	--	407.4	--	--
Total	320.0	3,078.6	3,814.5	2,868.7	435.7	3,062.3	4,469.3	2,043.2

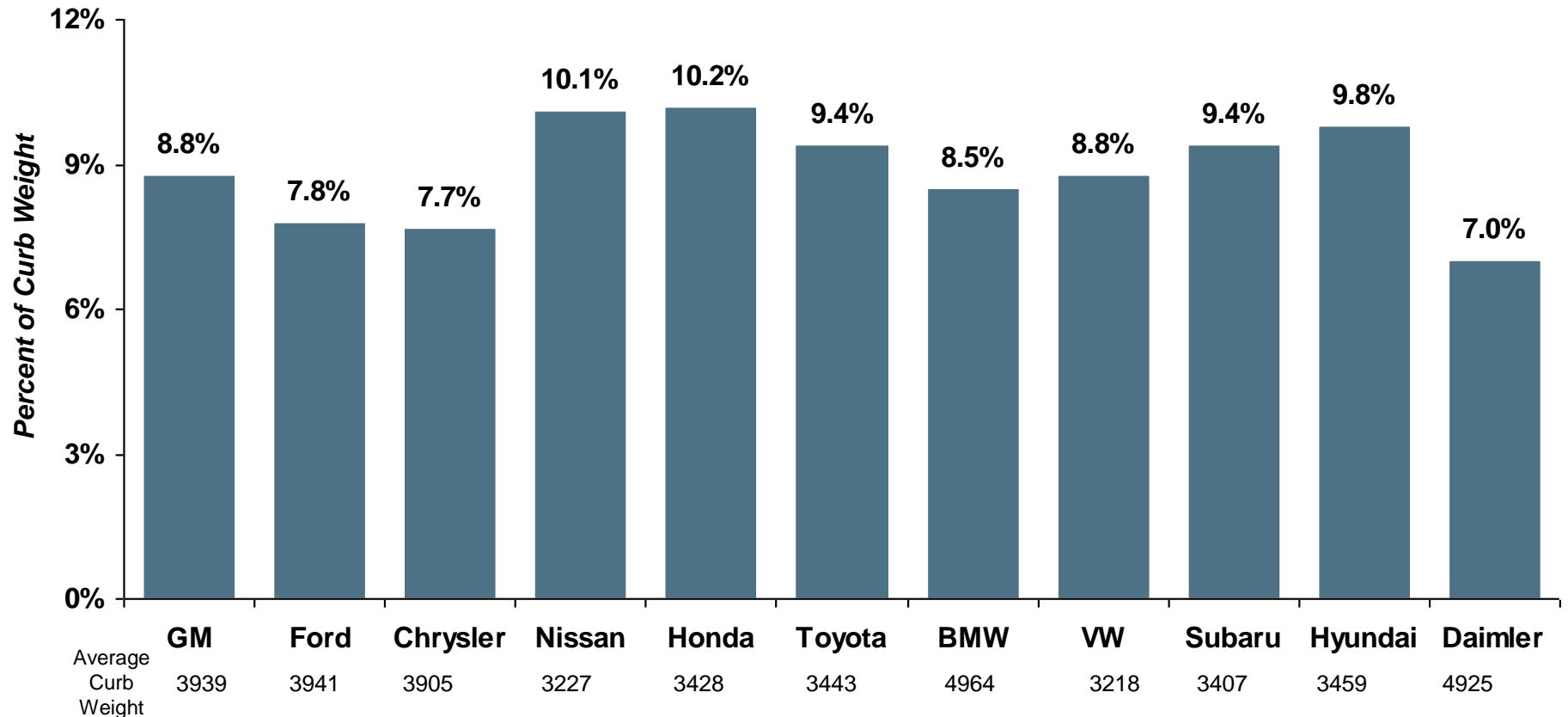
Source : CSM

2009 OEM Analysis

North American Light Vehicle Aluminum Content

- 2009 OEM Content as a Percent of OEM Curb Weight -

Honda is the aluminum content leader in North America based on aluminum as a percent of curb weight.



2009 OEM Analysis

North American Light Vehicle OEM Aluminum Summary

OEM	2009 Al Content (Pounds)	2009 Al % of Curb Weight	Al 2009 vs. 2006	Best Aluminum Vehicle Example	Future Aluminum Emphasis	Comments
BMW	421	8.5%	+13.0%	X6	Everything but complete bodies	BMW is also a leader in AHSS use for body structures
Honda	349	10.2%	+7.1%	Pilot/MDX	Everything but partial or complete bodies	Honda has become the aluminum content leader in the last three years
GM	346	8.8%	+5.5% (blocks)	Traverse	Everything but complete bodies	GM unibody vehicles will be 10% aluminum by 2011
Hyundai	339	9.8%	+0.6%	Santé Fe	Suspension parts and eventually hoods	Hyundai is moving toward aluminum, but needs some breakthrough body panels
Nissan	327	10.1%	-9.2% (chassis & closures losses)	Altima/Maxima	Eventually vehicles like the M45/M35 could come to North America	More emphasis on AHSS than aluminum. Altima subframes and deck lid went back to steel in 2008
Toyota	323	9.4%	+7.0% (wheels & bumpers)	RX 350/Highlander and 2011 Prius	Nonstructural cast parts & bumpers	Emphasis is on AHS Steel

2009 OEM Analysis

North American Light Vehicle OEM Aluminum Summary

OEM	2009 Al Content (Pounds)	2009 Al % of Curb Weight	Al 2009 vs. 2006	Best Aluminum Vehicle Example	Future Aluminum Emphasis	Comments
Ford	309	7.8%	-1.3% (mix & control arms losses)	Lincoln MKT	Hoods and partial body structures	AHSS for bumpers and control arms have replaced aluminum
Chrysler	301	7.7%	+4.5% (blocks)	Charger and Journey	Knuckles and suspensions, but approach is inconsistent	A merger with GM would help grow aluminum use at Chrysler. GM has a more consistent and aggressive approach to aluminum use
VW	283	8.8%	+8.0% (mix)	VW 411 platform in 2011	New vehicles with forged aluminum suspensions	In 2011, larger VW vehicles with more aluminum content will be made in the U.S.
Subaru	320	9.4%	-6.0% (Camry)	Tribeca	Taking off aluminum hoods and bumpers in 2010	Production of Toyota Camry has lowered average aluminum content at Subaru's Indiana plant
Daimler	345	7.0%	Flat	M Class	Suspensions and maybe hoods on next generation SUVs	U.S. SUVs are not enhanced with aluminum like the Daimler luxury passenger cars in Europe

2009 OEM Analysis

- The vehicles shown below are the **high volume** 2009 vehicles that use aluminum structural parts such as closures, bumpers, suspension arms and knuckles

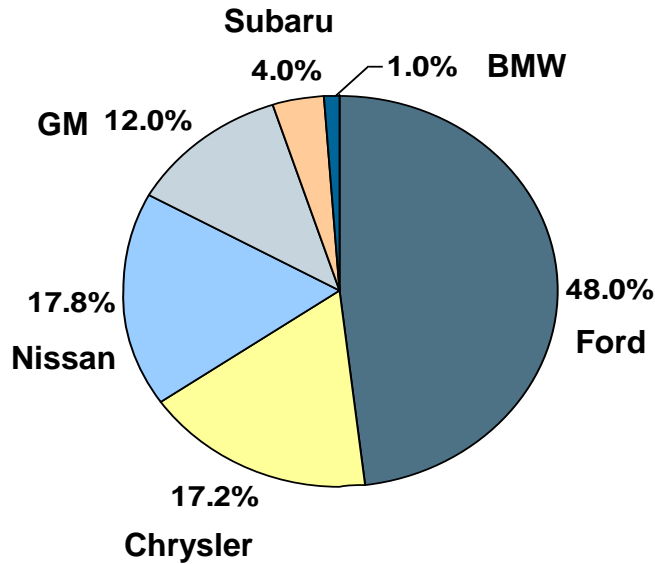
High Volume 2009 Light Vehicles with Aluminum Structural Parts											
Closure Leaders	Models	Variants	Suspension Leaders	Model	Variants	Bumper Leaders	Models	Variants	Knuckle Leaders	Models	Variants
BMW	X5		BMW	X5		BMW	X5		Ford	Flex	<i>MKT</i>
	X6			X6			X6			Malibu	<i>G6</i>
Chrysler	Town & Country	<i>Caravan</i>	Chrysler	300	<i>Charger</i>	Daimler	M-Class	<i>R-Class</i>	GM	Imapala	
	Charger	<i>300</i>		Ram				<i>G-Class</i>		VUE	
	Ram		GM	Malibu	<i>G6</i>	GM	CTS			Traverse	<i>Acadia</i>
Journey		Traverse			Lacrosse		<i>Allure</i>			<i>Enclave</i>	
Ford	F-150	<i>F Super Duty</i>	Honda	Pilot	<i>MDX</i>	Honda	Civic		Honda	Civic	
	Mustang				Traverse		<i>Acadia</i>	TL			Accord
GM	Traverse	<i>Acadia</i>			Nissan	Altima	<i>Maxima</i>	Toyota		Venza	
		<i>Enclave</i>					Sienna				Pilot
Honda	Pilot	<i>MDX</i>					RX	<i>Highlander</i>	Nissan	Altima	<i>Maxima</i>
Nissan	Altima	<i>Maxima</i>									

2009 OEM Analysis

North American Light Vehicle Aluminum Closures

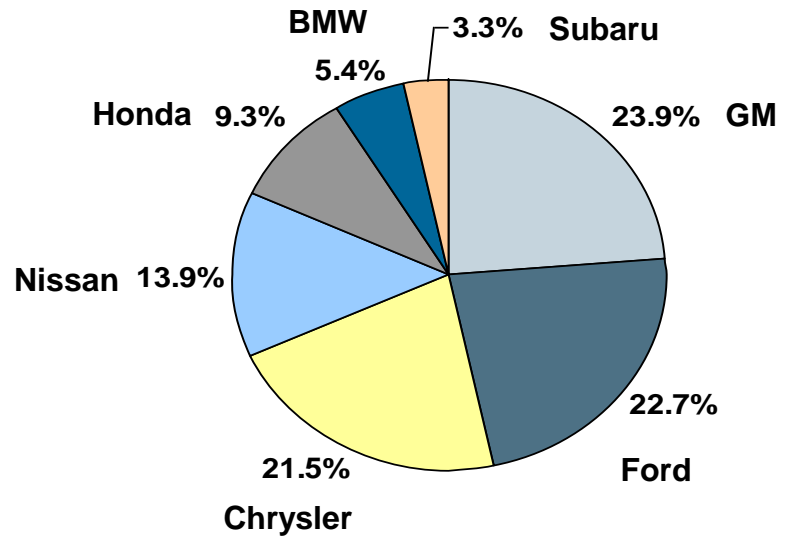
- Segmented by OEM -

2006



3.790 Million Parts
0.25 Parts Per Vehicle
39 Programs

2009



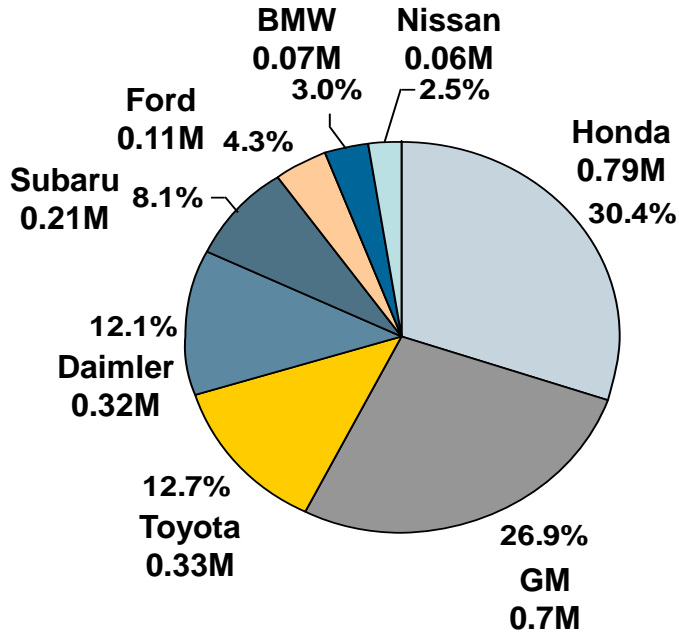
3.03 Million Parts
0.24 Parts Per Vehicle
46 Programs

2009 OEM Analysis

North American Light Vehicle Aluminum Bumper Beams

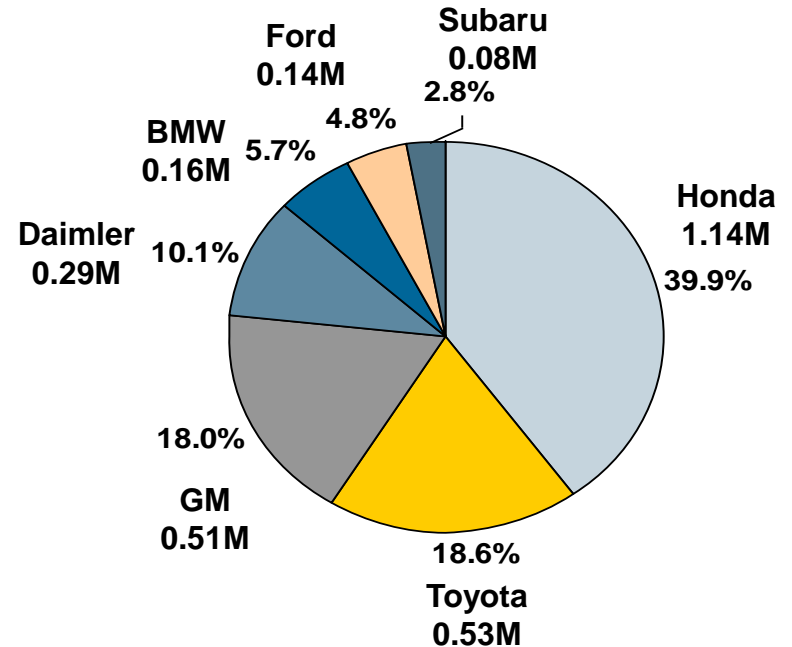
- Segmented by OEM -

2006



**2.6 Million Parts
1.91 Pounds Per Vehicle**

2009



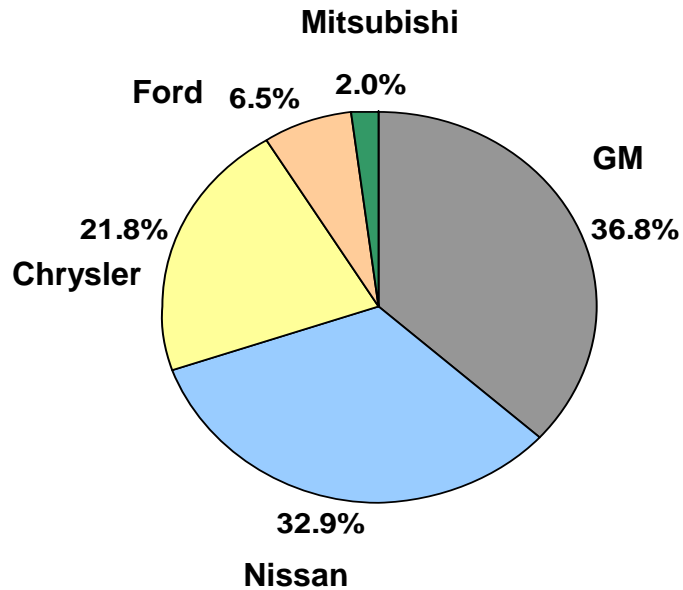
**2.848 Million Parts
2.4 Pounds Per Vehicle**

2009 OEM Analysis

North American Light Vehicle Aluminum Cradles, Crossmembers and Subframes

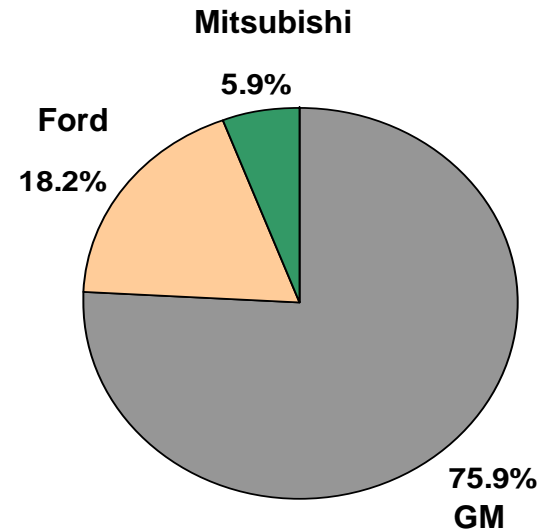
- Segmented by OEM -

2006



2.0 Million Units

2009



**0.568 Million Units
(an 80% decline)**

2009 OEM Analysis

North American Light Vehicle Aluminum Control Arm and Links

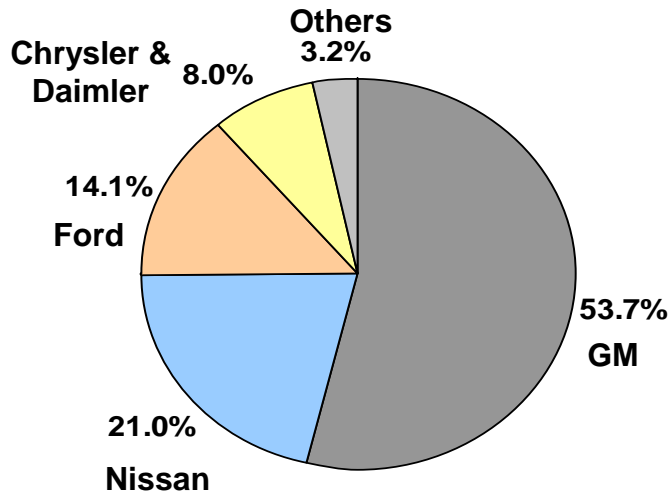
- Total Weight Segmented by OEM -

Weight is a better measure of OEM usage than units

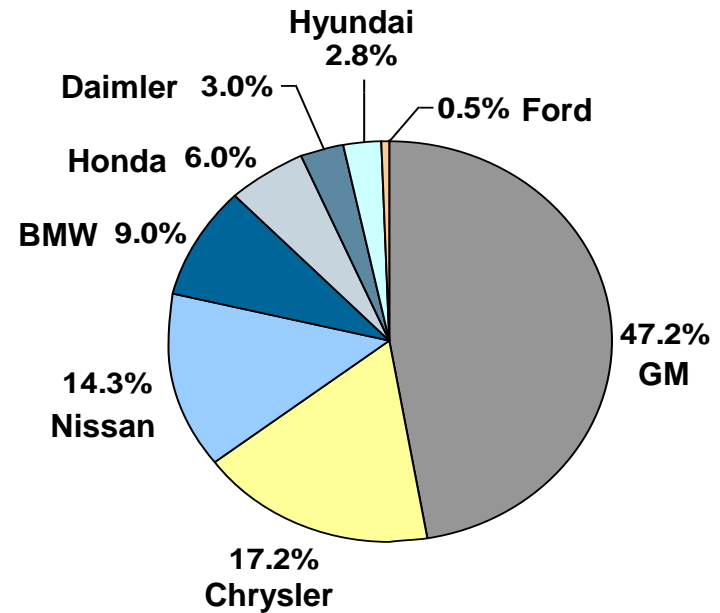
2006

W

2009



10.6 Million Units
9 Arms/1.6 Links
63 Million Lbs.



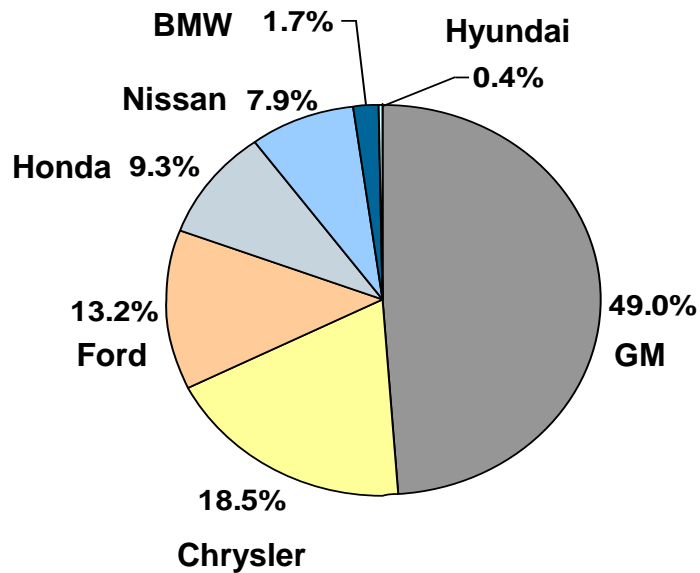
12.92 Million Units
10.8 Arms/2.1 Links
71 Million Lbs.

