Final Report

Aluminum Content for Light Non Commercial Vehicles to be Assembled in North America, Japan and the European Union in 2006

Client: The Auto & Light Truck Group of the North American Aluminum Association

Date: December 14, 2005

This material is to be utilized in conjunction with an oral presentation; it is not intended to be a complete record of the findings or the discussion.

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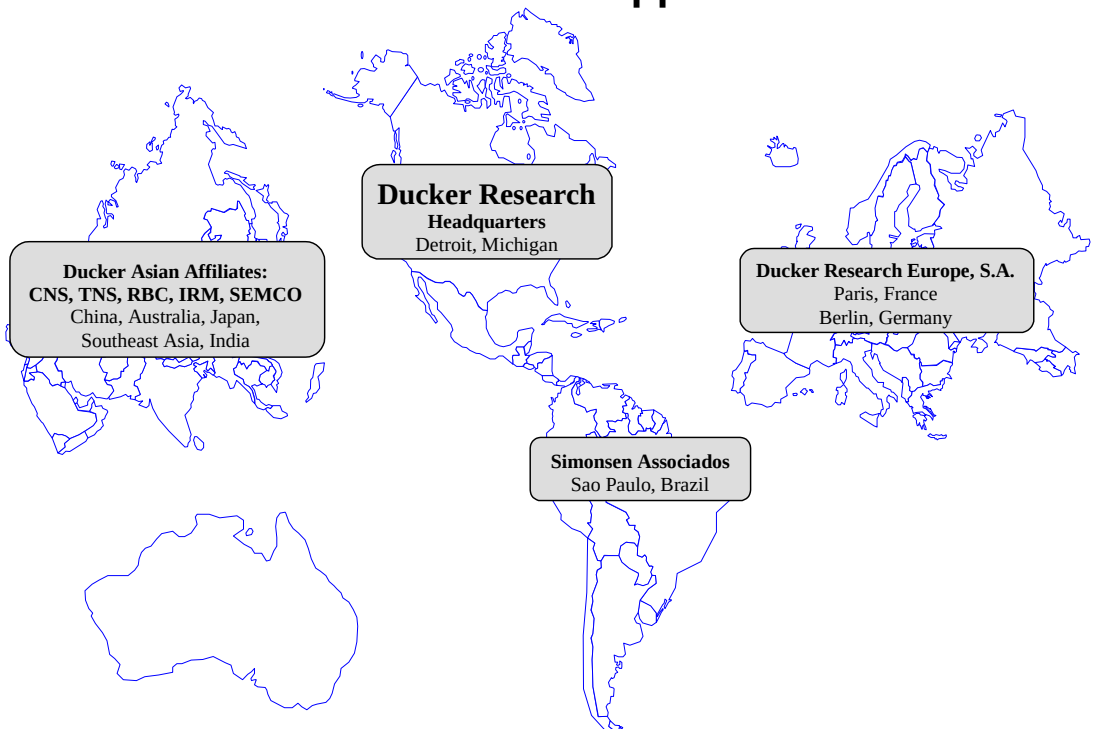
INTRODUCTION AND METHODOLOGY

Background

Ducker Research 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 and expanded into Europe and Japan in 2000. The data have been 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.



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 15 years, Ducker has developed an extensive industry network and is well positioned to gather any data point related to aluminum and automotive.

Ducker has conducted several studies on aluminum content in North American light vehicles for the Auto and Light Truck Group (ALTG) of the North American Aluminum Association. This study is the first time the ALTG of the Aluminum Association has requested data for Europe and Japan as well as North America. Ducker has been independently studying these other regions since the year 2000, but not for the ALTG. This project is the culmination of research we have been conducting in all three regions for the past five years.

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.

Study Methodology

The nearly 100 components, 20 countries and 40 OEMs studied for this project are shown on the next four pages. The aluminum penetration for every component can be different for every supplier in every region. The principal objective of the study was to determine the average pounds of aluminum for each of the components and systems shown on pages 6 and 7 for each of the three regions under study, and to use these system average weights to determine the average aluminum content for the vehicles forecast for production in each region in 2006. An example of our database for aluminum engine blocks and cylinder heads in North America is given in Appendix II. Finally, the average aluminum content in each region was to be separated into the various aluminum product forms ie: high pressure die castings, low pressure permanent mold and other castings, rolled products, extruded products, forgings and impacts.

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 we have ever developed.

INTRODUCTION AND METHODOLOGY

2006 Light Vehicle Components with Aluminum Content Included in the Study

Engine

Cylinder Blocks
Cylinder Heads
Oil Pans
Intake Manifolds
Pistons
Water Pump Housings
Alternator Cases
Fuel Rails
Front Covers
Bed Plates
Mounts
Timing Chain Covers
FEAD Brackets
Oil Filter Adapters
Rocker/Cam Covers
Thermostat Housings
Water Outlet Tubes

Transmission and Driveline

Automatic Cases
Manual Cases
Extension Covers
Transfer Cases
Transmission Brackets
Pistons
Stators
Valves
Valve Bodies
Transfer Plates
Differential Covers/Cases
Drive Shafts/Prop Shafts
Yokes

Heat Exchangers and Heat Transfer

Radiators
Heater Cores
Transmission Coolers
Condensers
Evaporators
Compressor Housings
Compressor Scrolls
Connection Hardware
Compressor Pistons
Oil Coolers
Receiver Dryers
Heat Shields
Heat Sinks

INTRODUCTION AND METHODOLOGY

2006 Light Vehicle Components with Aluminum Content Included in the Study

Wheels and Brakes

Wheels
Calipers
Master Cylinders
Brake Pistons
ABS Housings
Drums & Rotors

Steering

Knuckles/Hubs/Yokes
Column Housings
Rack and Pinion Housings
Wheels
Power Steering Fluid Tubes

Chassis and Suspension

Control Arms
Lateral Links
Subframes
Crossmembers
Cradles

Body and Closures

Front End Structures
Radiator Supports
Body in White (BIW)
Instrument Panel/ Cross Car Beams
Bumper Beams
Crash Boxes
Door Intrusion Beams
Door Sills
Pillars & Windshield Frames
Doors
Hoods/Bonnets
Fenders/Wings
Deck Lids/Boots
Liftgates
Tailgates
Roofs
Truck Bed Rails

Motor Housings

Wiper Motors
Starter Motors
Window, Seat and Sun Roof Motors

Other Components

Seats Pans and Frames
Seat Tracks
Seat Belt Spools and Retractors
Air Bag Canisters
Computer Housings
Sun Roofs and Sport Racks
Windshield Wiper Arms
DVD and other Overhead Rails
Interior Trim
Exterior Trim
Running Boards
Shock Towers

INTRODUCTION AND METHODOLOGY

Countries Included in the Study

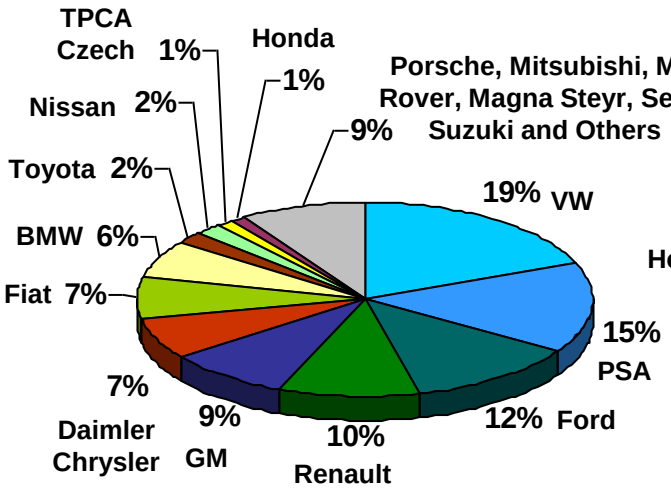
Austria	**Mexico**
Belgium	**Netherlands**
Canada	**Poland**
Czech Republic	**Portugal**
Finland	**Slovakia**
France	**Slovenia**
Germany	**Spain**
Hungary	**Sweden**
Italy	**United Kingdom**
Japan	**United States**

- These 20 countries will assemble 42 to 43 million light vehicles (cars, vans, SUVs and pickups) for non commercial use in 2006. OEMs by region are shown on the next page
- For this project we determined we needed to study an expanded list of countries in Europe to provide the most accurate comparisons with Japan and particularly North America
- This expanded look at Europe makes comparisons with our prior work in Europe difficult because all prior data collected was limited to only passenger cars in the eleven countries in Western Europe

INTRODUCTION AND METHODOLOGY

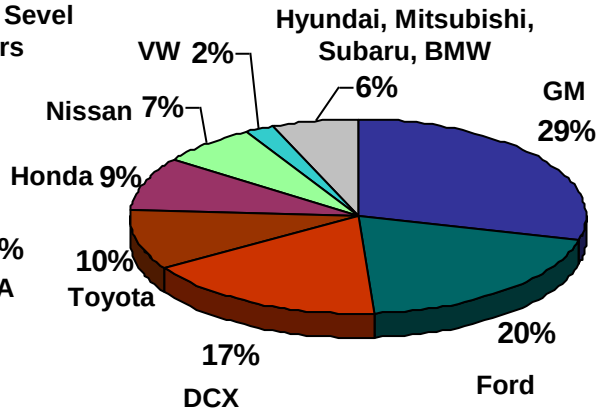
Forecast of 2006 Light Vehicle Production by Region and OEM

European Union



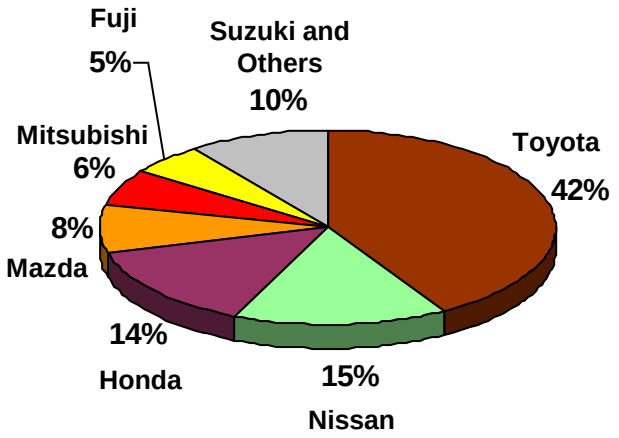
18.5 Million Vehicles

North America



15.75 Million Vehicles

Japan

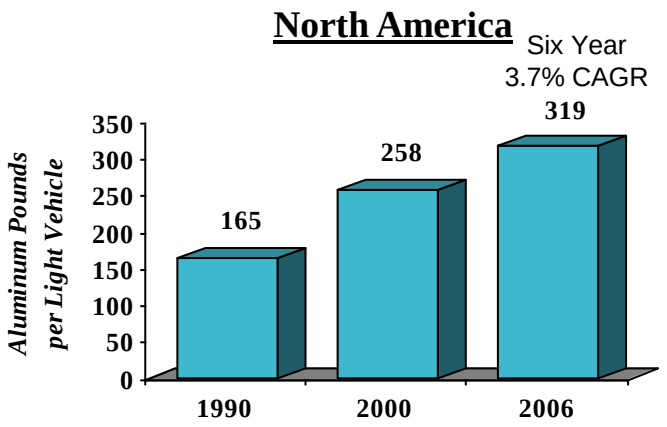


8.67 Million Vehicles

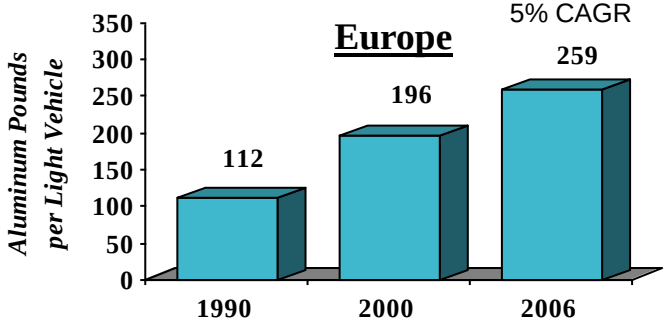
EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