2009 OEM Analysis

North American Light Vehicle Aluminum Steering Knuckles

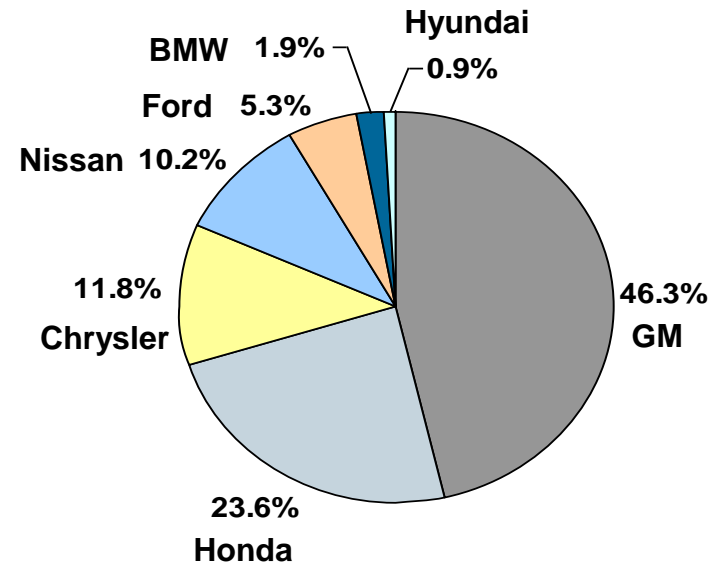
- Segmented by OEM -

2006



15.0 Million Units

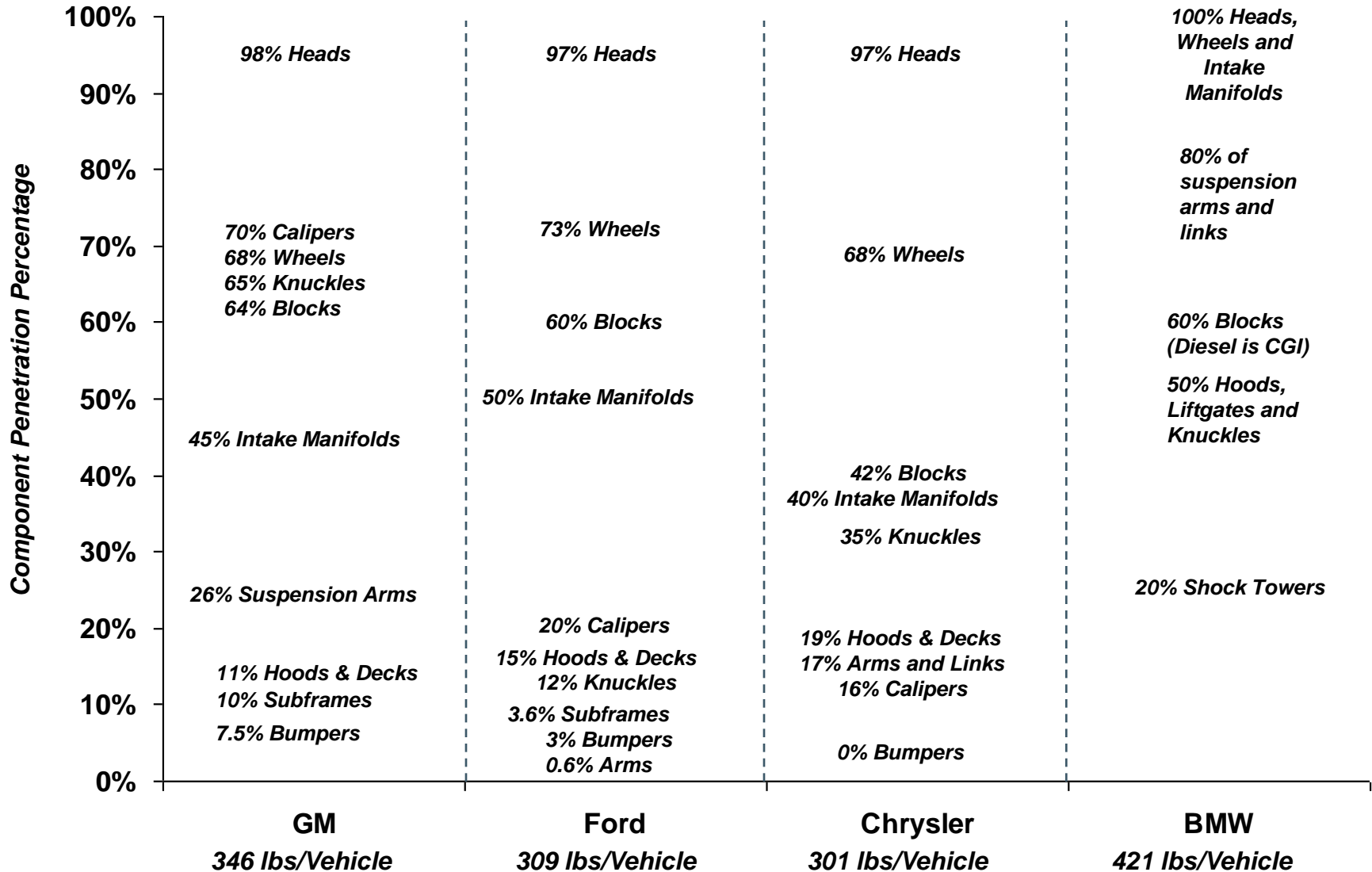
2009



16.8 Million Units

2009 OEM Analysis

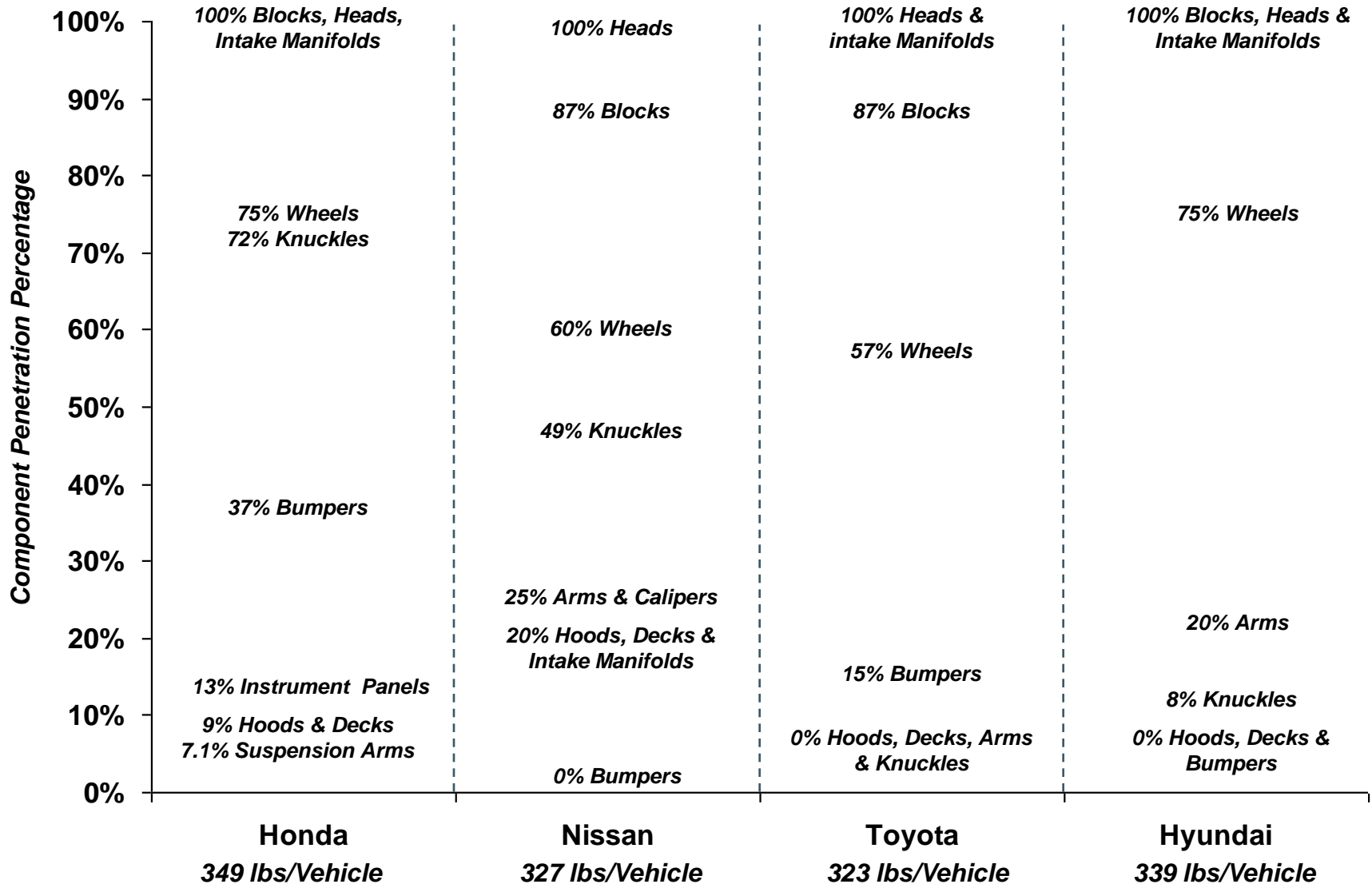
North American Light Vehicle 2009 Aluminum Penetration - By OEM Component -



2009 OEM Analysis

North American Light Vehicle 2009 Aluminum Penetration

- By OEM Component -



2009 OEM Analysis

North American Light Vehicle Aluminum Content

- 2006 Versus 2009 Total Pounds

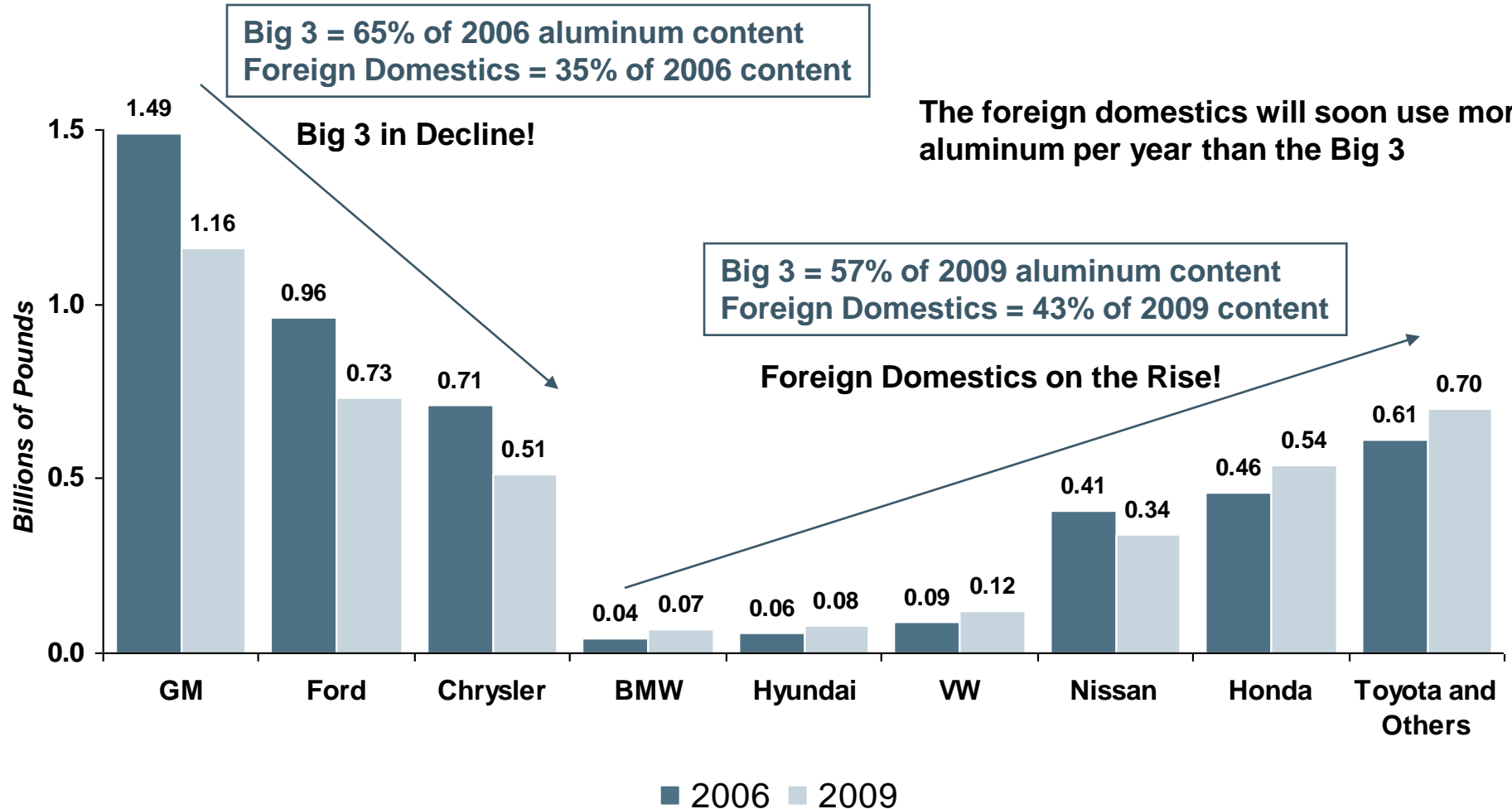
Big 3 = 65% of 2006 aluminum content
Foreign Domestics = 35% of 2006 content

The foreign domestics will soon use more aluminum per year than the Big 3

Big 3 in Decline!

Big 3 = 57% of 2009 aluminum content
Foreign Domestics = 43% of 2009 content

Foreign Domestics on the Rise!



2009 OEM Analysis



2009 BMW X6 4.4L V8 – D Segment Unibody

- 500 Pounds of finished aluminum with V8 engine (only 415 pounds with V6 CGI diesel block)
- Aluminum is 10% of overall weight for V8
- Hood is aluminum
- 80% of suspension arms and links are aluminum
- One pair of rear aluminum knuckles
- Vacuum die cast Shock Towers are aluminum



2009 DODGE JOURNEY-D Segment Unibody

- 390 Pounds of finished aluminum
- Aluminum is 10% of overall weight
- Hood is aluminum
- One pair of aluminum suspension arms

2009 OEM Analysis



2009 HONDA PILOT- D Segment Unibody

- 434 Pounds of finished aluminum
- 10.3% of overall weight is aluminum
- Hood is aluminum
- Instrument panel structure is aluminum
- One pair of suspension arms are forged aluminum
- One pair of knuckles is cast aluminum



2009 CHEVROLET TRAVERSE- E Segment Unibody

- 422 Pounds of finished aluminum
- 8.9% of overall weight is aluminum
- Hood is aluminum
- One pair of aluminum suspension arms
- Knuckles are 100% aluminum

2009 OEM Analysis



2009 DODGE CHARGER- E Segment Unibody

- 413 Pounds of finished aluminum
- 10.9% of overall weight is aluminum
- Hood is aluminum
- Two pairs of aluminum suspension arms
- One pair of aluminum knuckles



2009 NISSAN ALTIMA- D Segment Unibody

- 409 Pounds of finished aluminum
- 13% of overall weight is aluminum
- Hood is aluminum
- Two pairs of aluminum suspension arms
- One pair of aluminum knuckles

2009 OEM Analysis



2009 HONDA CIVIC- C Segment Unibody

- 310 Pounds of finished aluminum
- 11.5% of overall weight is aluminum
- Front and rear aluminum bumper beams
- Two pairs of aluminum knuckles



2010 LINCOLN MKT (2009 PRODUCTION) E Segment Unibody

- 431 Pounds of finished aluminum
- 10.6% of overall weight is aluminum
- Hood is aluminum
- Two pairs of aluminum suspension arms
- One pair of aluminum knuckles