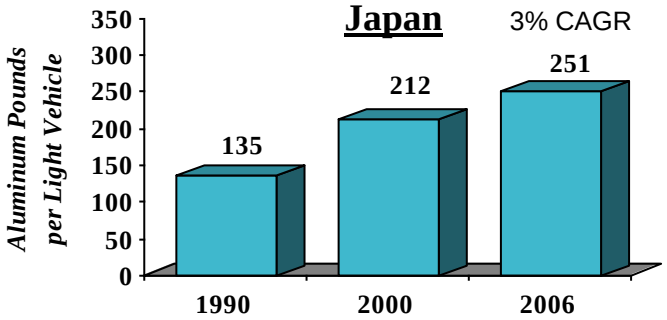
Light Vehicle Aluminum Content History and Forecast 1990 - 2006



- Historical growth in the North America was driven by wheels, cylinder heads, heat exchangers and transmissions
- **Engine blocks, cylinder heads, driveline components, suspension components, brake components and steering components account for nearly 85% of the growth so far this decade**
- The remaining growth so far this decade has been from closure panels, bumper beams, heat shields and a small increase in wheels



- Historical growth in Europe was driven by cylinder heads, at close to 100 percent penetration and to a lesser extent by transmissions, wheels, heat exchangers and suspension components
- **Closure panels, bumper beams, body structures, instrument panel supports and other sheet and extrusion uses have accounted for a larger share of the recent growth in Europe compared to North America**



- Historical growth in Japan was driven by cylinder heads, transmissions, wheels and recently heat exchangers and engine blocks
- **In this decade, suspension and chassis components, closure panels, steering knuckles and brake components have been the biggest contributors to growth**

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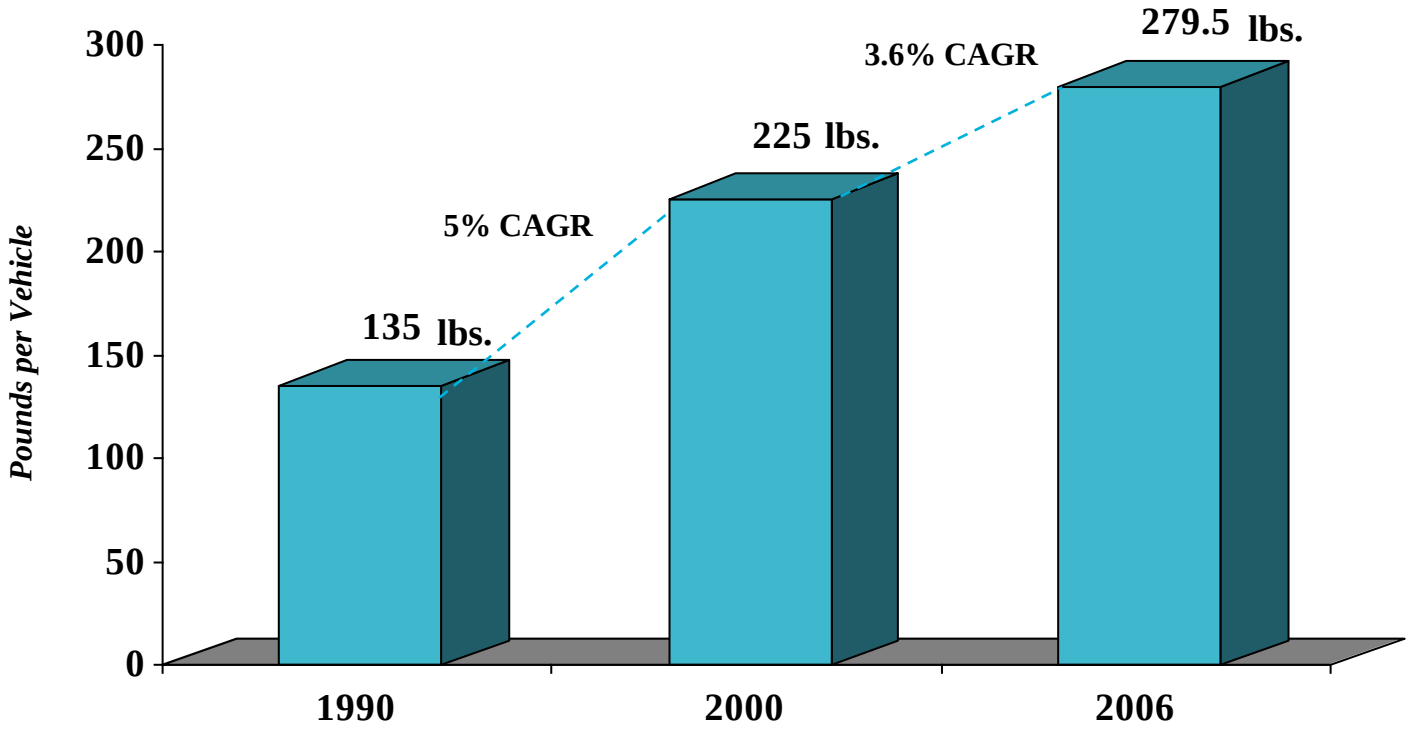
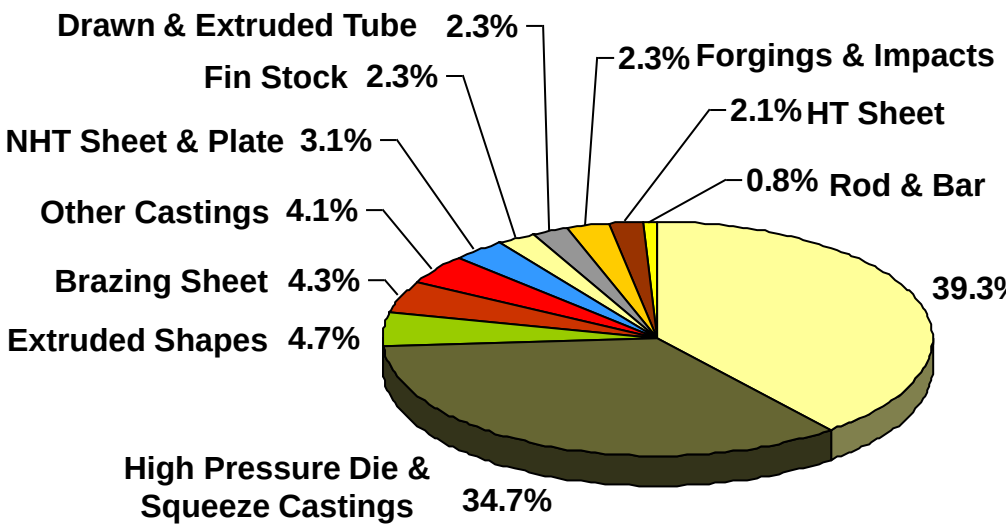
Weighted Average Light Vehicle Aluminum Content for North America, Europe and Japan



2006 Light Vehicle Aluminum Content

Total 2006 Aluminum Content All Regions

- Segmented by Product Form -



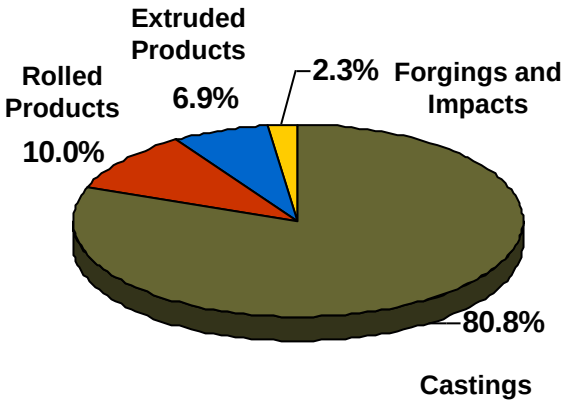
Industry statistics often mistakenly record the extruded rod used to make forged parts as a rod shipment and also as a forging shipment

11.994 Billion Pounds

2006 Light Vehicle Aluminum Content

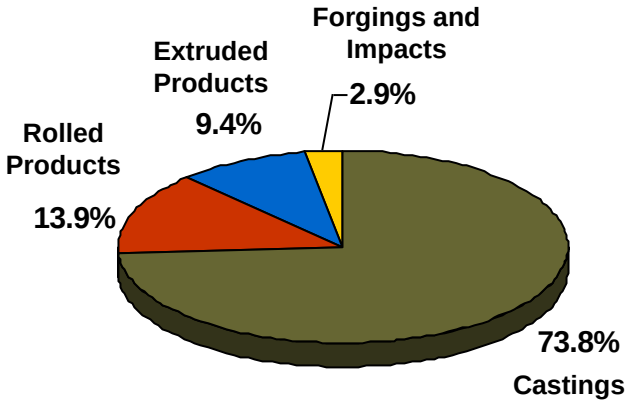
- Total Content Segmented by Region and Product Form -

North America



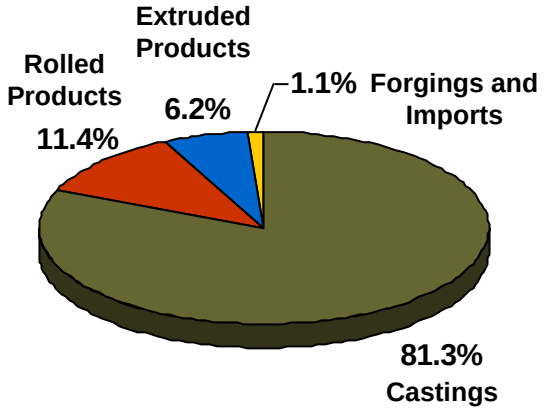
5.020 Billion Pounds
For 15.75 Million Vehicles
318.70 lbs. per vehicle
57% Secondary Aluminum