EXPERT INTERVIEWS

Expert Interviews

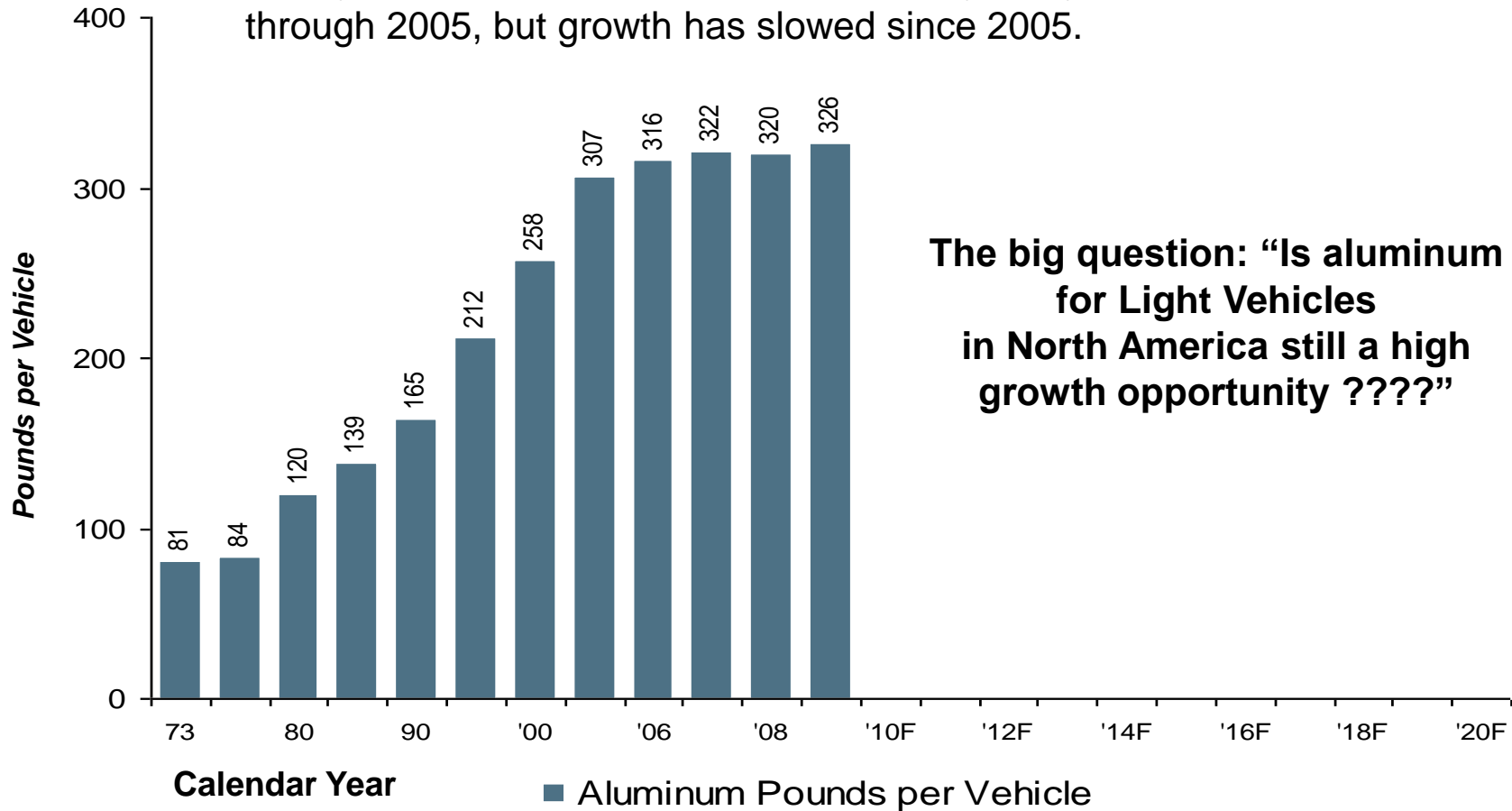
- With aluminum content up only ten pounds per vehicle in the last three years it is appropriate to ask the question “Is aluminum for light vehicles still a high growth opportunity?”
- To help answer that question in the context of volatile fuel prices and the government mandate to improve fuel economy to 35 miles per gallon by 2020, Ducker decided to seek organized input from over thirty automotive material experts. None of these experts were affiliated with any material producer so as to reduce bias toward specific metals or other materials. Over 60% of the experts used were well respected body, chassis and suspension engineers from the OEMs
- The results of the interviews are shown and discussed in the next fourteen pages
- The long term view of the significant role aluminum is likely to play and type of aluminum components that will generate the most growth was very positive and at the same time quite practical and achievable. Aluminum and advanced high strength steel substitution combined is only being counted on to improve fuel economy by a few MPG by 2020 even with secondary weight savings. This is a realistic view in our opinion
- What this is likely to mean for long term aluminum content and future component mix is discussed in the Forecast Section of this document

Expert Interviews

North American Light Vehicle Aluminum Content

- History and Forecast -

Nearly 50 lbs. of new aluminum parts every five years from 1990 through 2005, but growth has slowed since 2005.

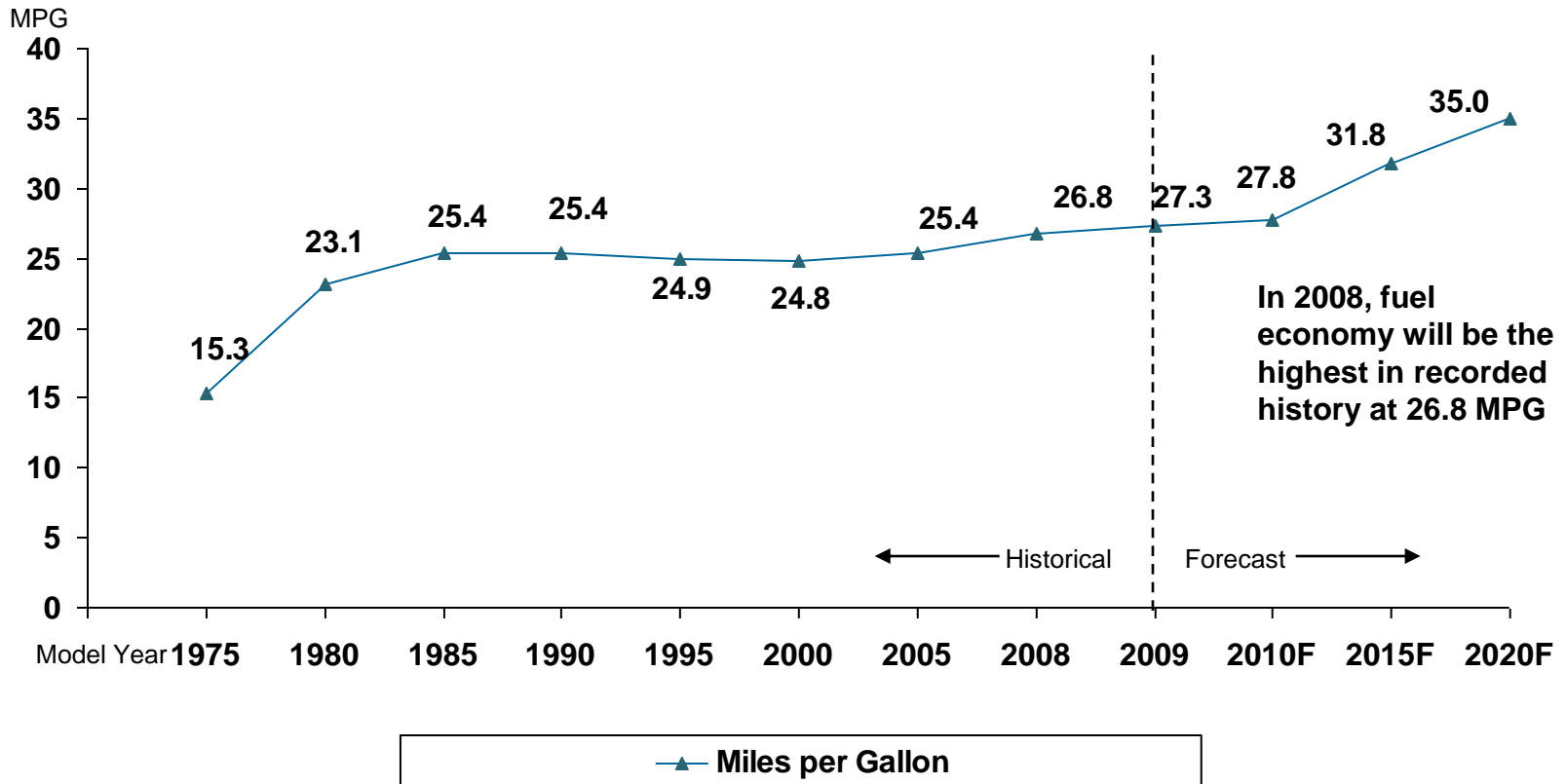


Expert Interviews

North American Light Vehicle Fuel Economy Measured in Miles per Gallon

- History and Forecast -

What role is aluminum most likely to play in achieving the 35 MPG mandate?



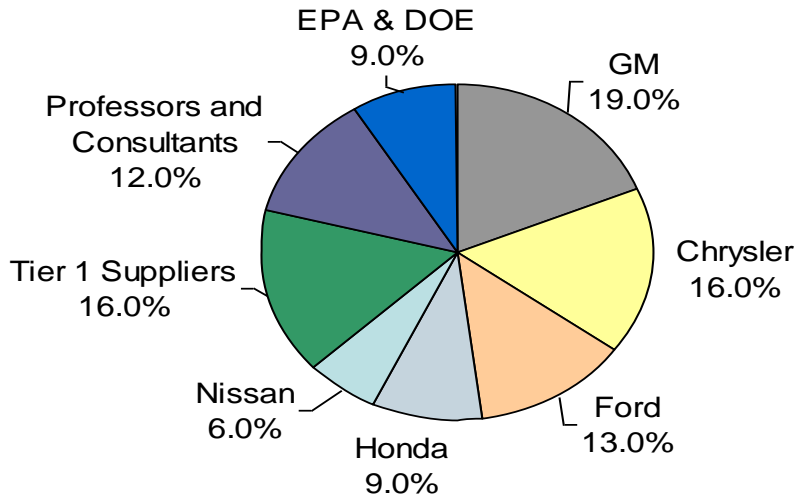
Expert Interviews

CAFÉ Survey Results and Analysis - Survey Importance Rating Scale

- Thirty two Experts (both OEM and Non-OEM) were asked to rate the importance of 14 options that might help to improve fuel economy by 2020 using the following scale:
 1. Insignificant
 2. Somewhat Significant
 3. Significant
 4. Very Significant
 5. Extremely Significant
- The same expert respondents were also asked five specific questions about aluminum. None of the respondents were affiliated with aluminum, steel, magnesium or plastics companies or associations.
- The participants / respondents were told they would receive a tabulation of results in return for their participation in the survey and the interviews. The following ten slides are our interpretation of the results:

Expert Interviews

Survey Respondents Segmented by Affiliation



32 Expert Interviews

Only Toyota declined to be interviewed

These are not consensus opinions just examples of comments

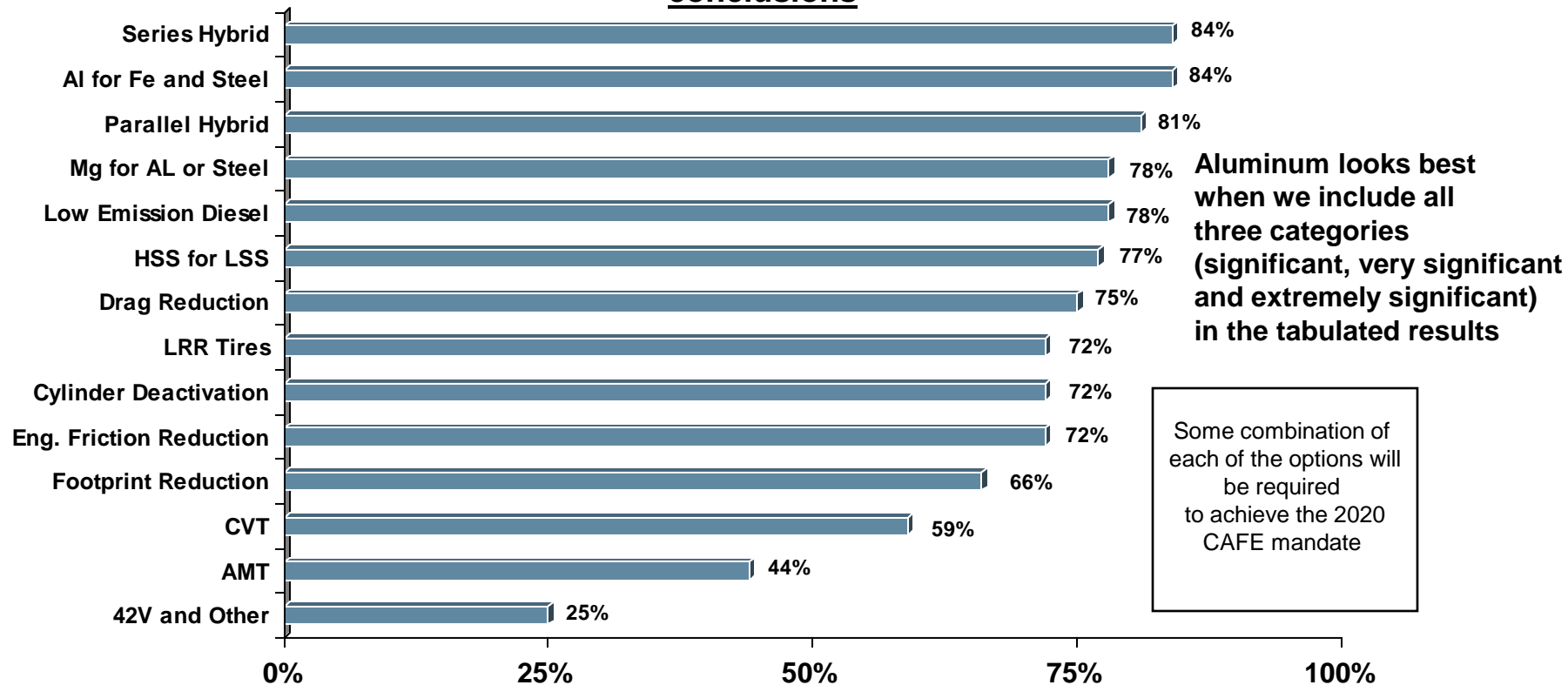
OEM Verbatims

- *“We see no evidence that steel will take back share from aluminum”*
- *“Cost will always be more important than weight savings for some vehicle segments”*
- *“Aluminum will easily be over 10% of curb weight by 2020, unless magnesium has a breakthrough in the powertrain”*
- *“Safety mandates such as roll over and side impact improvements are pushing us toward ultra high strength steels” (boron and martensite)*
- *“Handling issues may drive partial aluminum structures more than improved fuel economy.”*
“Aluminum competes better on NVH than on bearing the high loads required for safety critical body parts”
- *“Partial aluminum structures will only thrive when the components can be bolted into the final structure and not have to be welded, riveted or glued into the steel BIW”*

Expert Interviews

Expert OEM and Non OEM Opinions on the Significance of Various Options Needed to Improve Fuel Economy to 35 MPG by 2020

Actual Responses tabulated in the Appendix. Client can use the data to arrive at their own conclusions

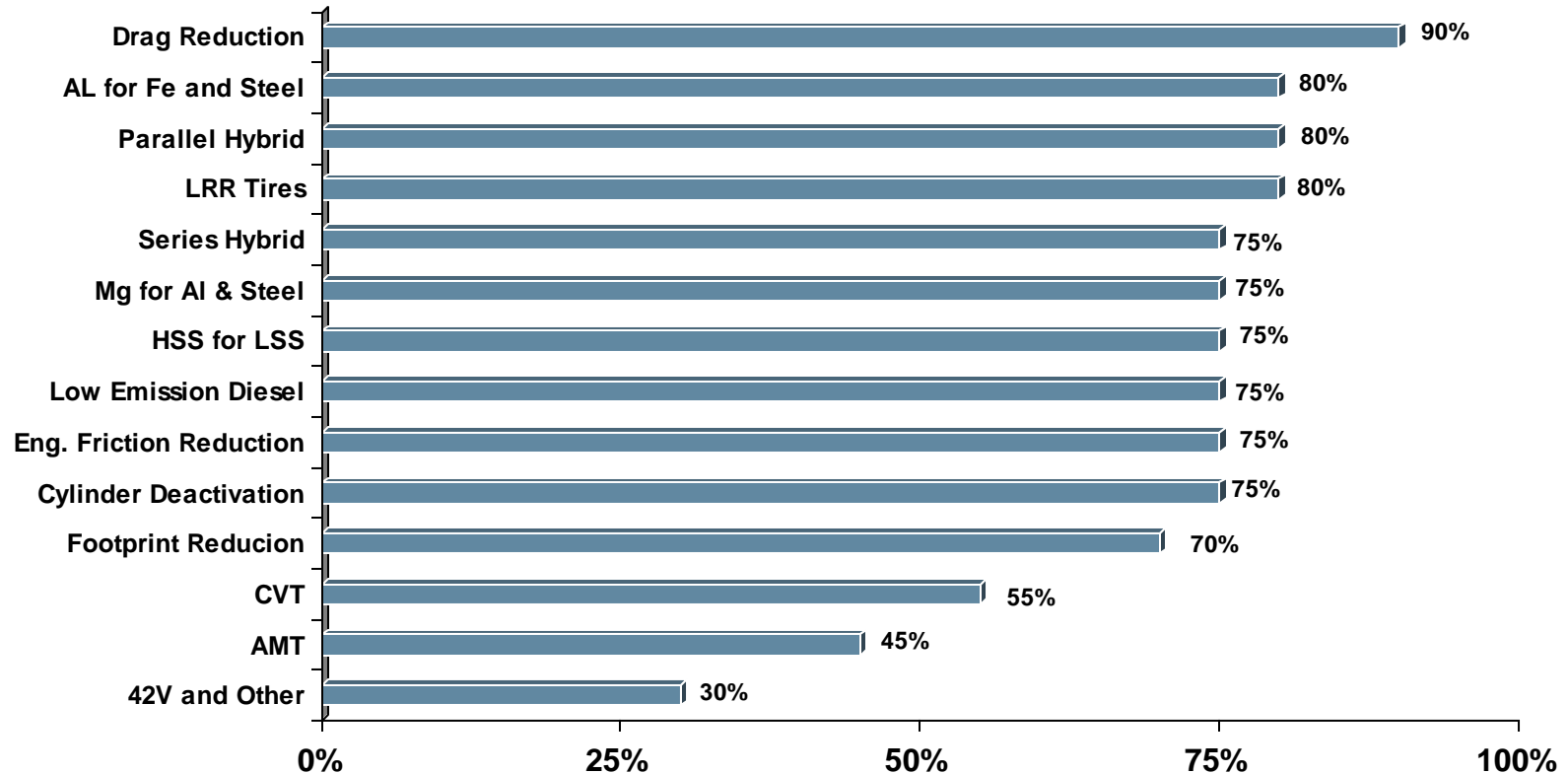


Percent of Experts Rating the Option: **Significant** | **Very Significant** | **Extremely Significant**

Expert Interviews

OEM Opinions on the Significance of Various Options Needed to Improve Fuel Economy to 35 MPG by 2020