European Union



4.796 Billion Pounds
For 18.5 Million Vehicles
259.28 lbs. per vehicle
50% Secondary Aluminum

Japan

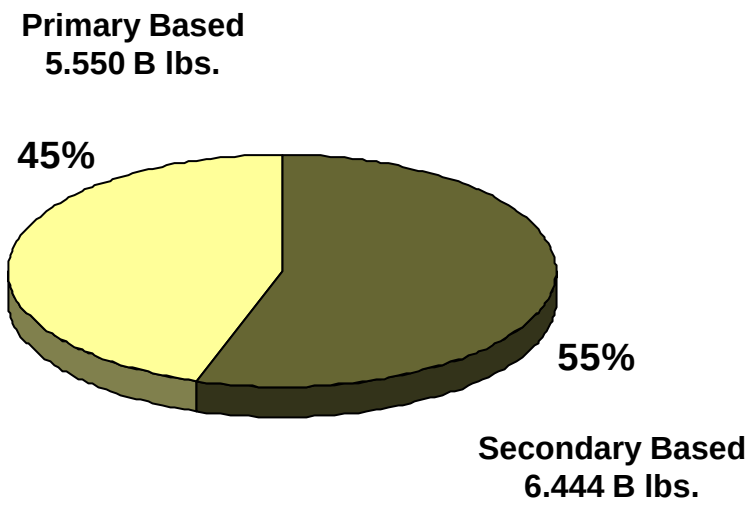


2.178 Billion Pounds
For 8.67 Million Vehicles
251.33 lbs. per vehicle
63% Secondary Aluminum

2006 Light Vehicle Aluminum Content

Total Aluminum Content All Regions

- Segmented by Metal Source -



11.994 Billion Pounds

- While nearly all of the aluminum contained in today's vehicle will be recovered and reused at the end of the vehicle's useful life, only 55% of the metal contained in the nearly 43 million light vehicles to be assembled in North America, Europe and Japan in 2006 will come from scrap
- Most high pressure die castings as well as the metal for cast low pressure permanent mold parts such as cylinder heads, pistons and intake manifolds is secondary based. Sand and lost foam castings also use secondary aluminum, but a few companies like GM use primary for these processes for commercial reasons
- Products such as fin stock and the sheet for heat shields can be made from scrap, but most of the current suppliers use primary. The same is true for some of the non structural extruded shapes. There is some closed loop recycling of auto body sheet, particularly in Europe

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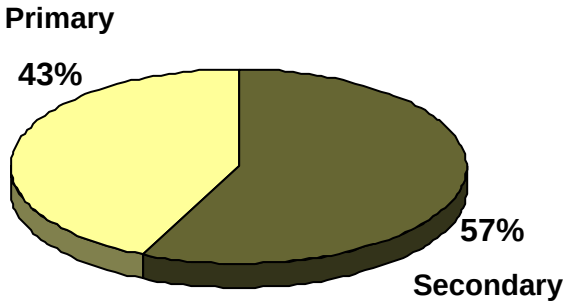
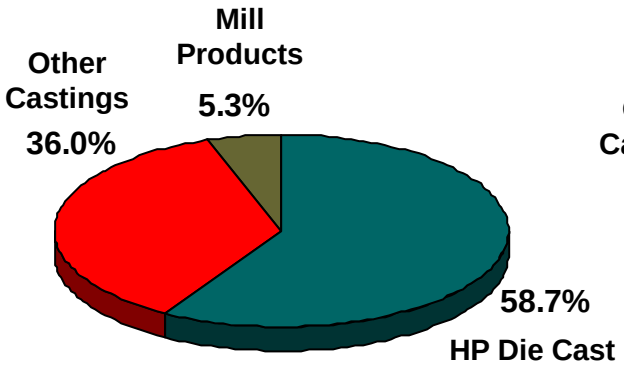
2006 Light Vehicle Aluminum Content

North America

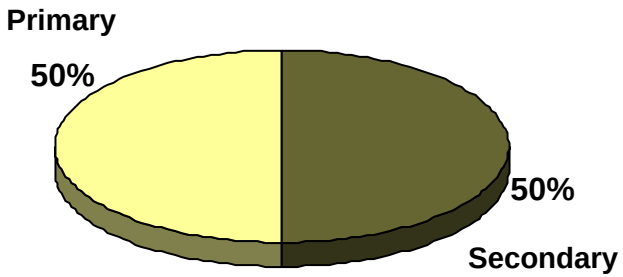


5.020 Billion Total Pounds

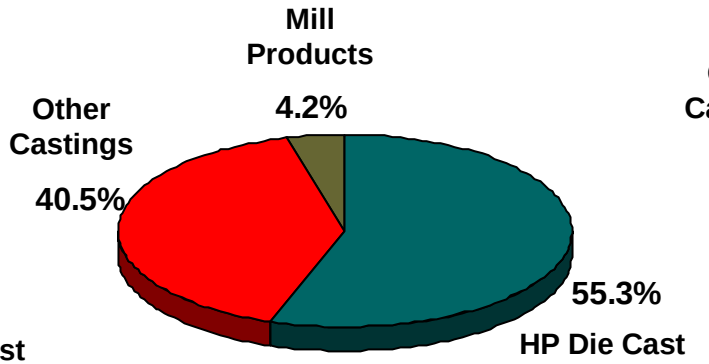


Secondary
2.835 Billion Pounds

European Union

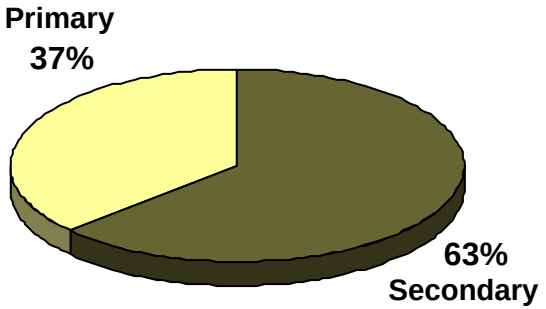


4.796 Billion Total Pounds

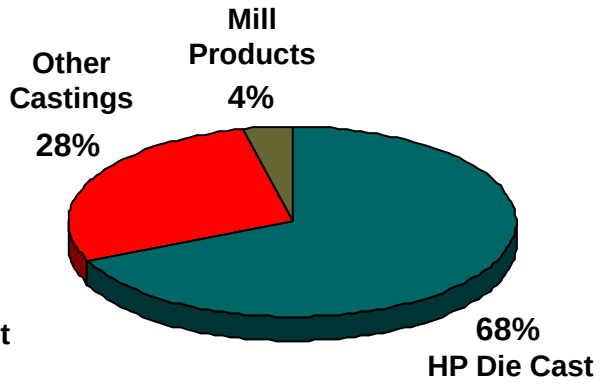


Secondary
2.377 Billion Pounds

Japan



2.179 Billion Total Pounds



Secondary
1.365 Billion Pounds

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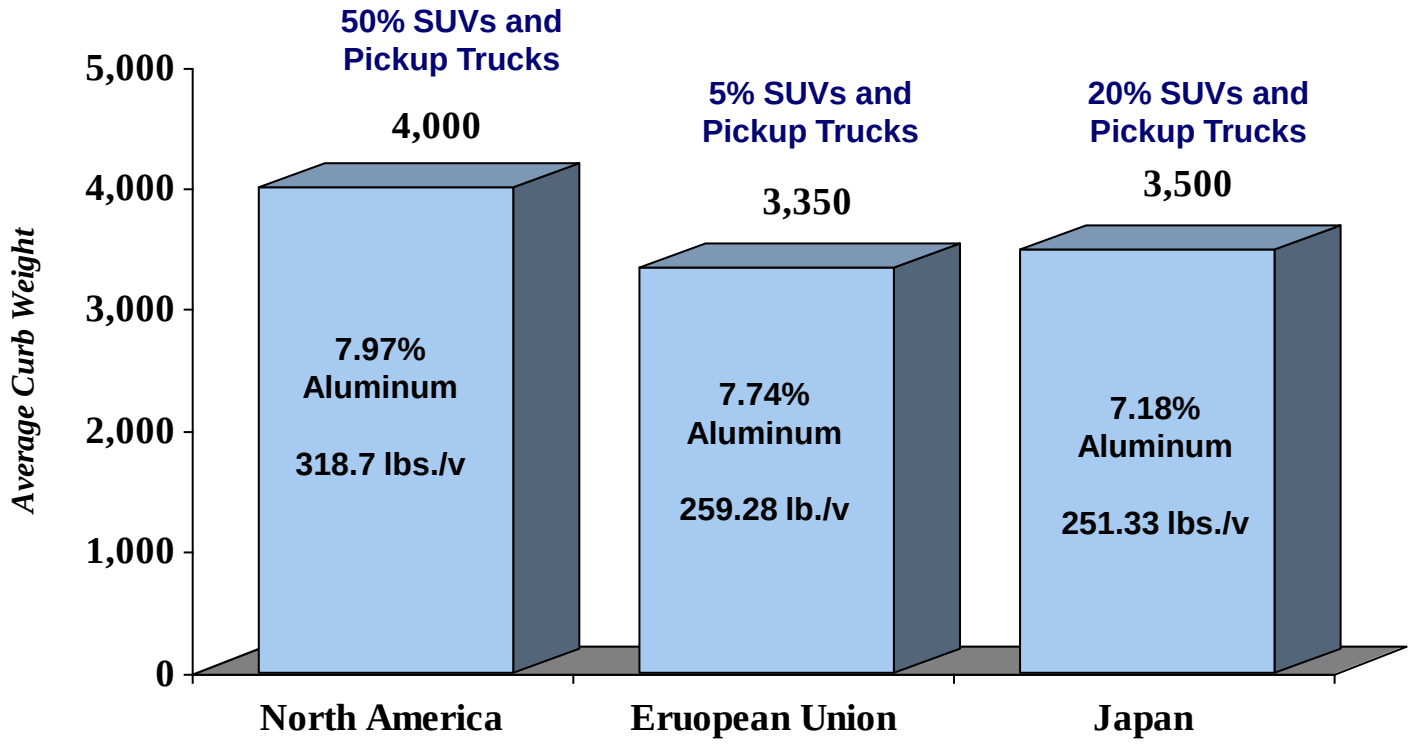
- As a percent of curb weight, aluminum content in the three regions is between seven percent and eight percent. Vehicles and vehicle parts weigh more in North America and that adds to the aluminum weight per vehicle

2006 Light Vehicle Aluminum Content



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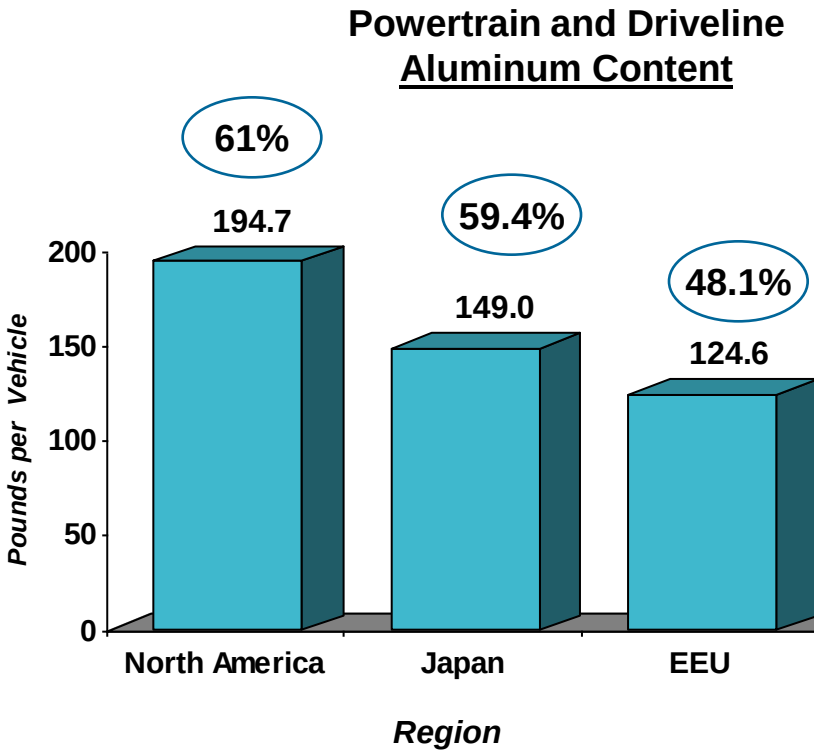
2006 Light Vehicle Aluminum Content

- Powertrain and Driveline Regional Comparison –

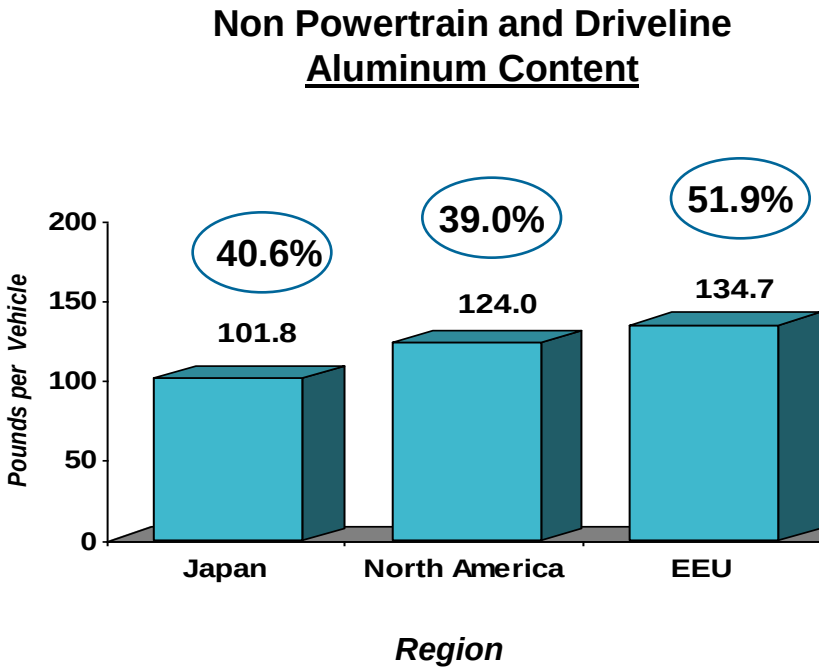


- Large gasoline engines, automatic transmissions and 4-wheel drive pickup trucks and SUVs add 70 additional pounds to the average aluminum content in North America compared to the average aluminum content per light vehicle in the EEU
- 61% of the aluminum content in North America is in the powertrain and driveline
- Higher aluminum block penetration and more automatic transmissions add 25 additional pounds to the aluminum content in Japan when compared to the EEU
- These powertrain and driveline differences make aluminum use in North America and Japan more casting intense than the EEU

EXECUTIVE SUMMARY

2006 Light Vehicle Aluminum Content

- Non-Powertrain and Driveline Regional Comparison –

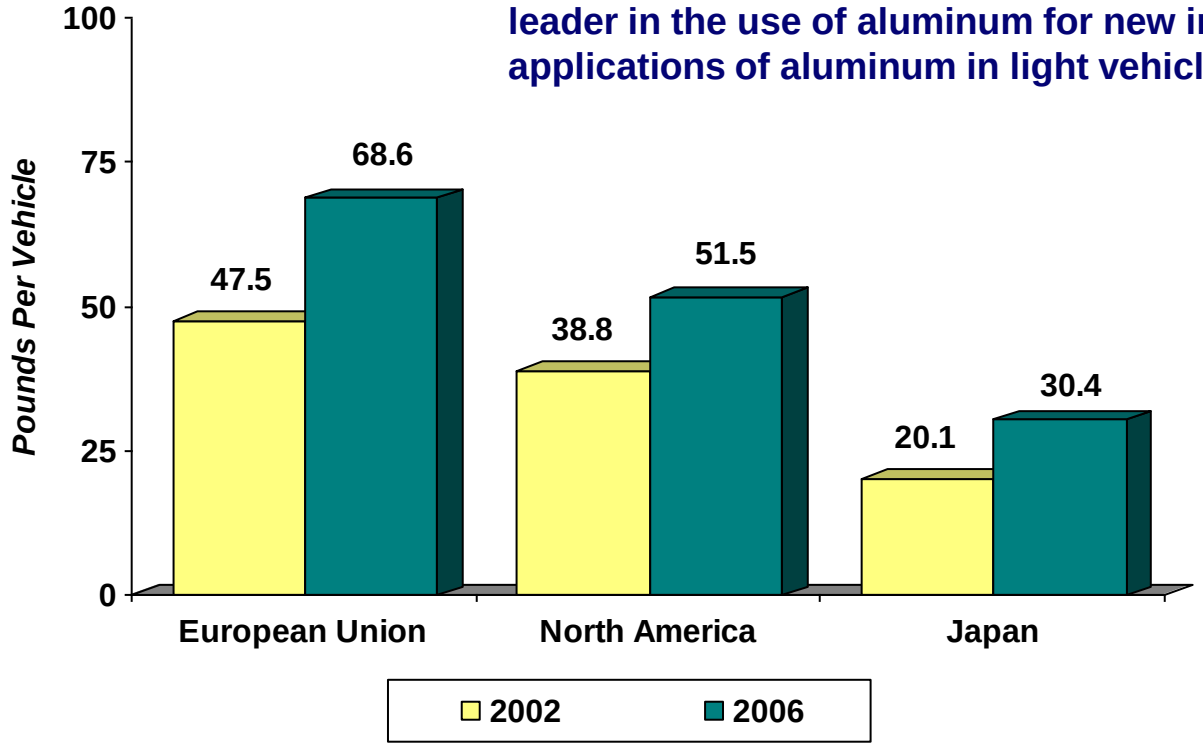


- **The EEU uses more aluminum per light vehicle for non-powertrain and driveline application than any other region**
- **Except for wheels, steering components, heat shields and heat exchangers, the EEU has a higher aluminum content than either North America or Japan for brakes, closures, bumpers, crash boxes, intrusion beams, subframes, body structures, IP beams and suspension components**
- **As a result, the EEU uses more sheet, extrusions and forgings per vehicle than North America and a lot more of these product forms per vehicle than Japan**

2006 Light Vehicle Aluminum Content

2002 Versus 2006 Content by Region for All Components other than Powertrain, Driveline, Wheels and Heat Exchangers

This comparison highlights why Europe is the worldwide leader in the use of aluminum for new innovative applications of aluminum in light vehicles.



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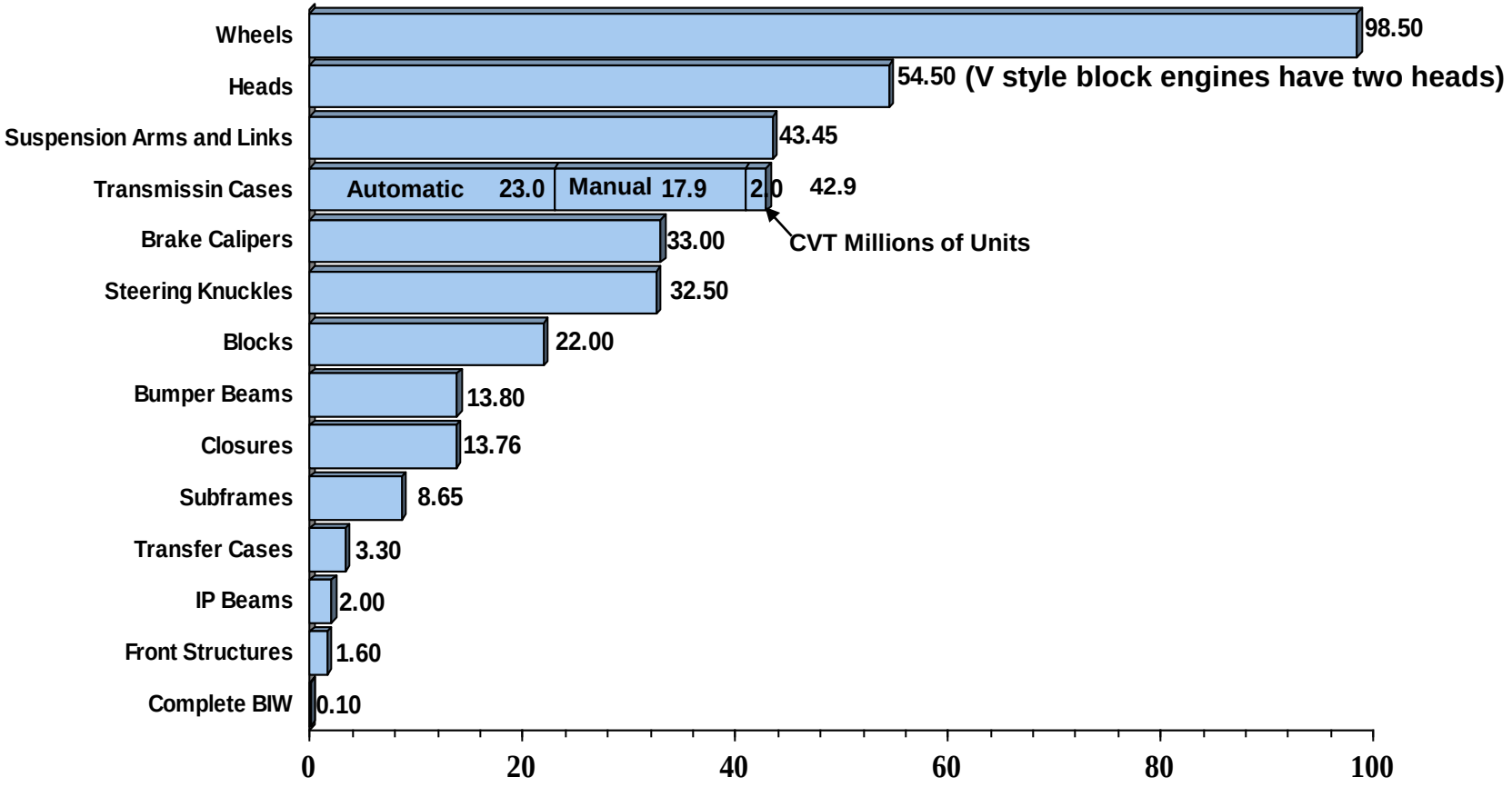
2006 Light Vehicle Aluminum Content