Actual Responses Tabulated in the Appendix

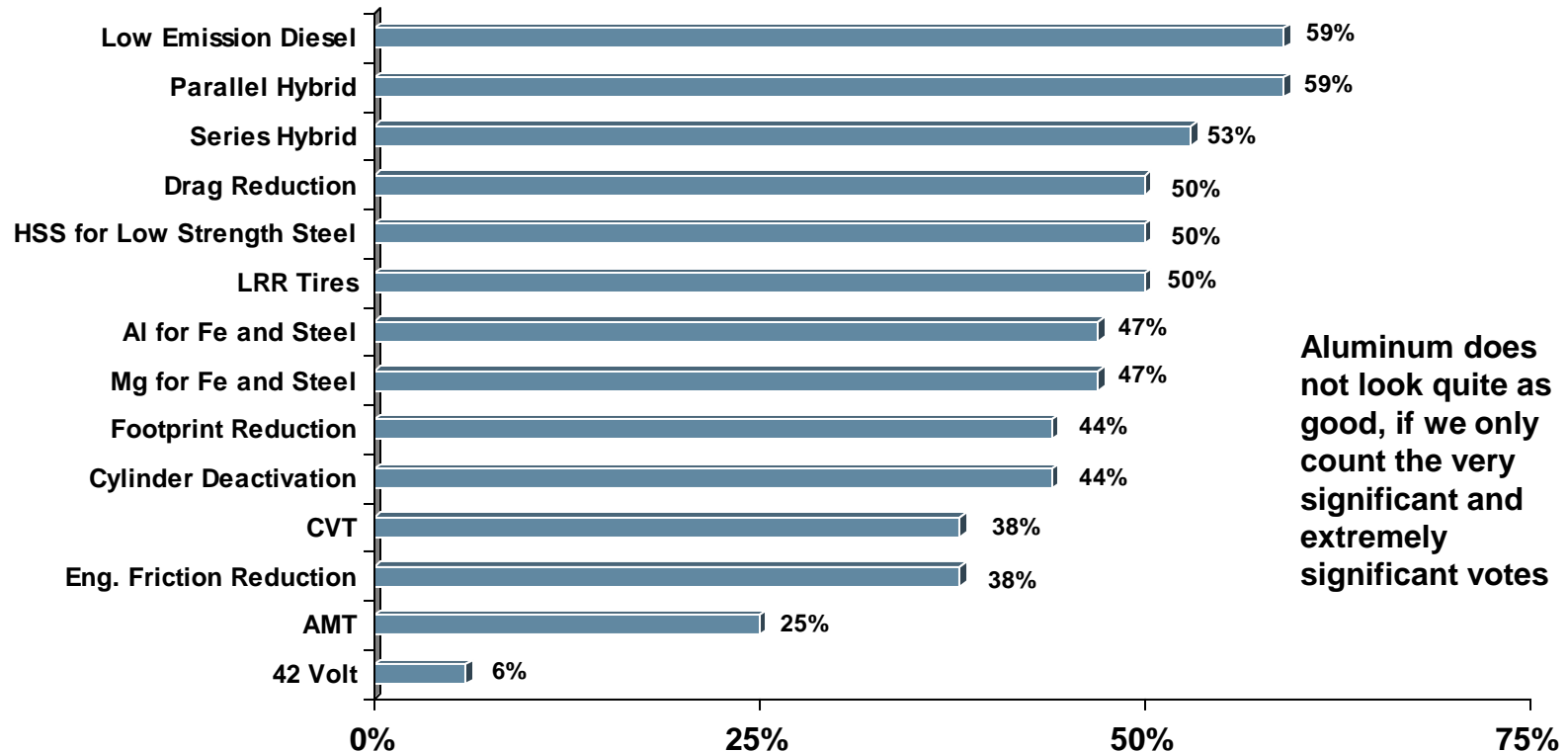


Percent of OEMs Rating the Option: **Significant | Very Significant | Extremely Significant**

Expert Interviews

Expert OEM and Non OEM Opinions on the Significance of Various Options Needed to Improve Fuel Economy to 35 MPG by 2020

Actual Responses Tabulated in the Appendix

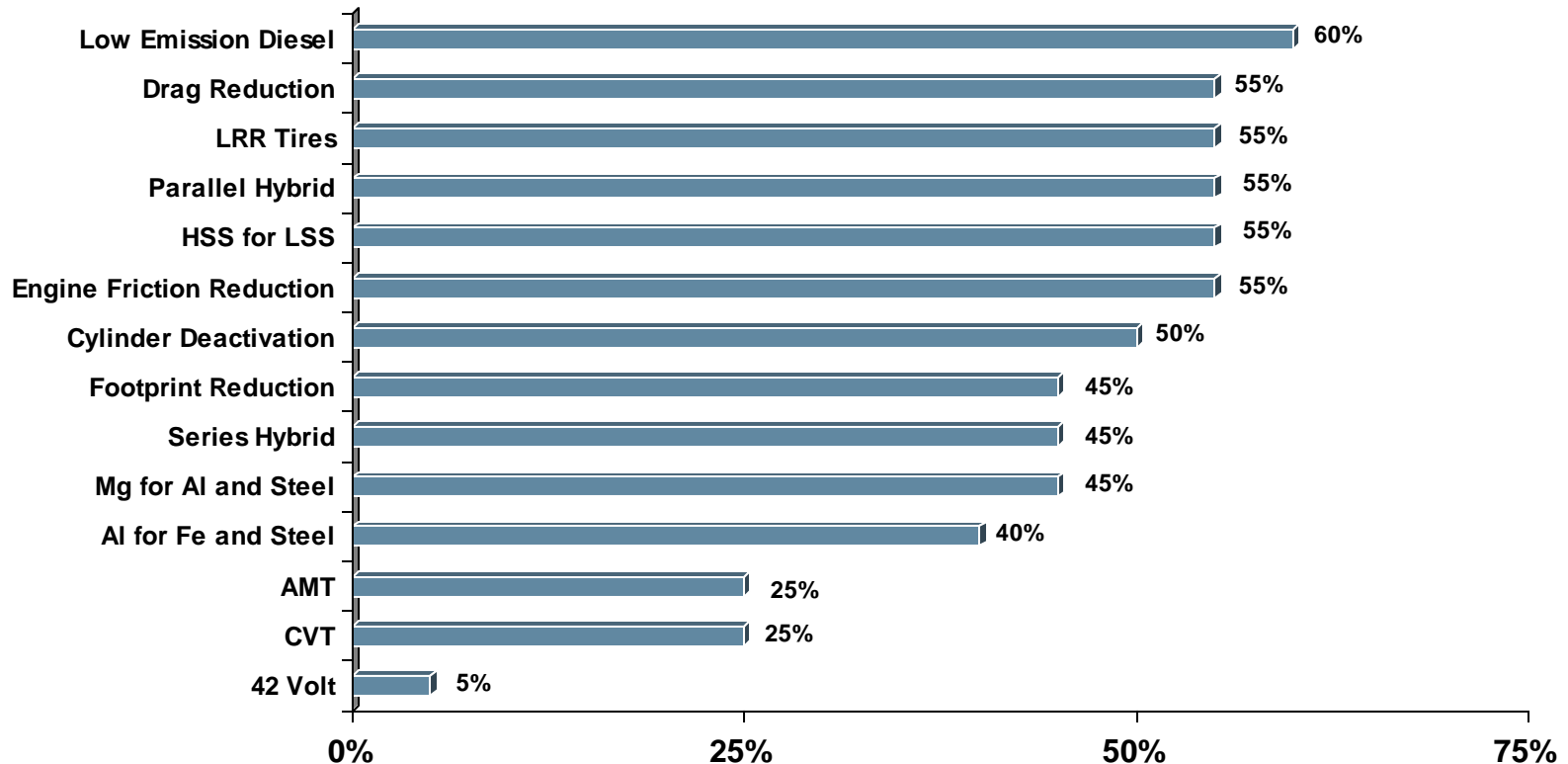


Percent of Experts Rating the Option: **Very Significant | Extremely Significant**

Expert Interviews

OEM Opinions on the Significance of Various Options Needed to Improve Fuel Economy to 35 MPG by 2020

Actual Responses Tabulated in the Appendix

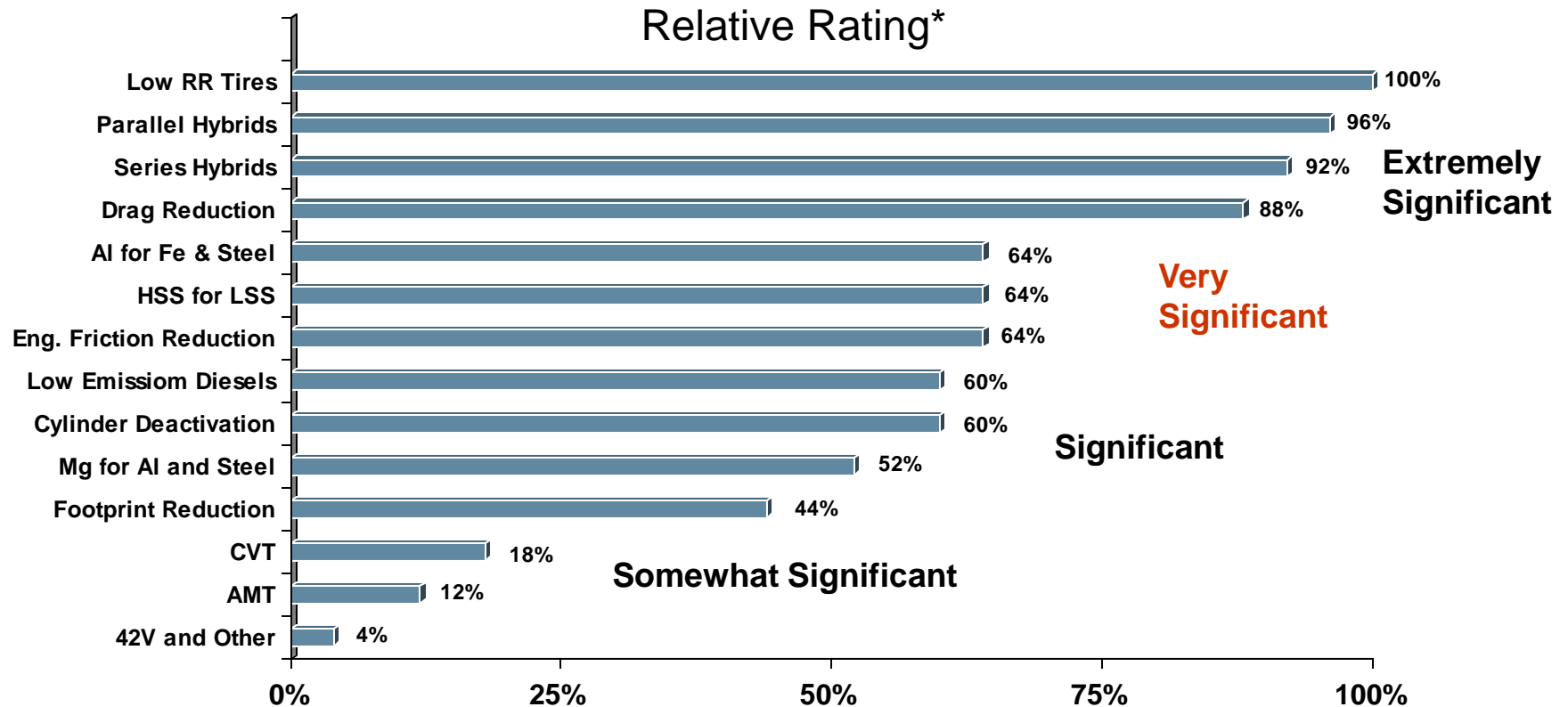


Percent of OEMs Rating the Option: **Very Significant | Extremely Significant**

Expert Interviews

This chart is recommended for public distribution

Expert and OEM Opinions on the Significance of Various Options Needed to Improve Fuel Economy to 35 MPG by 2020



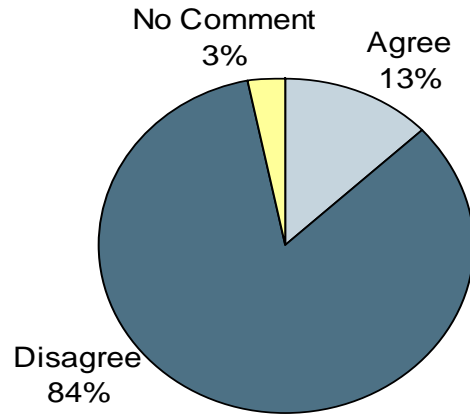
*Uses all the data with OEM responses given double weight

Relative Rating of Significance

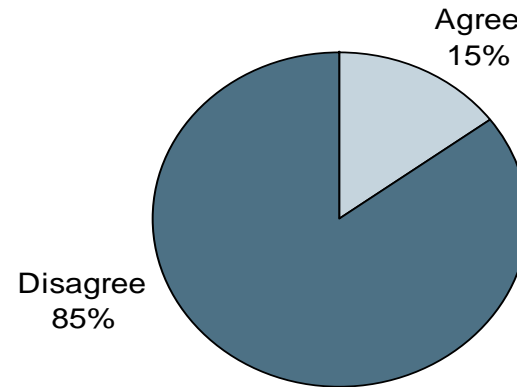
Expert Interviews

CAFÉ Survey Results and Analysis - Scenario A

- “Mass produced vehicles with **complete aluminum body structures**, such as the Jaguar XK and Audi A8, will begin to be manufactured or at least planned in North America before 2015 with over 5% of total production or about one million units in production by 2020”



All Respondents N=32 Including OEMs



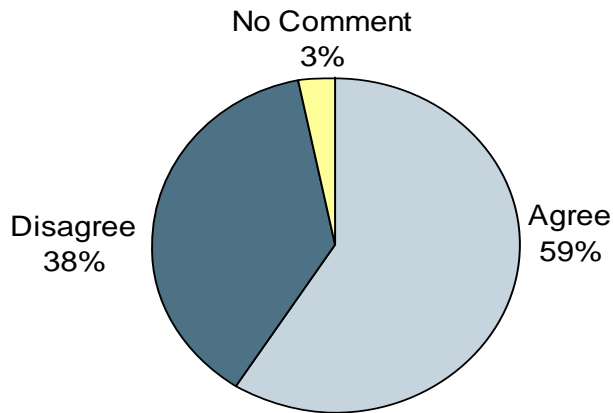
OEM Respondents N=20

- Conclusion:** There is a **less than a 15% probability** that there will be a significant number of **mass produced full aluminum bodies** by 2020

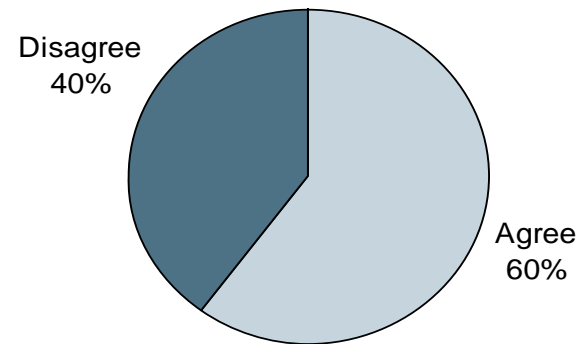
Expert Interviews

CAFÉ Survey Results and Analysis - Scenario B

- “Mass produced vehicles with **aluminum intense partial body structures**, such as the BMW 5 and 6 Series, will begin to be manufactured or at least planned in North America before 2015 with over 5% of total production or one million units in production by 2020”



All Respondents N=32 Including OEMs



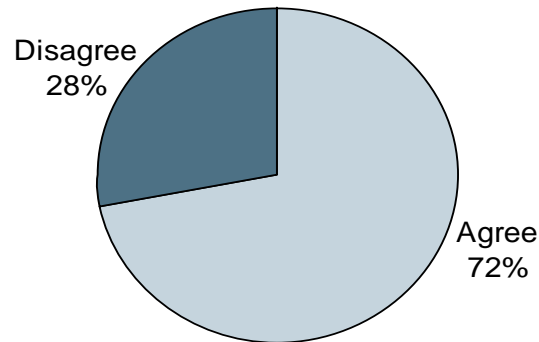
OEM Respondents N=20

- Conclusion:** There is a **60% probability** that a significant number of vehicles with **partial aluminum body structures** will be in production by 2020

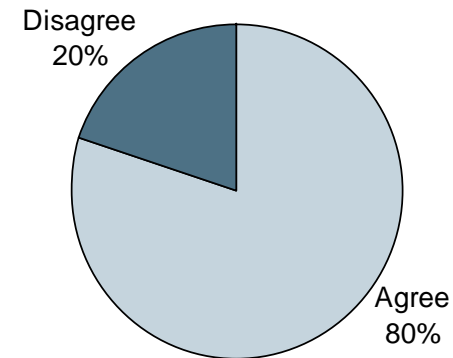
Expert Interviews

CAFÉ Survey Results and Analysis - Scenario C

- **“Aluminum growth** for closures, suspensions, engine blocks and smaller components will continue at the historical rate of capturing an additional **four to six pounds per year** of vehicle content between now and 2020”



All Respondents N=32 Including OEMs



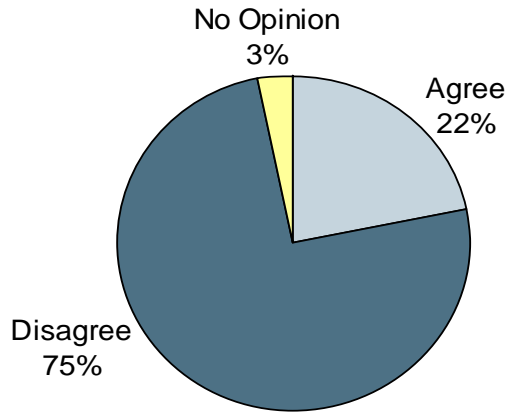
OEM Respondents N=20

- **Conclusions:** There is a **75% probability** that aluminum content growth will remain in the **four to six pounds per vehicle per year** range through 2020 in addition to what growth there is for aluminum partial and complete body structures. We believe that the 2008 decline in aluminum content is an **aberration** caused by mix shift and the one time loss of most subframes and cradles to steel

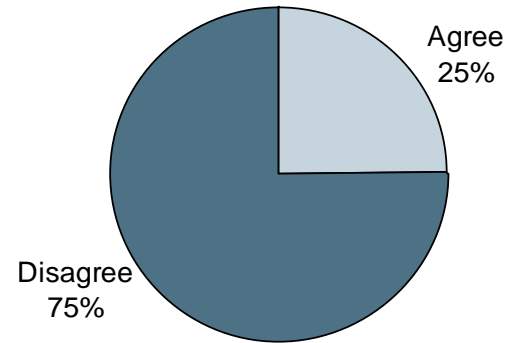
Expert Interviews

CAFÉ Survey Results and Analysis - Scenario D

- **“New aluminum programs will stagnate** by 2020 and total aluminum content per vehicle will plateau at approximately 9% of vehicle weight or 350 to 360 pounds per vehicle compared to 316 pounds per vehicle or 8% of vehicle weight in 2006”



All Respondents N=32 Including OEMs



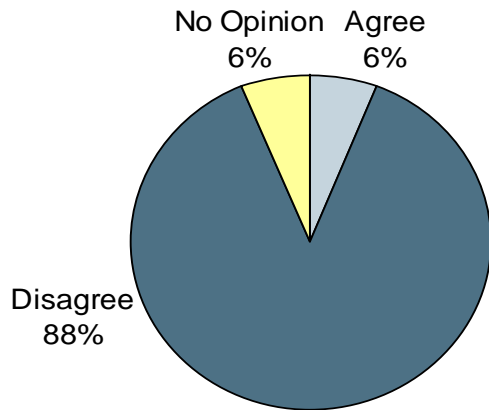
OEM Respondents N=20

- **Conclusion:** There is a **75% probability** that aluminum content will grow to **more than 350 to 360 pounds per vehicle** over the next twelve years and there is only a 25% probability of any decline in aluminum content during this period

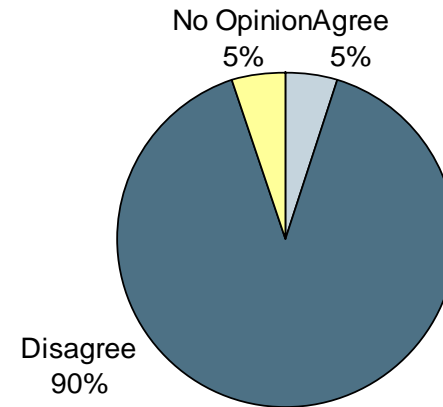
Expert Interviews

CAFÉ Survey Results and Analysis - Scenario E

- “Aluminum content will begin to gradually decline over the next six to twelve years as **steel takes back lost applications** for wheels, closures, bumper beams and suspension components, magnesium penetrates the powertrain and diesel engines with iron blocks capture over 10% of the market”



All Respondents N=32 Including OEMs



OEM Respondents N=20

- Conclusion:** There is a **very low probability**, less than 10%, that **aluminum will lose any significant share** to steel, iron or magnesium over the next twelve years



2020 FORECAST

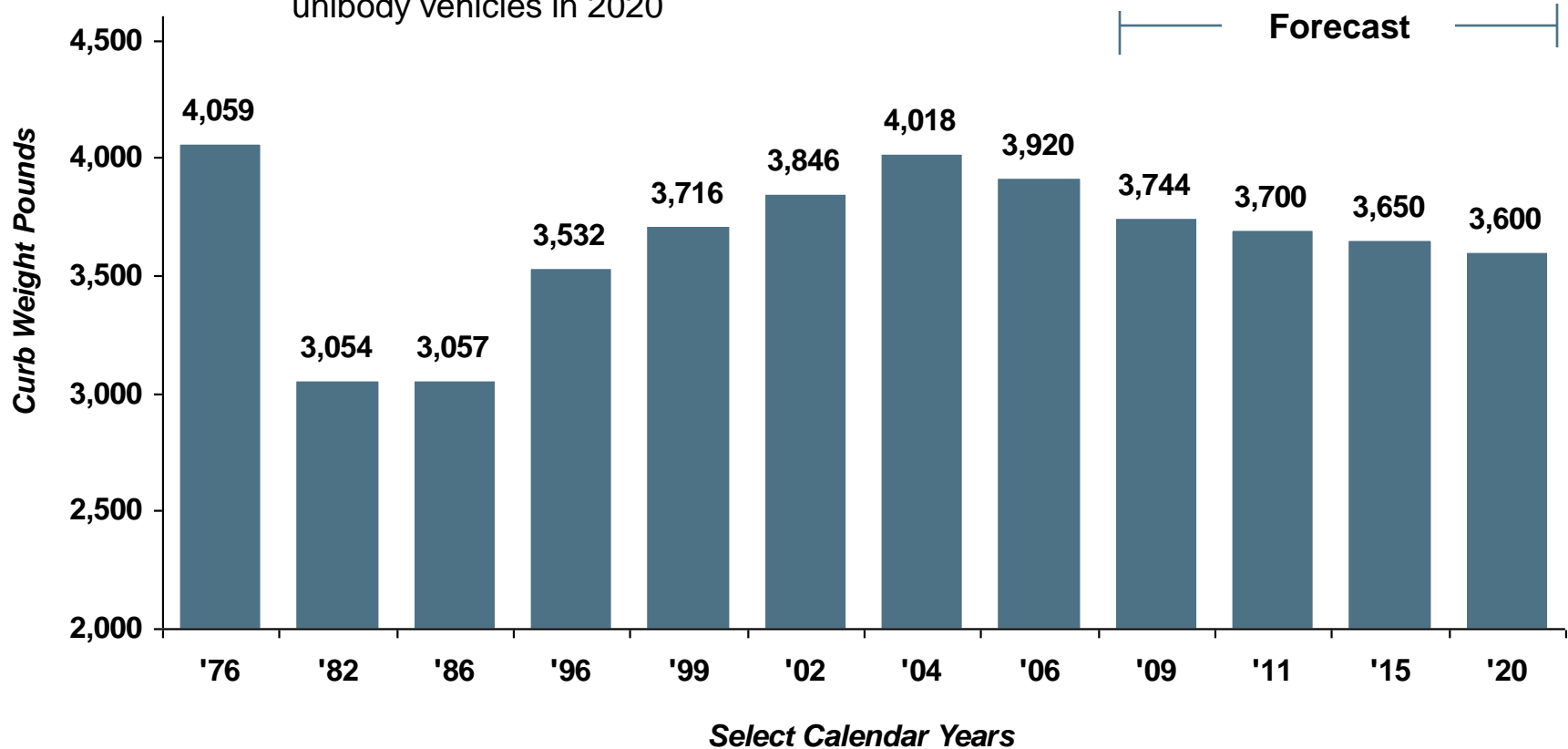
2020 Forecast

- Based on the expert interviews and the historical trend data for key components, Ducker has prepared a forecast of aluminum content in 2020 based on 16 million units of North American production and an average curb weight of 3,600 pounds
- The most likely scenario for aluminum body structures is 140,000 complete aluminum bodies in white and 440,000 partial body structures
- The 2020 estimates of aluminum penetration for aluminum blocks, heads, intake manifolds, wheels, brake calipers, hoods, bumpers, knuckles, suspension arms and links and cradles forms the foundation in addition to partial and complete body structures for our **most likely** 2020 forecast of 376 pounds of aluminum per vehicle. We have placed a probability of 50% on the most likely forecast
- The **optimistic** forecast is 394 pounds and has more partial and complete body structures, and no significant use of diesel engines with iron blocks. We have put a probability of 20% on this forecast
- The **pessimistic** forecast is 355 pounds per vehicle and does not have any significant complete body structures or partial body structures. It does have some losses to steel for suspension arms and bumpers. We have put a probability of 30% on this forecast

2020 Forecast

North American Light Vehicle Curb Weight *- History and Forecast -*

The 3,600 pound curb weight assumes
20% full frame vehicles and 80%
unibody vehicles in 2020

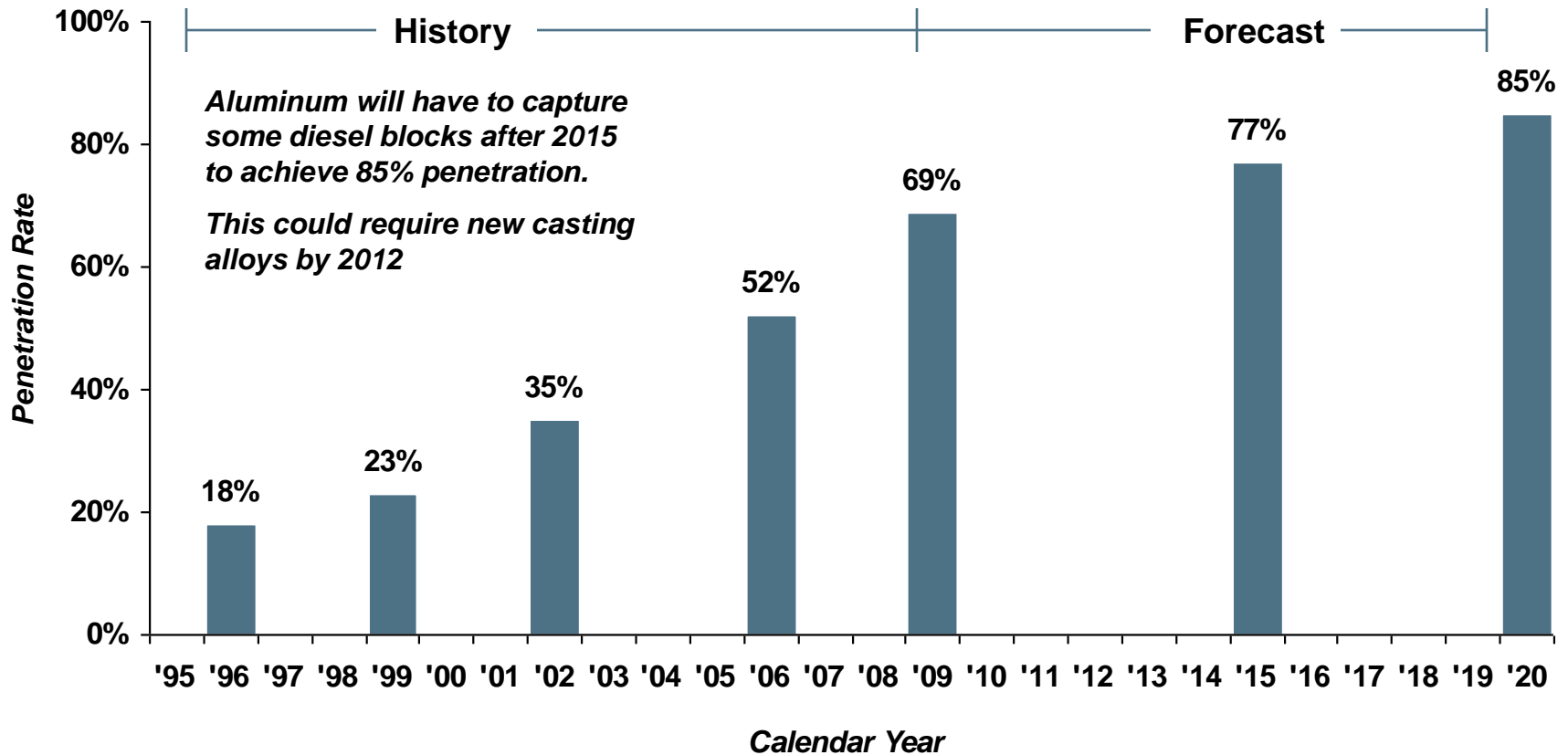


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Engine Blocks Percent Penetration

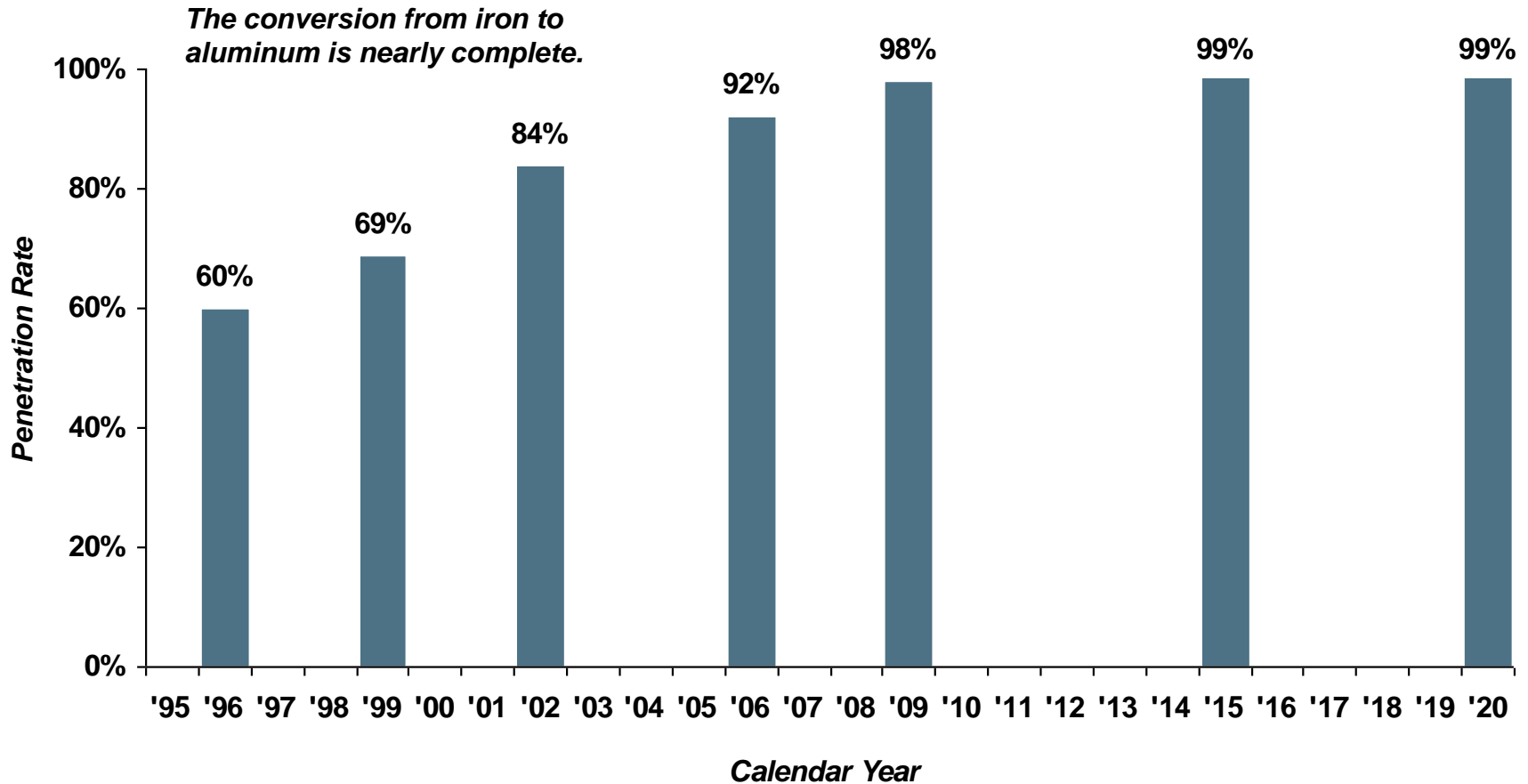
- History and Forecast -



Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Cylinder Heads

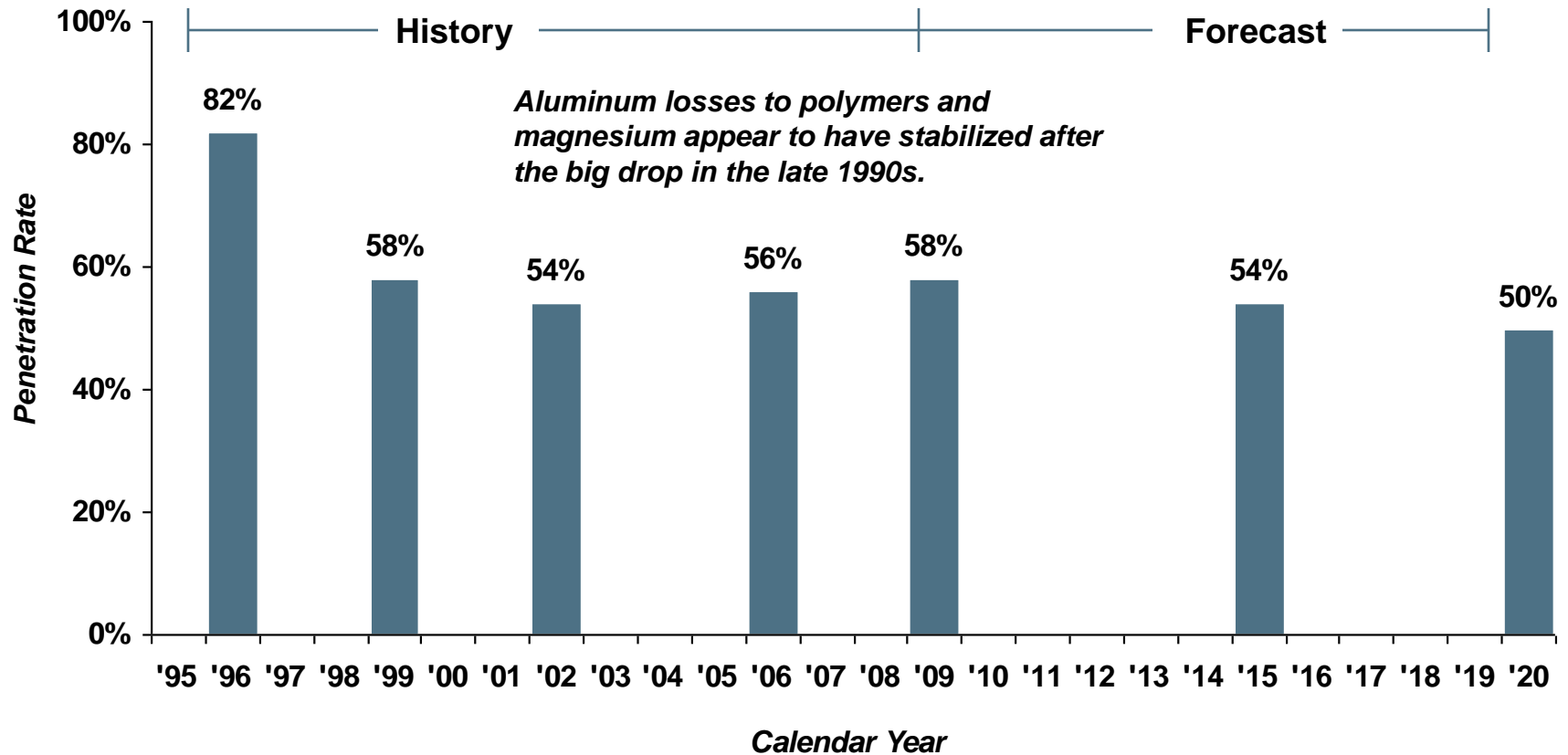


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Intake Manifolds Percent Penetration