Millions of Aluminum Units

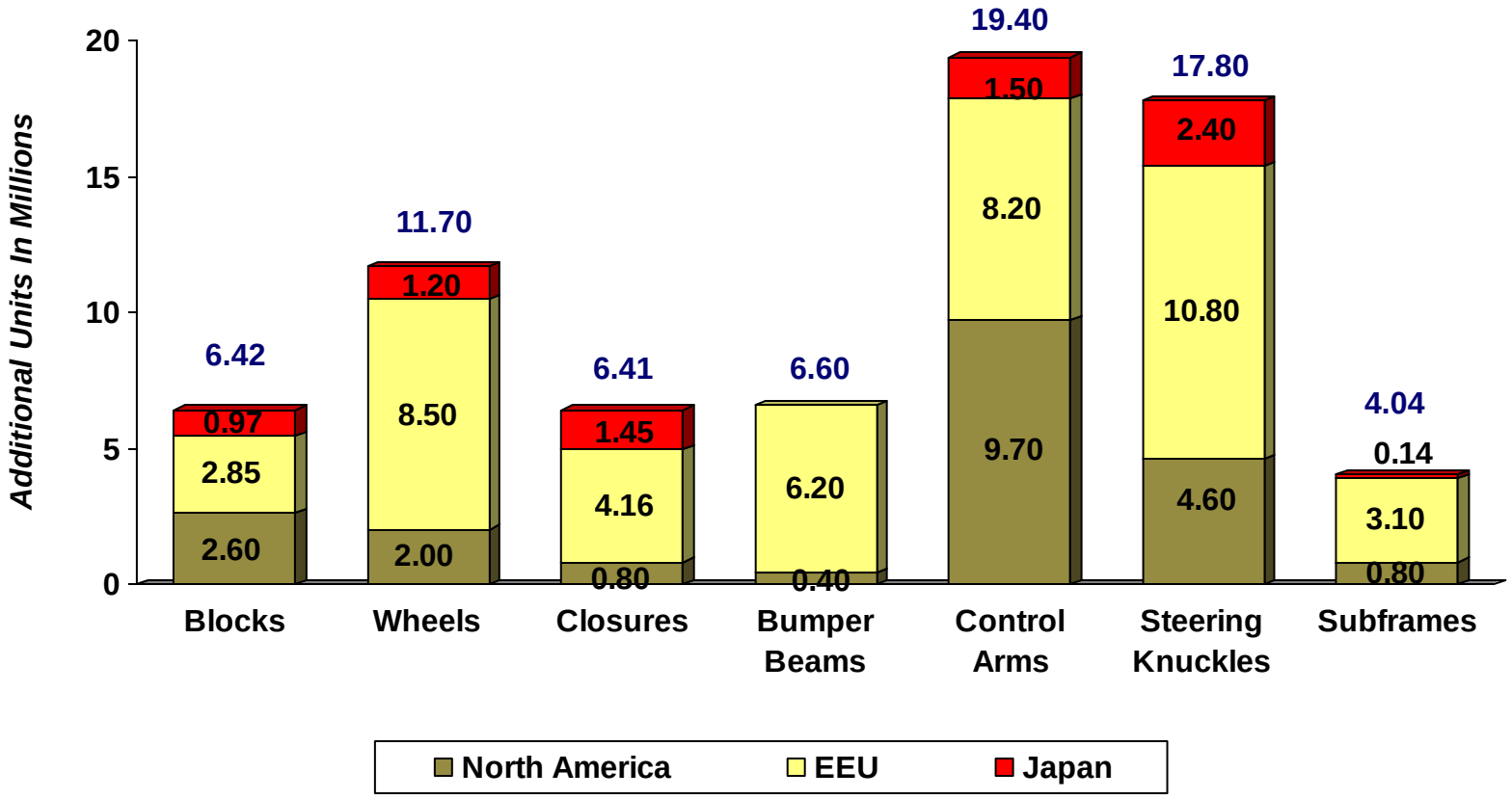
All Three Regions



EXECUTIVE SUMMARY

2006 Light Vehicle Aluminum Content

Millions of Additional Aluminum Units 2002 Versus 2006



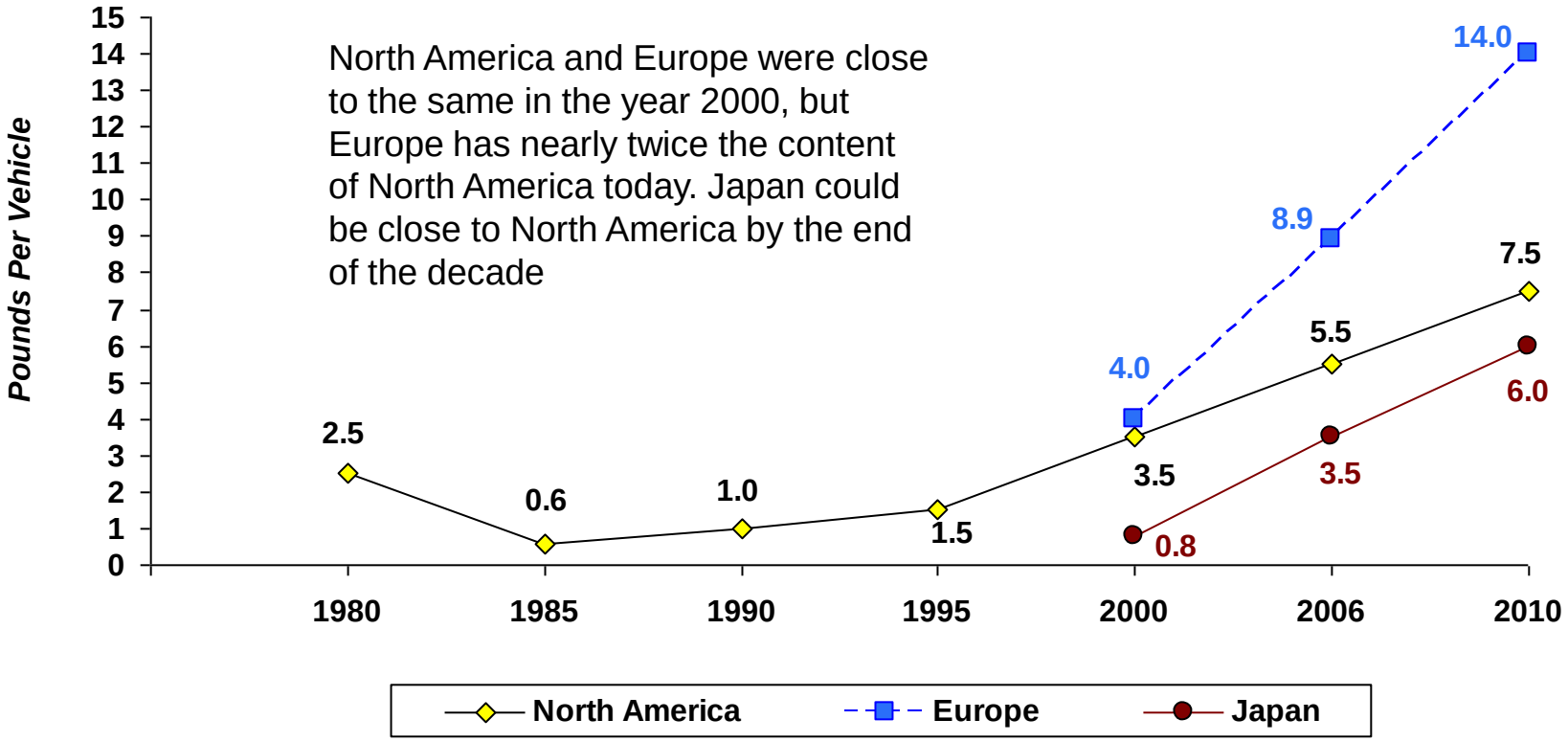
2006 Light Vehicle Aluminum Closure Content

- Number of Programs and Parts -

	Hoods	*Doors*	*Fenders*	*Deck Lid/ Lift and Tail Gates*	*Other*	*Total*
EEU						
Number of Programs	63	24	18	23	9	**137**
Parts (Millions)	3.762	1.287	2.176	0.815	0.124	**8.164**
North America						
Number of Programs	29	None	1	9	None	**39**
Parts (Millions)	2.922	None	0.028	0.887	None	**3.820**
Japan						
Number of Program	25	3	4	6	3	**41**
Parts (Millions)	1.100	0.332	0.076	0.207	0.082	**1.797**
Total						
Number of Programs	**117**	**27**	**23**	**38**	**12**	**217**
Parts (Millions)	**7.784**	**1.619**	**2.280**	**1.909**	**0.206**	**13.781**

EXECUTIVE SUMMARY

Aluminum Closure Content Per Light Vehicle



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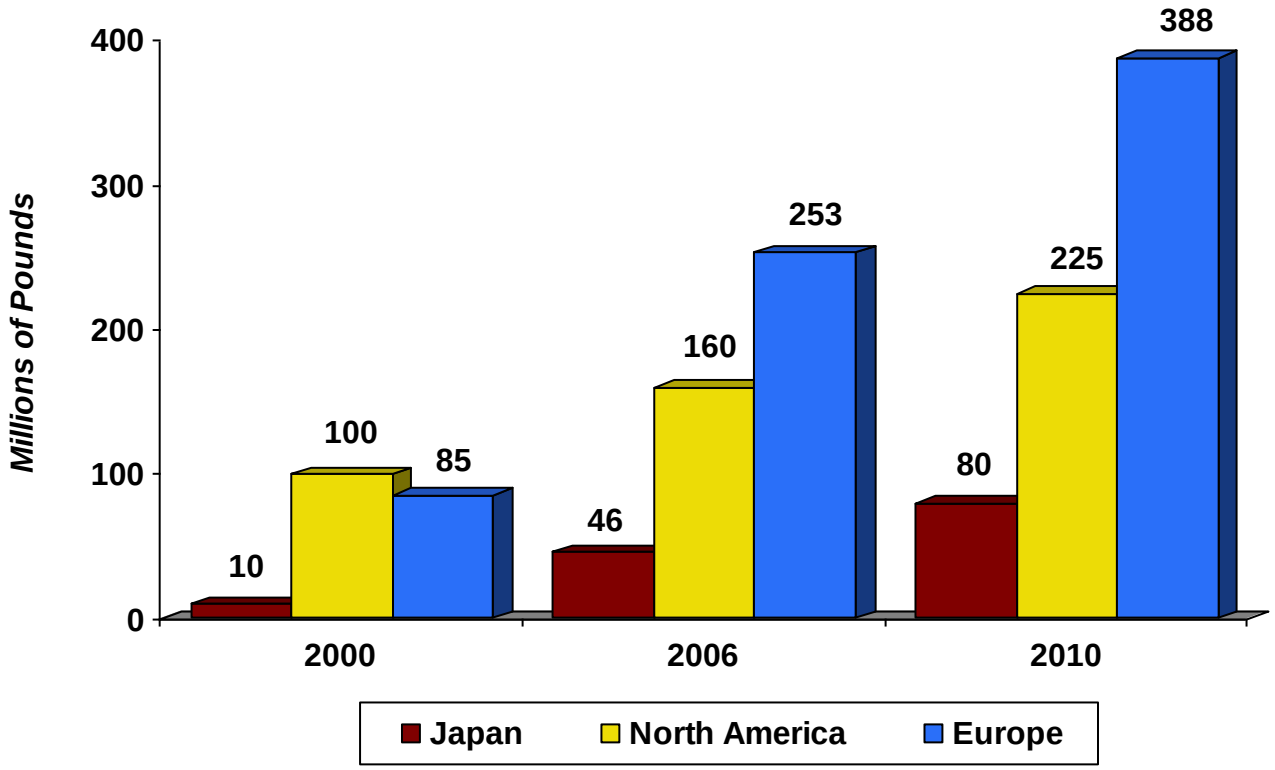
Europe will continue to be the leading geographic region for aluminum closure sheet use with over a fourfold increase in this decade