- History and Forecast -

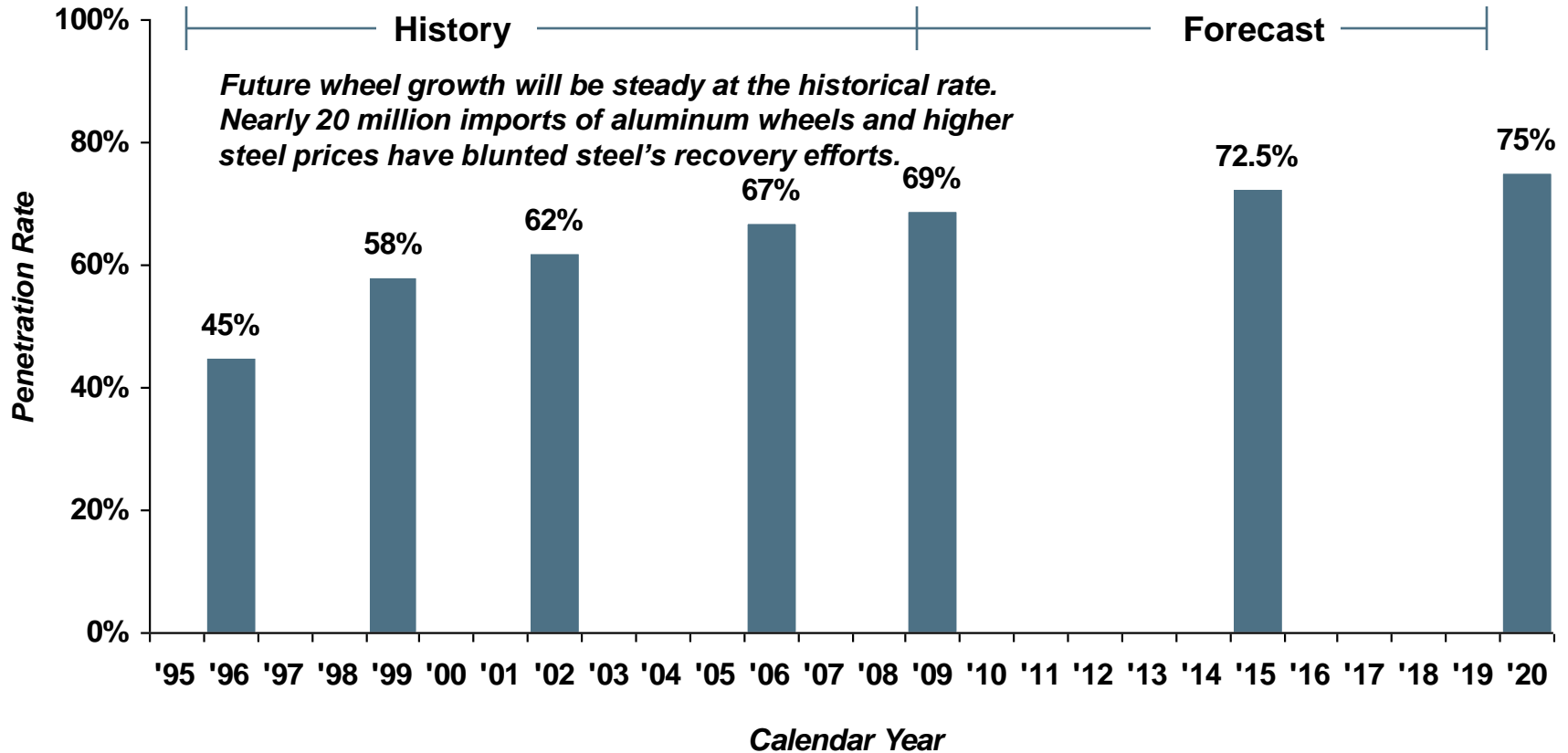


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Wheels Percent Penetration

- History and Forecast -

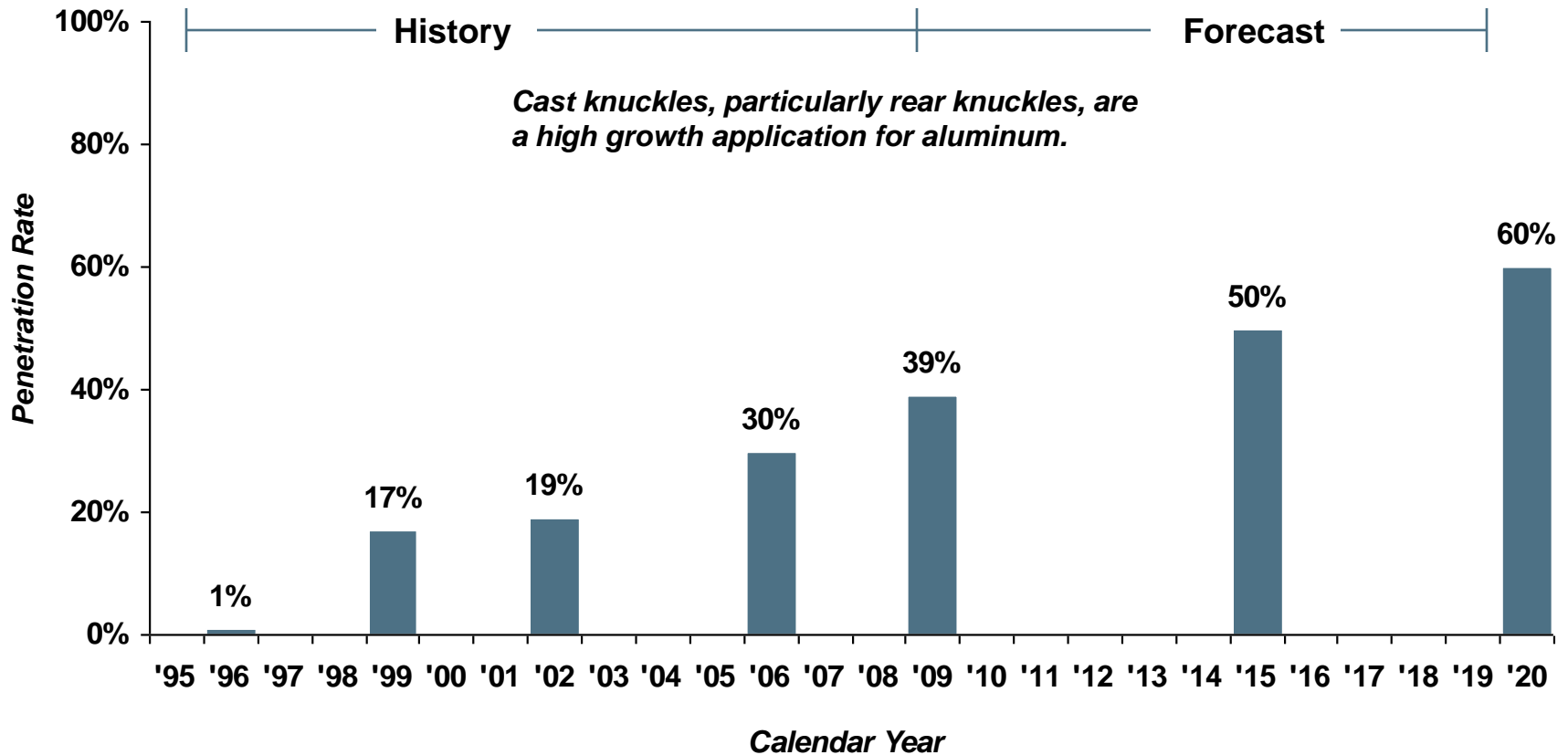


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Steering Knuckles Percent Penetration

- History and Forecast -

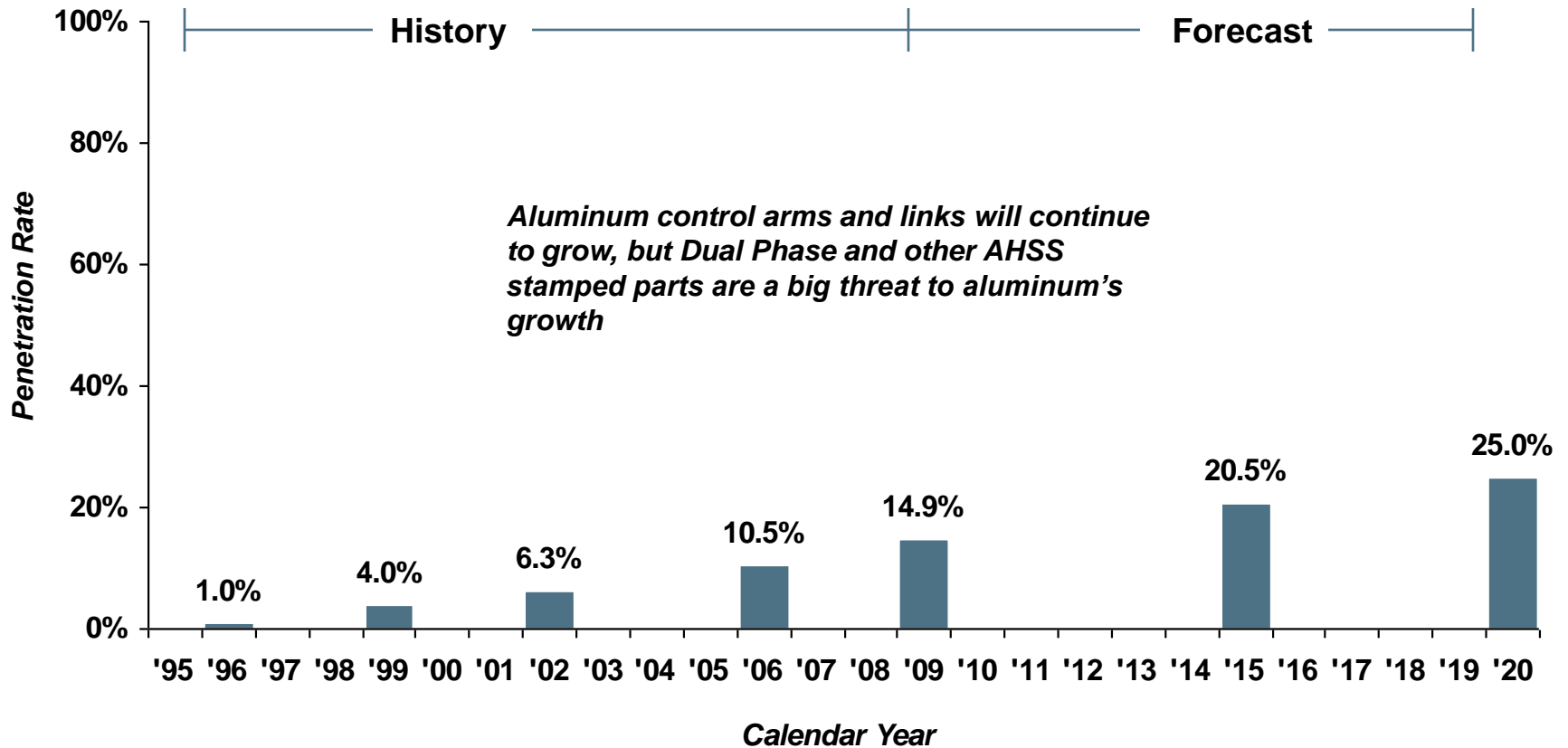


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Control Arm and Link Percent Penetration

- History and Forecast -

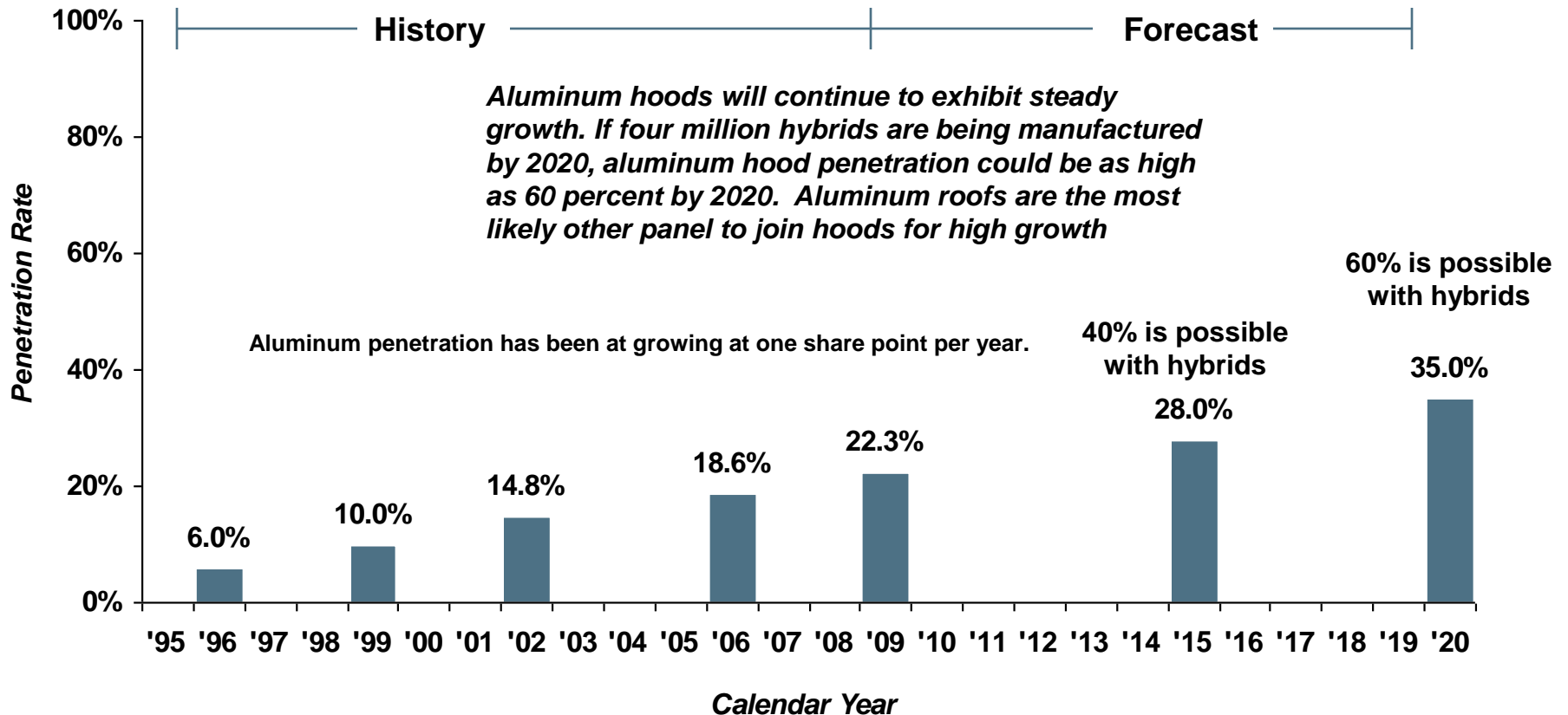


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Hoods Percent Penetration

- History and Forecast -

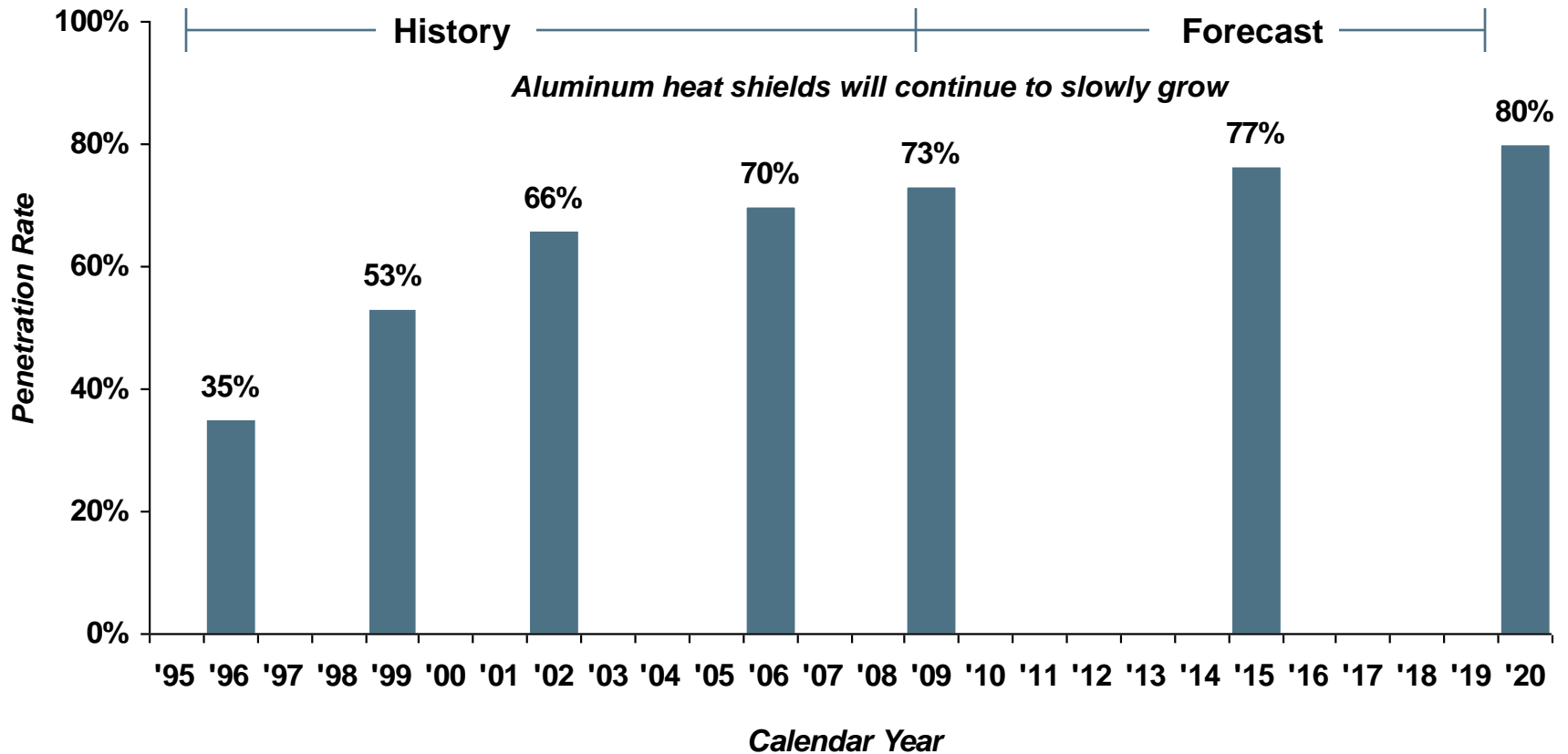


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Heat Shields Percent Penetration

- History and Forecast -

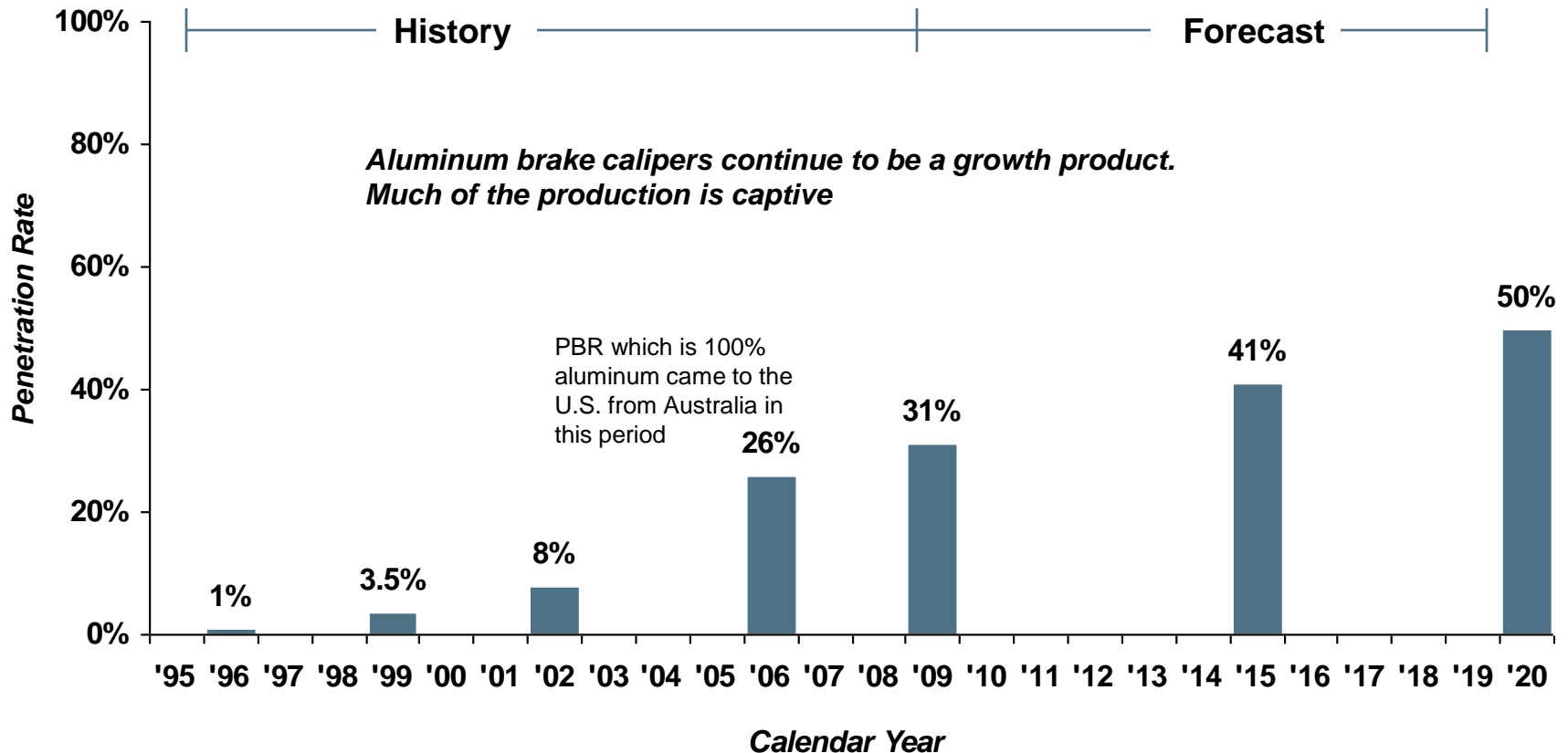


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Brake Caliper Percent Penetration

- History and Forecast -

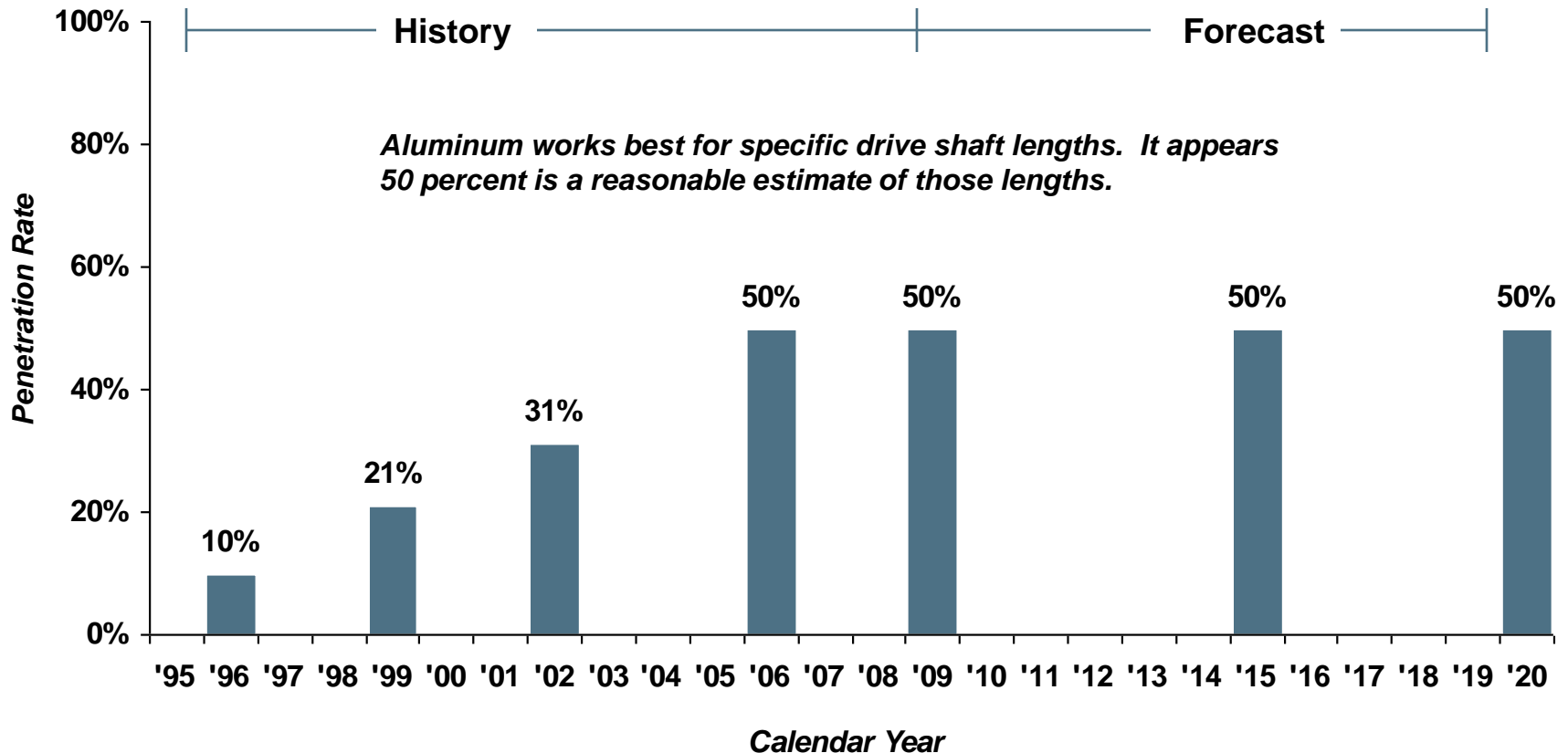


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Drive Shafts Percent Penetration

- History and Forecast -

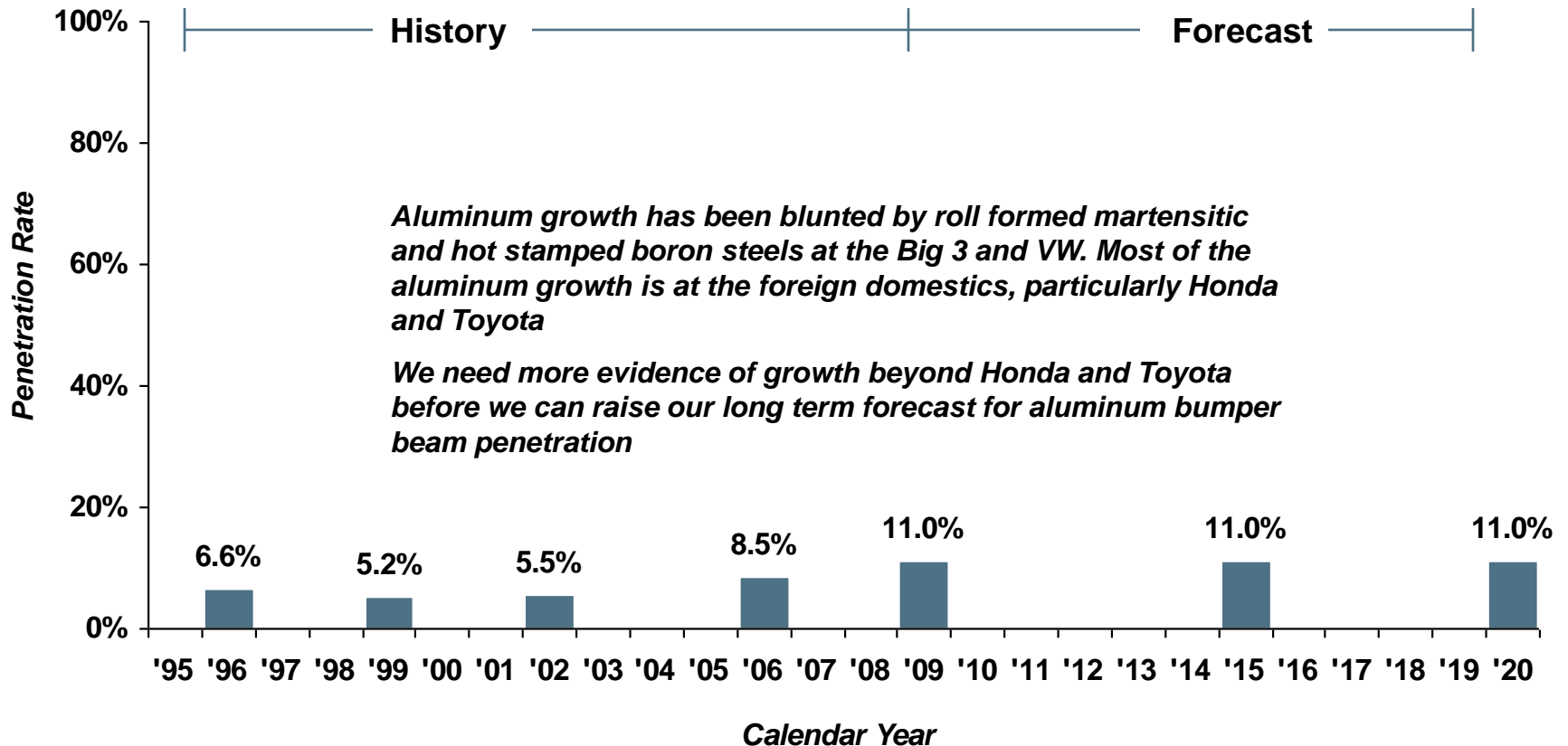


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Bumper Beams Percent Penetration

- History and Forecast -

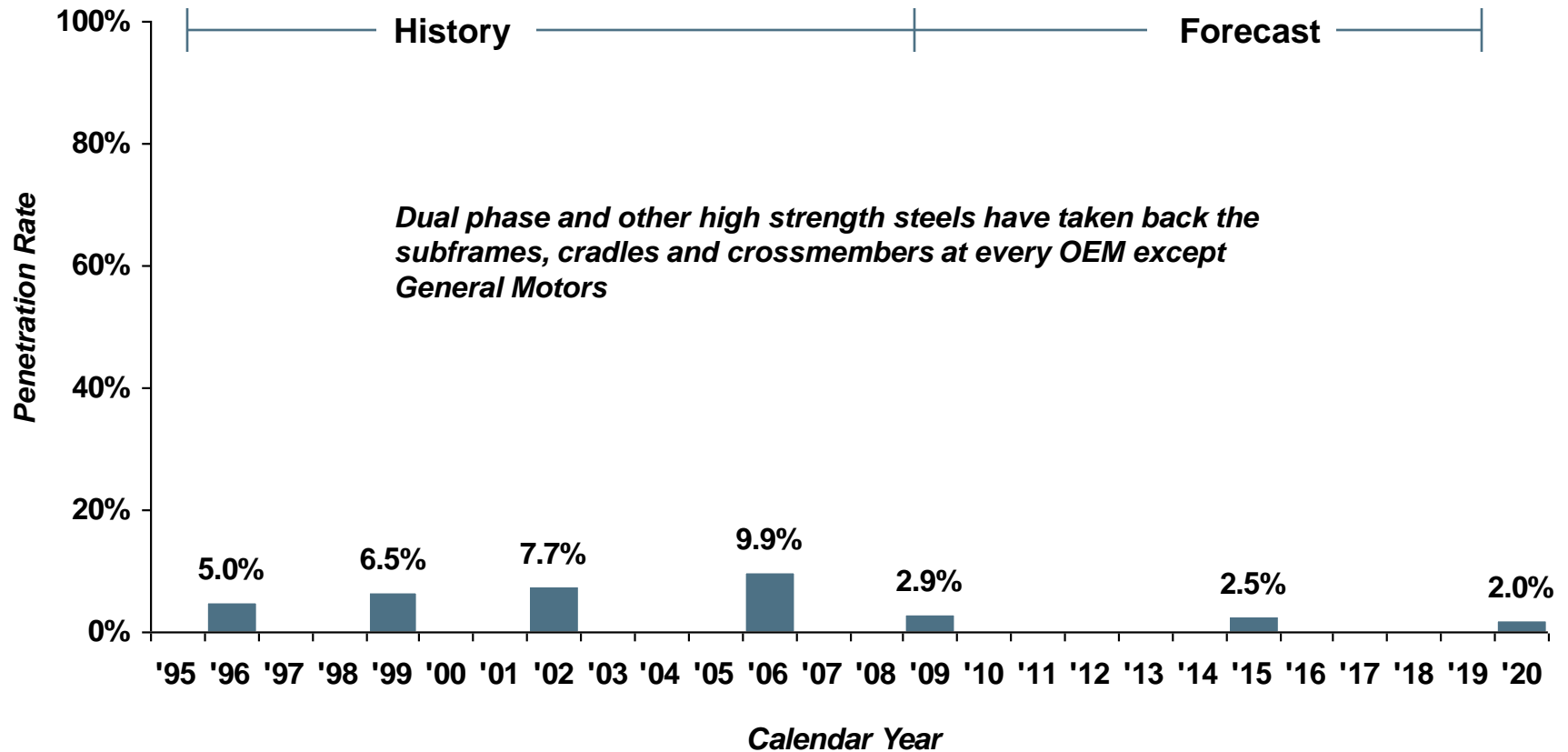


Source: Ducker

2020 Forecast

North American Light Vehicle Aluminum Cradles, Subframes and Cross Members Percent Penetration

- History and Forecast -



Source: Ducker

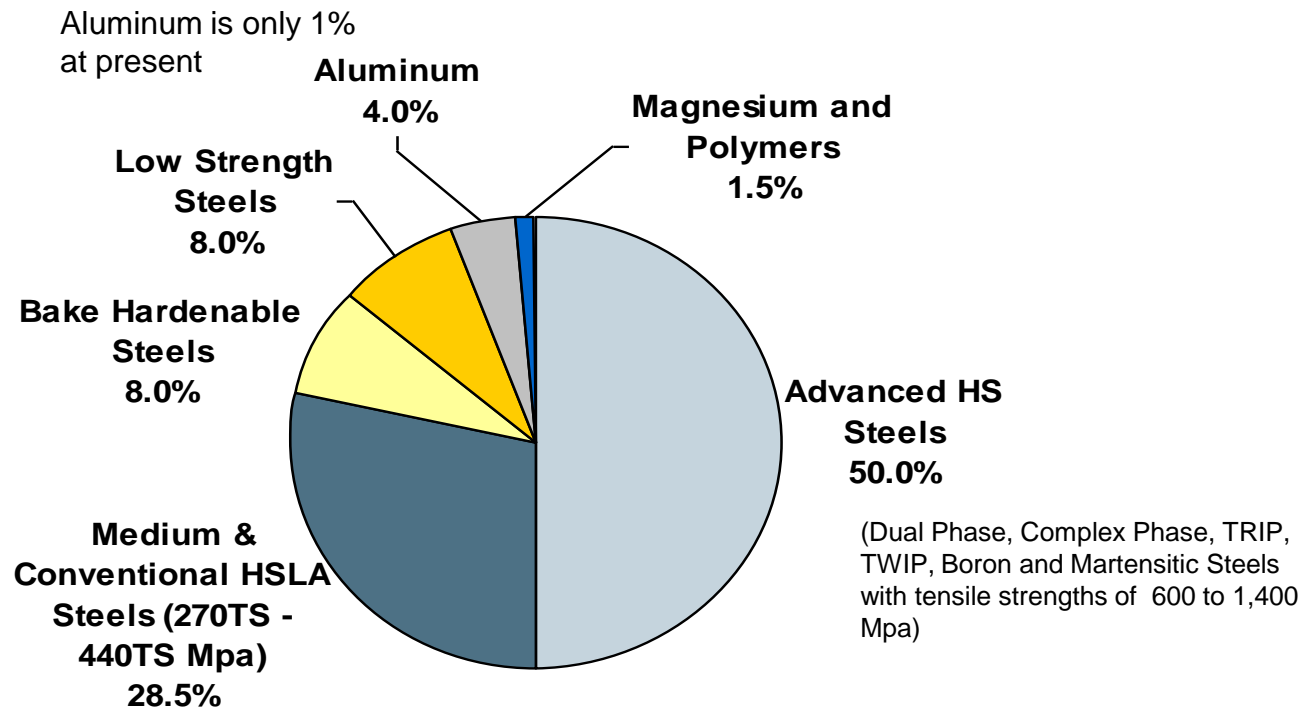
2020 Forecast

- Based on the OEM survey and extensive work on high strength steels and other materials we are forecasting the following 2020 material mix for “unibody” bodies and closures

North American 2020 Light Vehicles with Unibody Architecture

- Probable Material Mix for the Body in White plus Closures -

26 pounds of aluminum in the body and closures in 2020 versus less than eight pounds today