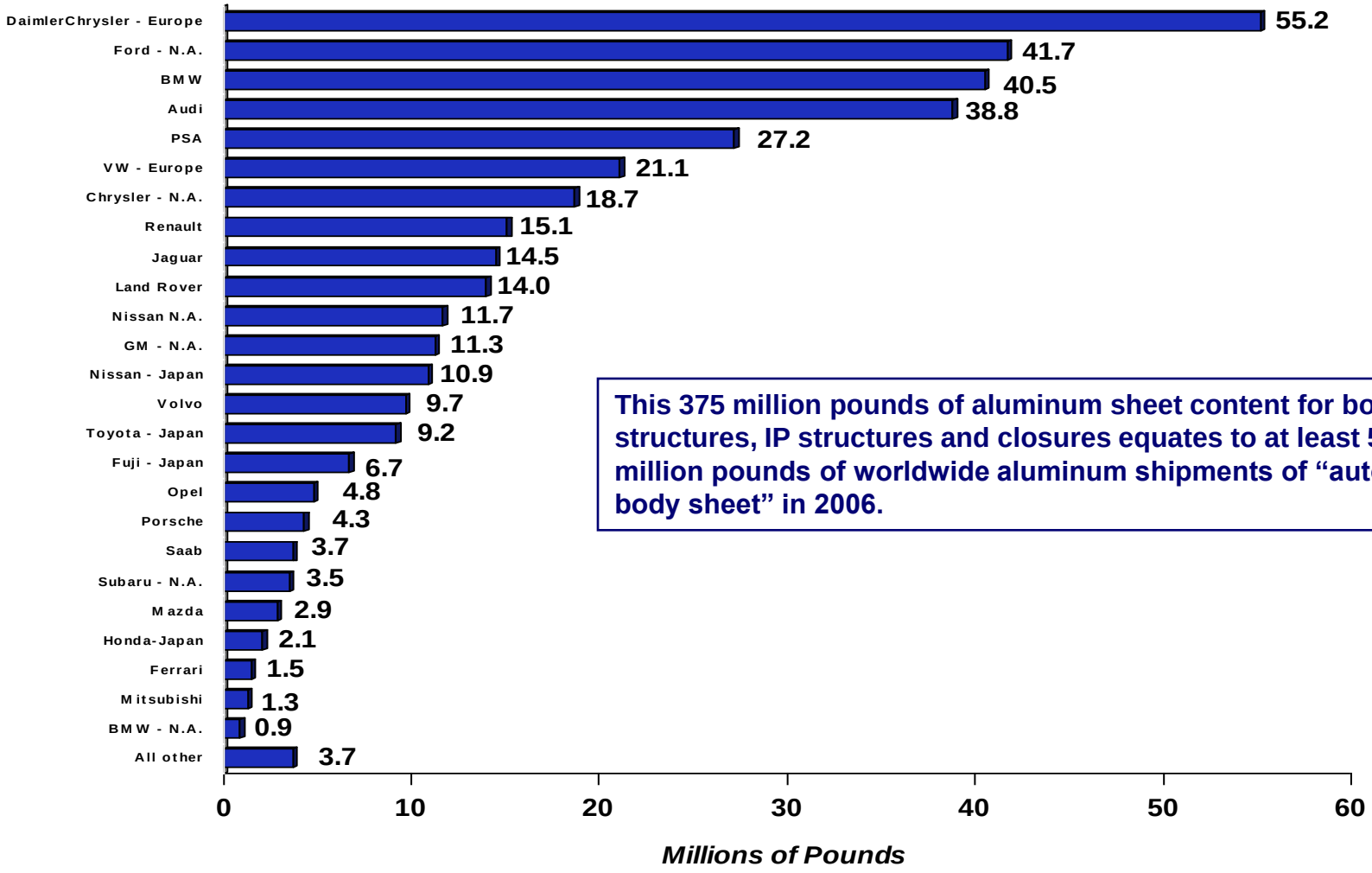
Aluminum Closure Sheet Shipments



EXECUTIVE SUMMARY

2006 Light Vehicle Aluminum Content

- 2006 Body and Closure Aluminum Sheet Content by OEM-



This 375 million pounds of aluminum sheet content for body structures, IP structures and closures equates to at least 575 million pounds of worldwide aluminum shipments of "auto body sheet" in 2006.

2006 Light Vehicle Aluminum Content

Key Aluminum Component Comparisons 2002 Versus 2006

(Millions of Units)

	North America		*European Union*		*Japan*	
	2002	***2006***	***2002***	***2006***	***2002***	***2006***
Engine Blocks	5.5	8.1	5.0	7.85	5.10	6.07
Wheels and Spares	39.0	41.0	28.5	37.00	19.80	21.00
Closures	3.0	3.8	4.0	8.16	0.35	1.80
Bumper Beams	1.7	2.1	4.7	10.50	1.20	1.20
Control Arms and Links	6.8	16.5	17.0	25.20	0.25	1.75
Steering Knuckles	10.4	15.0	4.0	14.80	0.30	2.70
Cradles, Subframes and Crossmembers	1.5	2.3	3.0	6.10	0.11	0.25

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Light Vehicle Aluminum Content Per Vehicle

- 2002 Versus 2006 -

	North America		*European Union*		*Japan*	
	Revised 2002	***2006***	***Revised 2002***	***2006***	***Revised 2002***	***2006***
Engines	92.66	113.84	80.60	88.76	98.00	100.92
Transmission and Driveline	62.04	69.46	34.00	35.84	45.30	48.10
Chassis, Suspension and Steering	13.76	22.18	18.10	27.66	6.50	8.23
Wheels and Spares	49.32	52.06	31.35	39.08	39.20	41.64
Heat Exchanger	32.00	31.87	24.30	27.03	26.40	29.99
Brakes	5.48	7.75	6.00	8.22	3.69	7.50
Closures	4.32	5.52	5.30	8.92	0.60	3.47
Body and IP Beams	1.00	1.16	3.90	6.21	0.30	0.51
Heat Shields	3.82	4.05	2.60	3.00	1.20	2.28
Bumper Beams	1.35	1.82	3.13	6.07	1.71	1.69
All Other Components	9.03	8.99	8.50	8.49	6.10	7.00
Totals	274.78	318.70	217.78	259.28	229.00	251.33

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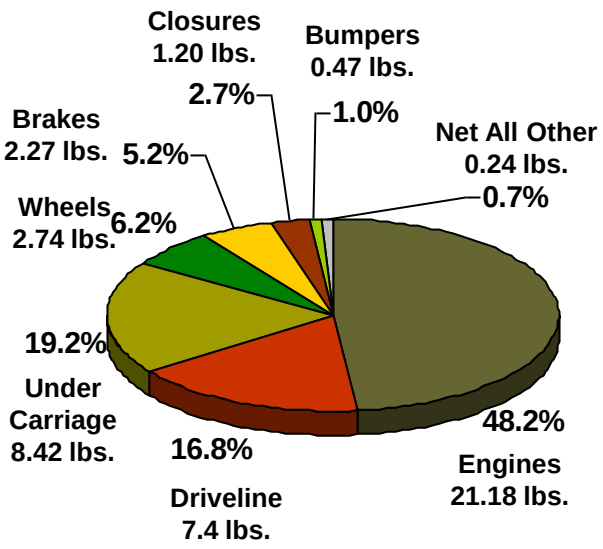
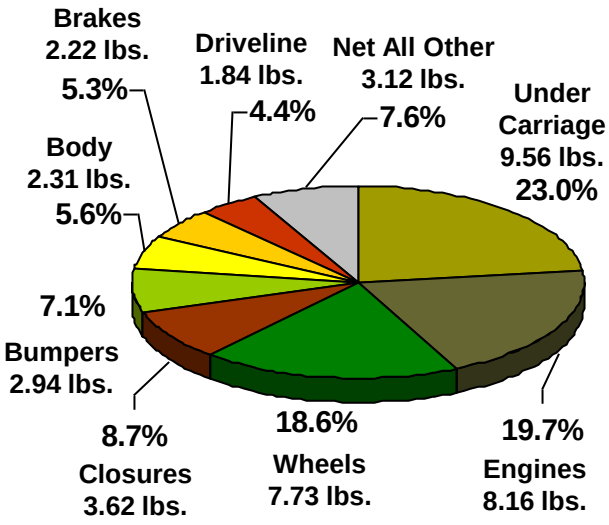
2006 Light Vehicle Aluminum Content
Increased Aluminum Content Per Vehicle Compared to 2002
- Segmented by Region and Component -

North America



43.92 Pounds Per Vehicle

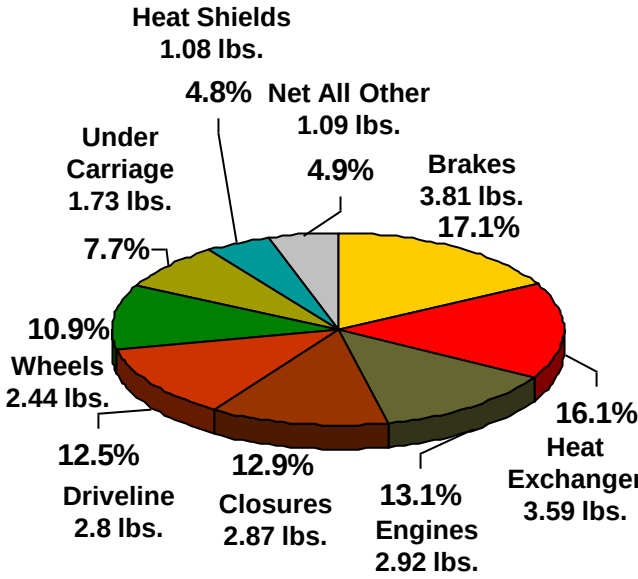
European Union



41.50 Pounds Per Vehicle*

47 pounds for passenger car only

Japan



22.33 Pounds Per Vehicle

EXECUTIVE SUMMARY

2006 Light Vehicle Aluminum Content

- Partial List of High Aluminum Content Vehicles by Region -

European Union Aluminum Content		*N. American Aluminum Content*		*Japan Aluminum Content*	
Over 500 lbs.	***400 to 500 lbs.***	***Over 500 lbs.***	***400 to 500 lbs.***	***Over 500 lbs.***	***400 to 500 lbs.***
Audi A6	Rover Defender	Altima	Chrysler 300	Nissan Cima/Q45	Subaru Legacy
Audi A7/Q7	Range Rover	Maxima	Charger	Nissan Fuga/M45/M36	Nissan Stagea
Audi A8	Renault Espace	Lincoln LS	Magnum	Nissan Skyline/G35	Nisan Fairady Z
Audi TT	Renault Vel Satis	Navigator	Ford F150	Toyota Celsior	Toyota Majesta
Audi LeMans	Citron C6	Expedition	Explorer	Toyota Soarer	Toyota Aristo
Bentley Continental	Volvo V70	Corvette	Ford GT	Toyota Crown	Honda S2000
BMW 5 Series	Volvo S60	Cadillac CTS	Mustang	Toyota Mark X	Dashatsu Copen
BMW 6 Series	Volvo S80	Cadillac STS	Legacy/Outback	Honda Legend	Honda Insight
BMW 7 Series	Porsche 911	Cadillac DTS	New Escalade	Acura RL	
Rolls Royce Phantom	Porsche Boxster	Cadillac XLR	New Suburban	Mazda RX8	
Mercedes C Class	Porsche Cayenne	Pacifica	New Yukon		
Mercedes E Class	Opel Signum	BMW Z4	New Tahoe		
Mercedes S Class	Opel Vectra		Subaru Tribeca		
Mercedes CLK	Saab 9-3		Lincoln Towncar		
Mercedes SL Roadster	Saab 9-5		Ford 500		
Mercedes Maybach			Ford Freestyle		
Jaguar XJ 350					
Jaguar XK 150					
VW Phaeton					
Ferrari F430					
Various Aston Martin's					
Various Lamborghini's					

Certain engine, transmission and wheel combinations for some of these vehicles may contain less aluminum than indicated

EXECUTIVE SUMMARY

Key Findings of the Study:

- **2006 aluminum content will be nearly 12 billion pounds with shipments of 14 billion pounds in the three regions under study. This amount of aluminum will replace nearly 30 billion pounds of iron, steel and other materials**
- **Average light vehicle aluminum content in the three regions will increase by 54 pounds to 279 pounds in 2006 versus an average of 225 pounds in 2000, a CAGR of 3.6%. The CAGR over the next five years should be in the range of 3% to 3.5%**
- **Average aluminum content in North America will be up 16% to 319 pounds, the European Union will be up 19% to 259 pounds and Japan will be up 10% to 251 pounds over 2002**
- **For innovative applications beyond the powertrain, driveline, wheels and heat exchangers, aluminum content in Europe will be 69 pounds, innovative North American content will be 52 pounds (54 pounds including drive shafts) and Japan will be 30 pounds. In our opinion, this will make Europe the worldwide leader in the innovative use of aluminum for light vehicles in 2006**
- **The aluminum industry will ship at least 570 million pounds of sheet for auto body, IP structures and closure applications in 2006 versus only 280 million pounds in 2002. Two thirds of the 2006 aluminum use for auto body and closures will be in Europe. 11.8% of the worldwide aluminum content is rolled products**

EXECUTIVE SUMMARY

Key Findings of the Study:

- Although the spread in pounds per vehicle is from 251 pounds to 319 pounds by region, the spread in content as a percent of the average curb weight by region is less dramatic at from 7.18% to 7.97%. In a macro sense, the regions are more alike than different
- There are over 200 individual aluminum closure programs in the three regions under study. Europe has nearly 140 programs and North America and Japan each have about 40 programs. 54% of the programs are for hoods, 17.5% are deck lid, tailgate and liftgate programs, 12.4% are door programs and the remainder are fender and roof programs.
- Nearly 50 vehicles and two million units of production in 2006 will be high aluminum content vehicles containing over 500 pounds of aluminum per vehicle. Only 100,000 of these vehicles will have complete aluminum body structures
- A few vehicles like the Acura RL contain nearly 800 pounds of aluminum as part of vehicle with a high strength steel body structure. Honda is the world leader in the use of high strength steel. Honda is a model for using the right materials in the right applications. Honda converted their engines to aluminum long before any other manufacturer, but they have been slow to use aluminum for stampings because of the cost penalty

EXECUTIVE SUMMARY

Key Findings of the Study:

- The use of primary aluminum rather than secondary aluminum for light vehicle components is increasing. In 2006, 57% of the aluminum content in North America and 63% of the aluminum content in Japan will be sourced from recycled metal. However, in Europe only 50% of the aluminum content will be sourced from recycled metal. High pressure die castings, which are the principal user of recycled metal, are a smaller share of the aluminum content in Europe. The average for the three regions is 55%. The “practical limit” for recycled aluminum in light vehicles, based on the 2006 product mix, is between 58% and 63%
- The growth in aluminum over the last four years exceeded our forecasts. We found more engine blocks, suspension arms, steering knuckles, closures, bumper beams and body and chassis components than we expected. While Europe shows the highest numbers for most of these components, there are also many aluminum success stories in North America and Japan.
- This study has confirmed that aluminum continues to make great progress and the 2,000,000 vehicles with an aluminum content over 500 pounds, and the anticipated 2006 shipments of 14 billion pounds is testimony that the acceptance of aluminum continues to grow at an astounding rate

COMPONENT ANALYSIS

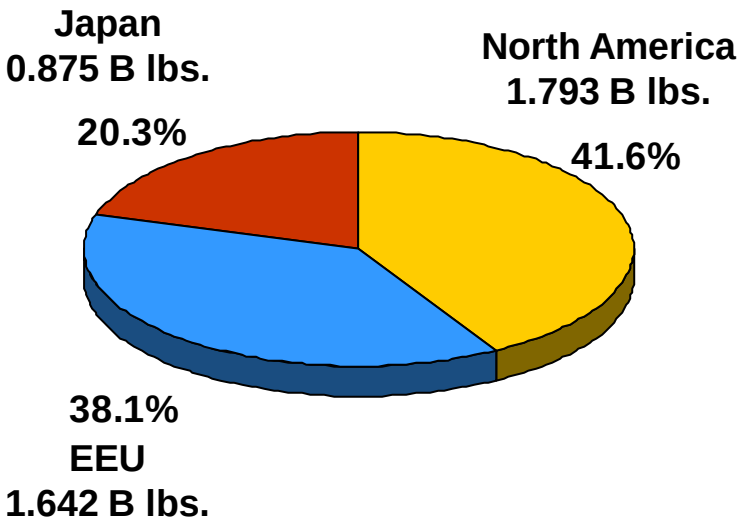
POWERTRAIN AND DRIVELINE

POWERTRAIN AND DRIVELINE

Light vehicle powertrains and drivelines contain over one half of the aluminum contained in most vehicles

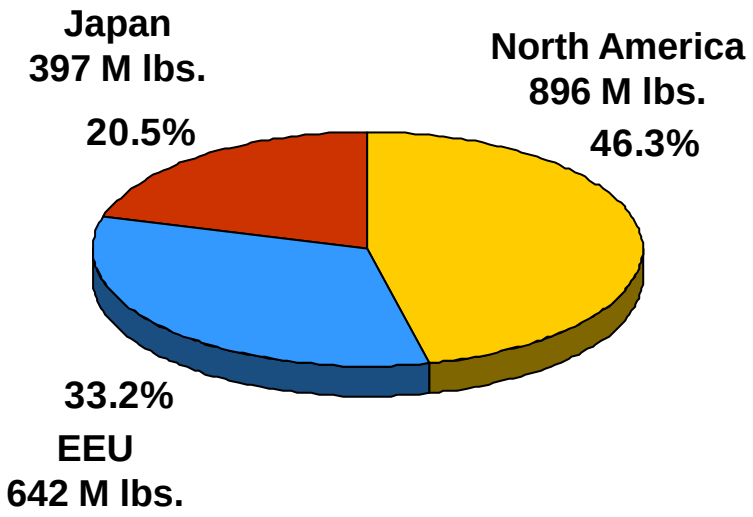
2006 Light Vehicle Aluminum Content

Engines



4.310 Billion Pounds

Transmissions



1.935 Billion Pounds

POWERTRAIN AND DRIVELINE

Every cell in the table below is assigned a different aluminum weight that is determined by type of vehicle, OEM and region of the world

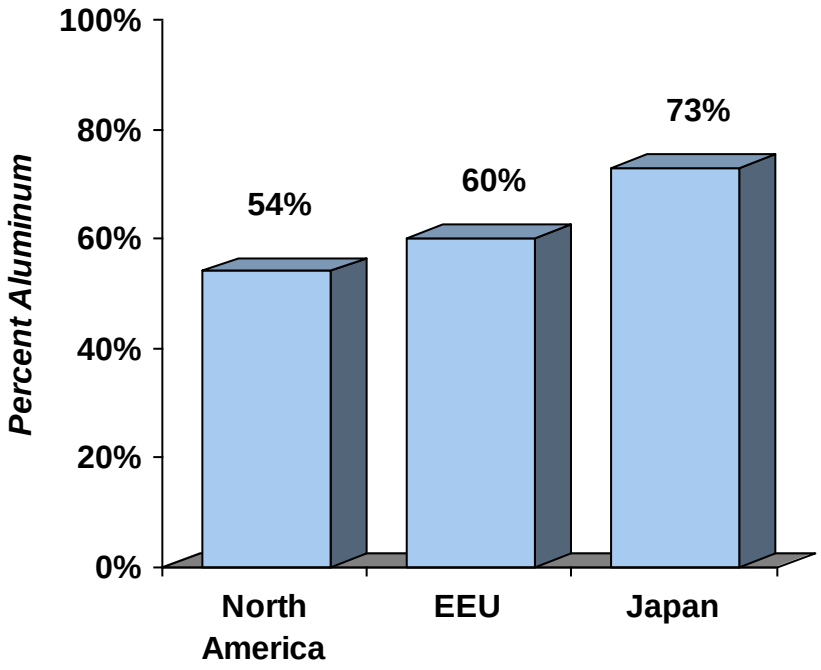
2006 Light Vehicle Engine Segmentation

	North America				*EEU*				*Japan*			
	Car	***SUV***	***Van***	***Pickup***	***Car***	***SUV***	***Van***	***Pickup***	***Car***	***SUV***	***Van***	***Pickup***
I 3	--	--	--	--	6%	--	--	--	20%	28%	27%	--
I 4	52%	7%	14%	8%	80%	41%	93%	86%	66%	64%	67%	95%
I 5	2%	1%	--	4%	3%	11%	6%	--	--	--	--	--
I 6	2%	10%	--	69%	3%	13%	Neg'l	--	--	4%	--	--
V6	34%	51%	69%	18%	6%	18%	1%	14%	12%	25%	6%	5%
V8	9%	31%	15%	63%	2%	15%	--	--	2%	6%	--	--
V10	Neg'l	Neg'l	2%	1%	Neg'l%	2%	--	--	--	--	--	--
Gasoline	99.3%	99.7%	95%	83%	56%	43%	24%	35%	97%	91%	96%	76%
Diesel	0.7%	0.3%	5%	17%	44%	57%	76%	65%	3%	9%	4%	24%
# of Vehicles (millions)	7.0	4.0	1.45	3.3	14.56	0.911	3.014	0.015	5.315	1.7	1.5	0.155

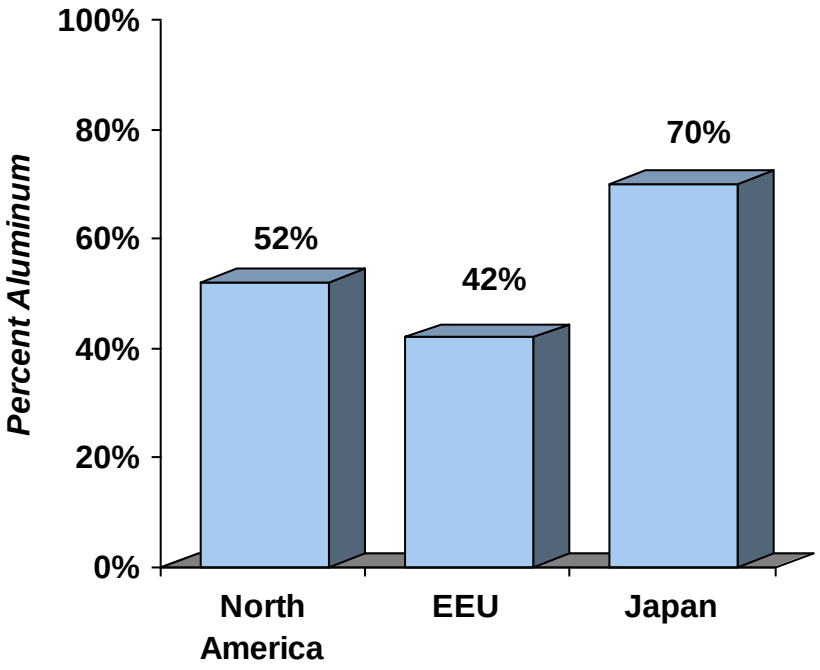
Gasoline engine blocks around the world are steadily moving to at least 75% aluminum! Diesel engine blocks are only 24% aluminum