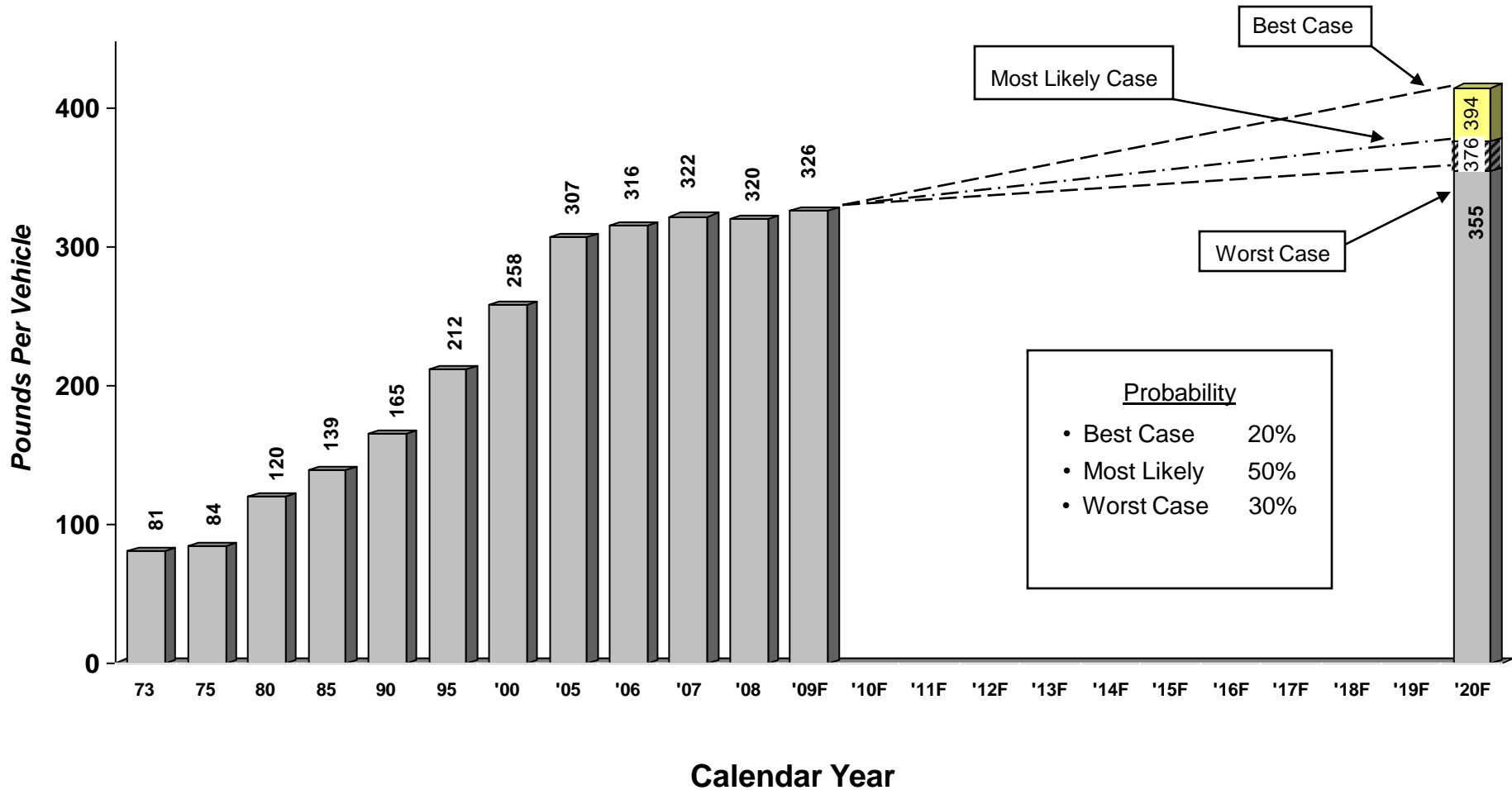


700 Pounds of Net Weight Versus 763 Pounds at Present

2020 Forecast

North American Light Vehicle Aluminum Content

- History and Forecast -



Source: Ducker

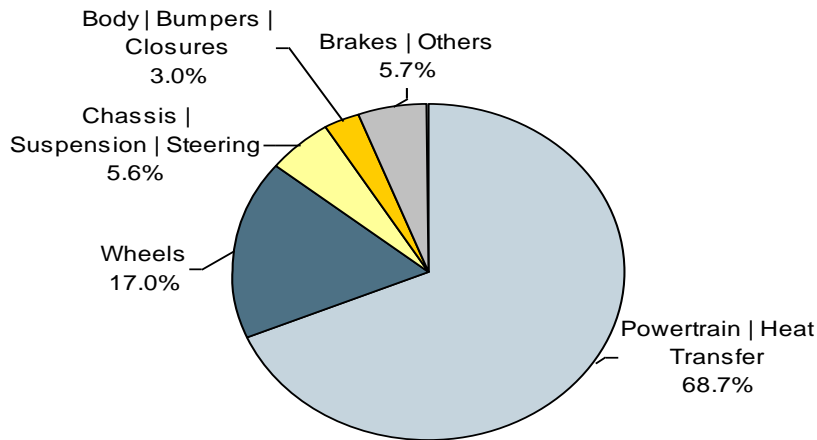
2020 Forecast

- Fifty percent of the growth over the next twelve years is expected to come from increased aluminum use for closures, knuckles, suspension arms and body structures

North American Light Vehicle Aluminum Content Forecast

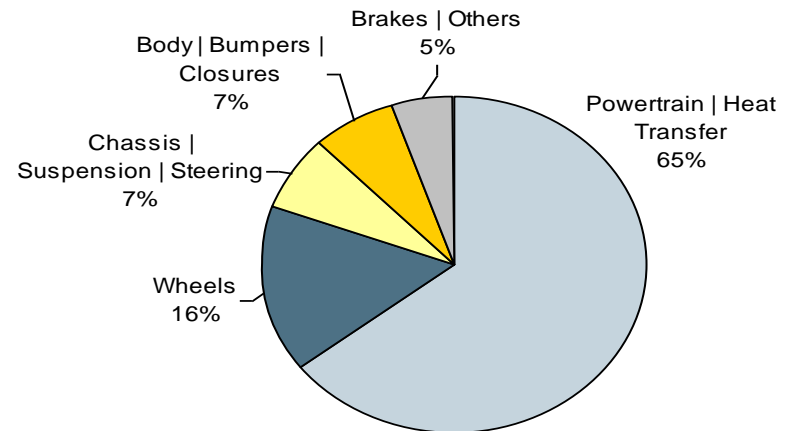
- 2009 versus 2020 -

2009 Estimate



326 Pounds per Vehicle

2020 Forecast

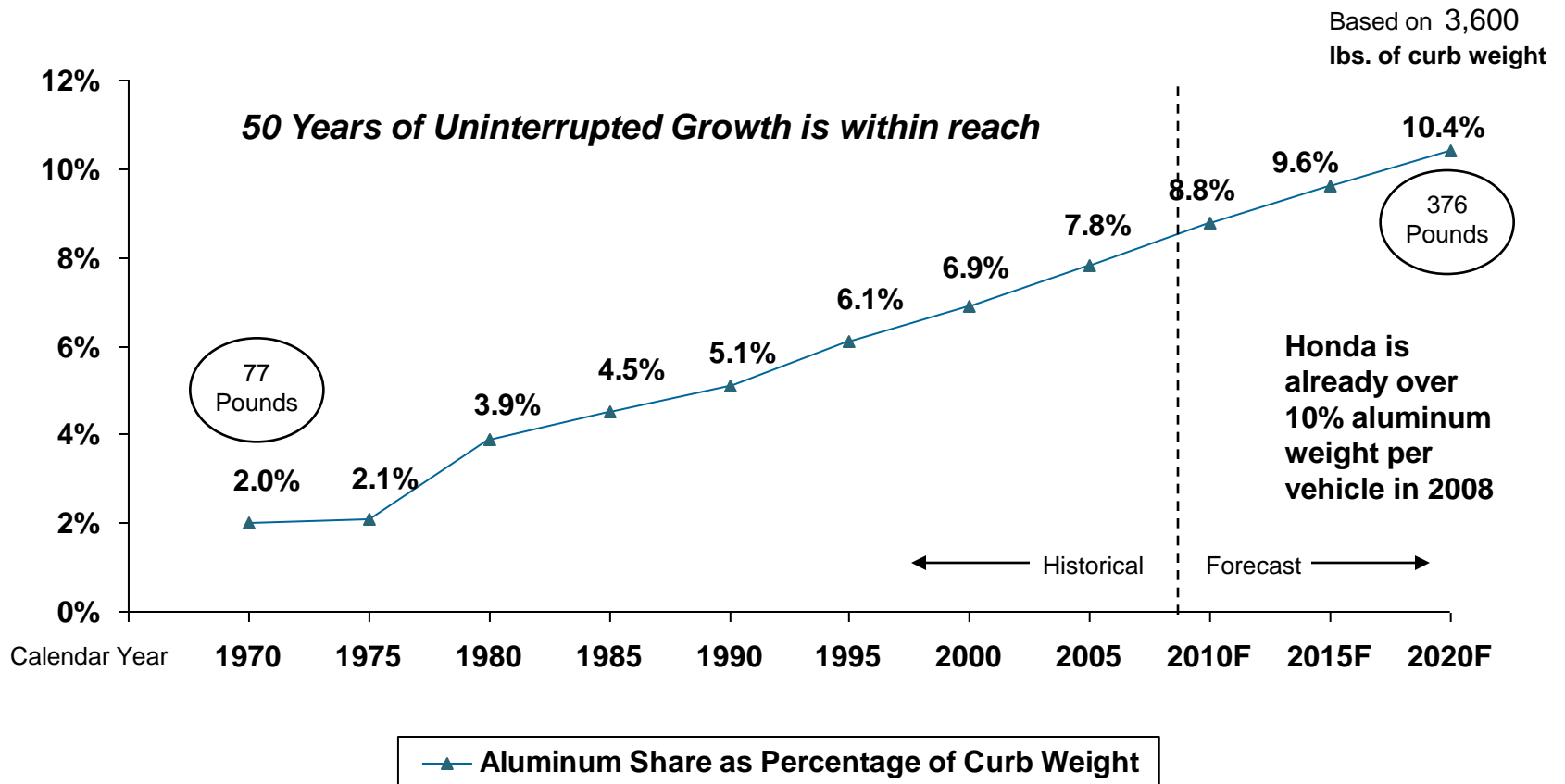


376 Pounds per Vehicle

2020 Forecast

North American Light Vehicle Aluminum Content as a Percent of Curb Weight

- History and Forecast -



2020 Forecast

Conclusions:

- Heat transfer, powertrain components and wheels fueled most of the aluminum growth for North American light vehicles over the last 20 years. Growth in the next decade is likely to be driven primarily by new applications for suspensions, knuckles, closures and body structures. Those applications account for less than 20 pounds of aluminum content today, but could grow to 45 to 50 pounds of vehicle content by 2020 or 50% of all the expected growth over the next twelve years
- North America with a much higher percentage of unibody vehicles than in the recent past, is going to look a lot more like Europe in terms of aluminum use in light vehicles over the next twelve years. This is good news for the aluminum structural parts makers, but it could be bad news for the makers of cast aluminum engine blocks, if diesel engines take hold before new aluminum casting alloys can be developed
- The growth of aluminum structural parts will also be influenced by which OEMs dominate the market in the next decade, and the type of powertrains they decide to adopt. The best aluminum as a percent of curb weight scenario is 100% unibody vehicles with low torque gasoline or hybrid engines with Honda as the best model for the other OEMs to follow for optimum aluminum use (Honda uses aluminum diesels)
- Material substitution from both aluminum and advanced high strength steels including secondary weight savings is not likely to yield more than 2 MPG or 25% of the fuel economy improvement needed by 2020. The other 75% will have to come from vehicle mix changes, powertrain changes, aerodynamic changes and a few other options like low roll resistance tires



APPENDIX

Appendix

- Ducker has been collecting aluminum penetration rates, part weights and product form data on the 100 components listed below and on the next page in order to determine aluminum content in North American light vehicles since 1991**

North American Light Vehicle Aluminum Components			North American Light Vehicle Aluminum Components		
System	Component	Product Form	System	Component	Product Form
Engine	Blocks	Various castings	Transmission & Driveline	Valve bodies	HPD cast
Engine	Cylinder heads	Various castings	Transmission & Driveline	Transfer plates	Cold finished rod
Engine	Oil pans	HPD cast	Transmission & Driveline	Differential Carriers	LPPM & HPDC
Engine	Intake manifolds	PM cast	Transmission & Driveline	Drive shafts	Drawn tube
Engine	Pistons	Various castings	Transmission & Driveline	Yokes	impact extrusion
Engine	Water pump housings	HPD cast	Heat transfer	Radiators	Fin stock
Engine	Alternator case	HPD cast	Heat transfer	Heater cores	Brazing sheet
Engine	Fuel rails	Extruded/cast	Heat transfer	Transmission coolers	Brazing sheet
Engine	Front covers	HPD cast	Heat transfer	Condensers	Fin stock
Engine	Bed plates	Various castings	Heat transfer	Evaporators	Fin stock
Engine	Mounts	Extruded/cast	Heat transfer	Compressors Housings	HPD cast
Engine	Timing chain covers	HPD cast	Heat transfer	Compressor scrolls	Squeeze cast
Engine	Accessory brackets	HPD cast	Heat transfer	Compressor pistons	Cold finished rod
Engine	Oil filter adapters	HPD cast	Heat transfer	Connection hardware	Extruded tube
Engine	Cam covers	HPD cast	Heat transfer	Oil coolers	Brazing sheet
Engine	Thermostat housings	HPD cast	Heat transfer	Receiver/dryers	Impact extruded
Engine	Water outlet tubes	Extruded tube	Heat transfer	Heat shields	NHT sheet
Transmission & Driveline	Automatic & CVT cases	HPD cast	Wheels & Brakes	Wheels	PM cast and forged
Transmission & Driveline	Manual Clutch Housings	HPD cast	Wheels & Brakes	Brake calipers	PM cast
Transmission & Driveline	Extension covers	HPD cast	Wheels & Brakes	Master cylinders	PM cast
Transmission & Driveline	Transfer cases/PTUs	HPD cast	Wheels & Brakes	Brake pistons	Cold finished rod
Transmission & Driveline	Brackets	HPD cast	Wheels & Brakes	ABS housings	Extruded bar & PM cast
Transmission & Driveline	Pistons	Cold finished rod	Wheels & Brakes	Drums & rotors	Various castings
Transmission & Driveline	Stators	Cold finished rod	Steering	Knuckles	PM cast/forged
Transmission & Driveline	Valves	Cold finished rod	Steering	Column housings	Extruded/ HPD cast

Appendix

- Forged aluminum ball joint yokes and vacuum die cast aluminum shock towers were new additions to the aluminum parts list in 2009

North American Light Vehicle Aluminum Components			North American Light Vehicle Aluminum Components		
System	Component	Product Form	System	Component	Product Form
Steering	Rack & pinion housings	HPD cast	Body & Closures	Roofs	HT sheet
Steering	Wheels	HPD cast	Body & Closures	Shock towers	Vacuum die cast
Steering	Ball joint yokes	Forged	Other Exterior	Truck bed rails	Extruded profiles
Chassis & Suspension	Control arms	PM cast, forged & extruded	Other Exterior	Running boards	Extruded profiles
Chassis & Suspension	Lateral links	Forged & squeeze cast	Other Exterior	Sun roofs	Extruded assembly
Chassis & Suspension	Sub-frames	Extruded assembly	Other Exterior	Sport racks	Extruded assembly
Chassis & Suspension	Cross members	PM cast and machined	Other Exterior	Wiper arms	HPD cast
Chassis & Suspension	Cradles	PM cast & extruded	Other Exterior	Trim	NHT sheet
Body & Closures	Front end structures	Sheet & Extruded Assemblies	Other Interior	Wiper motor housings	HPD cast
Body & Closures	Radiator supports	Extruded assembly	Other Interior	Sun roof motor housings	HPD cast
Body & Closures	Complete body	Sheet & extruded cast	Other Interior	Starter motor housings	HPD cast
Body & Closures	Instrument panel structures	Sheet & extruded assembly	Other Interior	Seat motor housings	HPD cast
Body & Closures	Bumper beams	Bent extruded profiles	Other Interior	Seat pans	NHT sheet
Body & Closures	Crash boxes	Extruded profiles	Other Interior	Seat frames	Extruded profiles
Body & Closures	Door intrusion beams	Extruded profiles	Other Interior	Seat tracks	Extruded profiles
Body & Closures	Door sills	Extruded profiles	Other Interior	Seat belt spools & retractors	HPD cast
Body & Closures	Pillars & windshield frames	Sheet, cast & extruded	Other Interior	Heat Sinks	Extruded and Cast
Body & Closures	Doors	HT Sheet	Other Interior	Air bag canisters	Impact extrusions
Body & Closures	Hoods/bonnets	HT sheet	Other Interior	Computer housings	HPD cast
Body & Closures	Fender/wings	HT sheet	Other Interior	Overhead rails	Extruded profiles
Body & Closures	Deck lids/boots	HT sheet	Other Interior	DVD enclosures	Extruded profiles
Body & Closures	Lift gates	HT sheet	Other Interior	All other parts	Various
Body & Closures	Tailgates	HT sheet			

Inner panels for closures can also use NHT sheet

Appendix

Actual tabulated results of OEM and Non OEM Expert interviews on the significance of various options for improving fuel economy by 40% by 2020
Client can use this raw data to reach their own conclusions

Options	Insignificant	Somewhat Significant	Significant	Very Significant	Extremely Significant	Don't Know
Cylinder deactivation	1	7	9	9	5	1
42V electrical system	7	10	6	2	0	7
Engine friction reduction	1	8	11	6	6	0
Low rolling resistance tires	0	8	7	8	8	1
Diesel engines	2	4	6	14	5	1
Footprint & interior volume reduction	3	5	7	10	4	3
Full Parallel Hybrids (Prius)	0	4	7	12	7	2
Aero drag reduction (Cd)	1	6	8	9	7	1
Full Series Hybrid (Volt)	0	3	10	10	7	2
Continuously variable transmission (CVT)	1	10	7	11	1	2
Automated manual transmission (AMT)	6	9	6	6	2	3
Aluminum substitution for steel and iron	0	5	12	10	5	0
Advanced HSS and HSS substitution for mild steel	3	3	9	10	6	1
Other material substitution	1	6	10	12	3	0
Other options	0	2	0	1	3	26

Appendix

Actual tabulated results of only OEM interviews on the significance of various options for improving fuel economy by 40% by 2020
Client can use this raw data to reach their own conclusions

Options	Insignificant	Somewhat Significant	Significant	Very Significant	Extremely Significant	Don't Know
Cylinder deactivation	1	4	5	6	4	0
42V electrical system	2	6	5	1	0	6
Engine friction reduction	0	5	4	5	6	0
Low rolling resistance tires	0	4	5	4	7	1
Diesel engines	1	3	3	10	2	1
Footprint & interior volume reduction	2	2	5	6	3	2
Full Parallel Hybrids (Prius)	0	3	5	6	5	1
Aero drag reduction (Cd)	0	2	7	5	6	0
Full Series Hybrid (Volt)	2	3	6	5	4	0
Continuously variable transmission (CVT)	1	7	6	5	0	1
Automated manual transmission (AMT)	3	5	4	4	1	3
Aluminum substitution for steel and iron	0	4	8	5	3	0
Advanced HSS and HSS substitution for mild steel	3	1	4	7	4	1
Other material substitution	0	5	6	7	2	0
Other options	0	0	0	1	1	18

This concludes our presentation. Thank you.

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