2006 Light Vehicle Aluminum Engine Block Penetration

Gasoline Engines

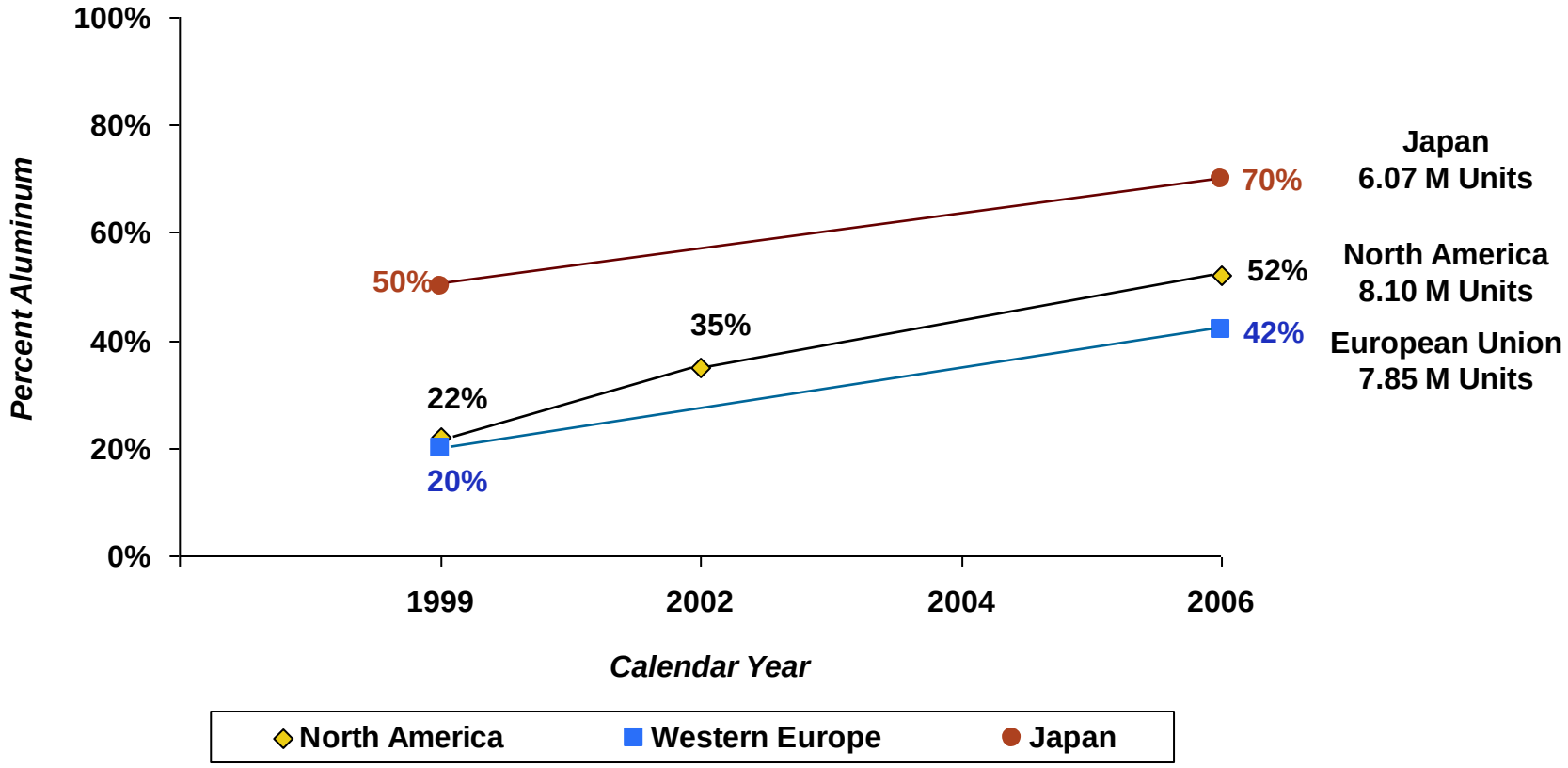


All Engines



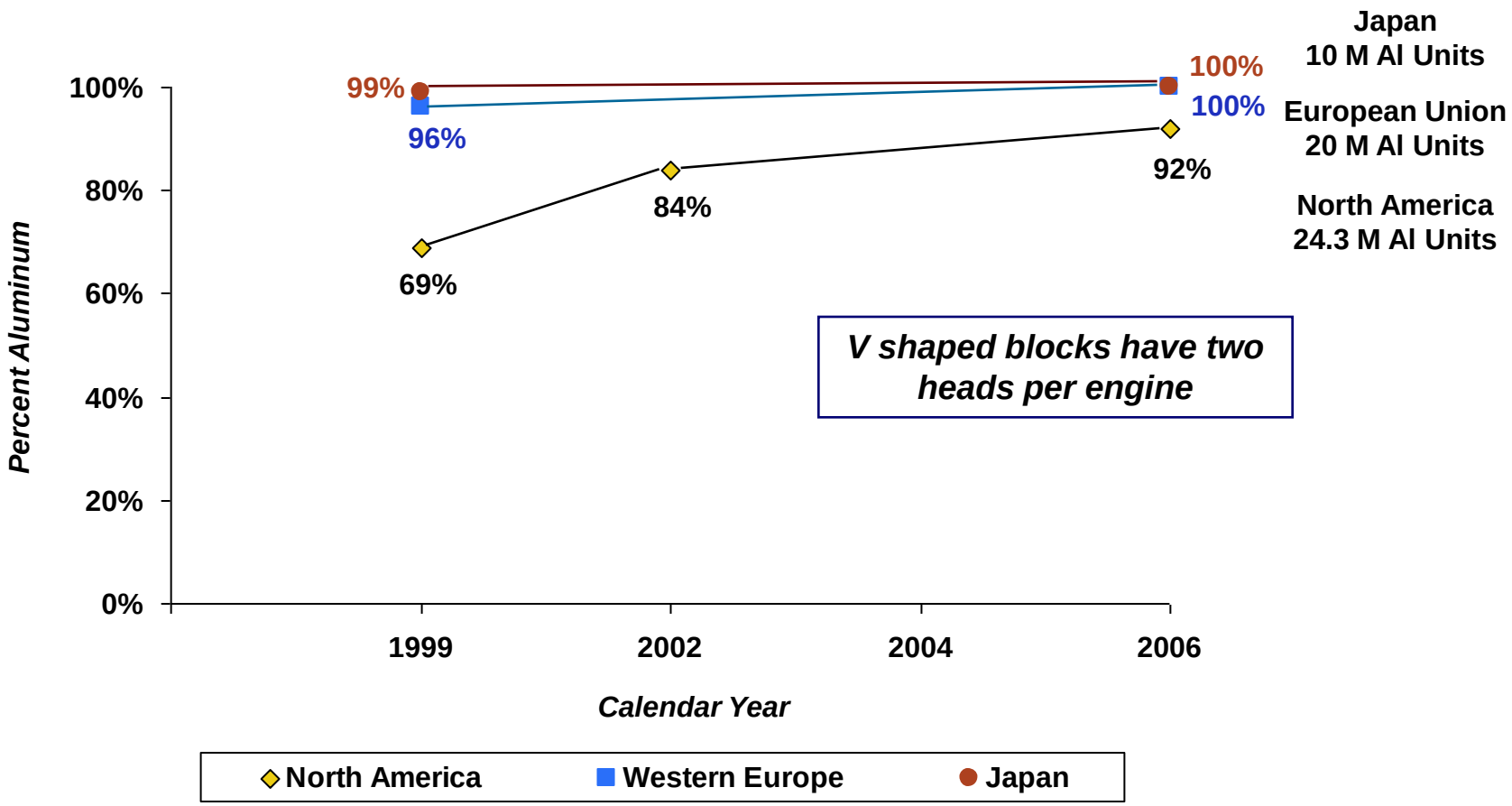
The growth in the use of aluminum for light vehicle engine cylinder blocks continues its strong upward trend. Over 50% of all blocks will be aluminum in 2006

2006 Light Vehicle Aluminum Engine Block Penetration



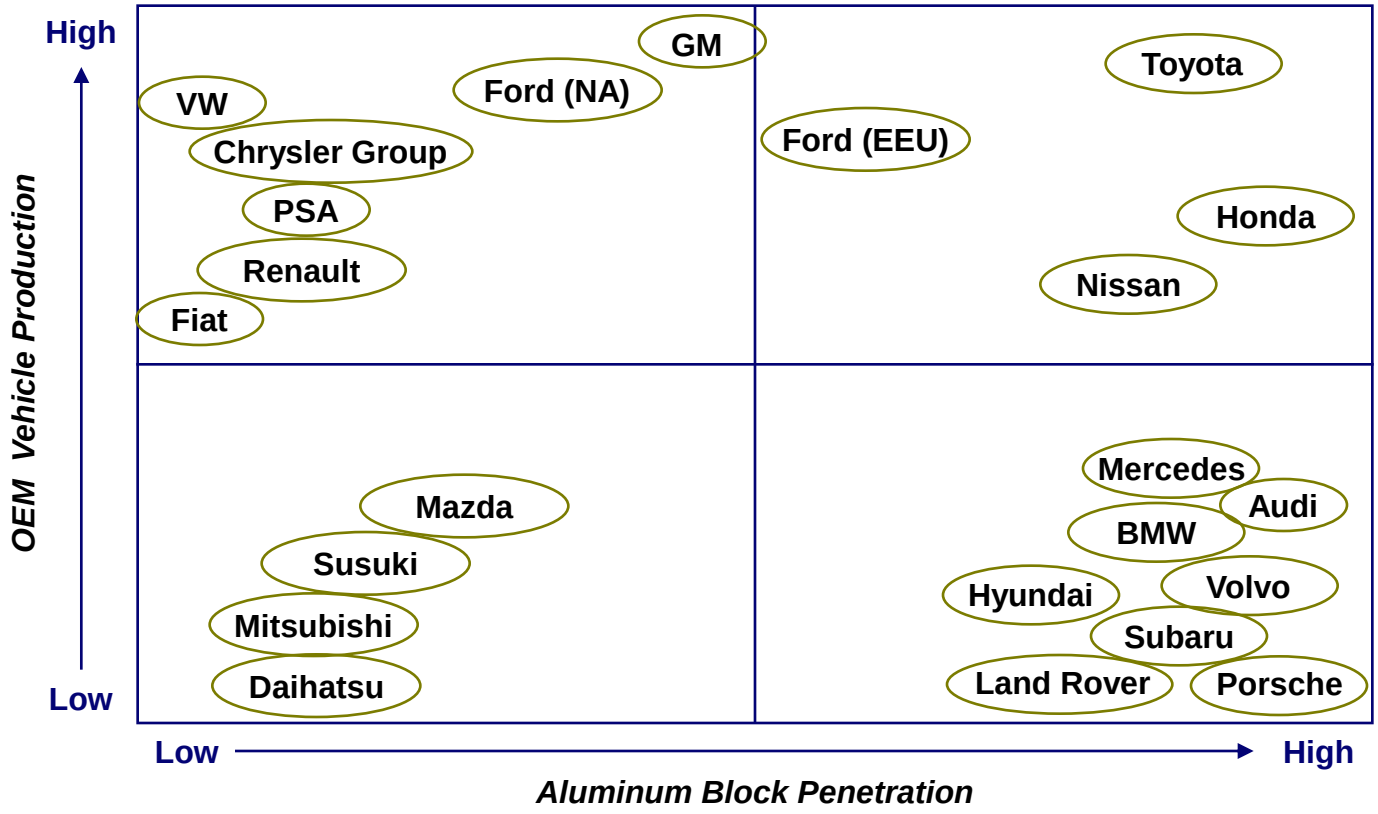
The worldwide conversion to aluminum cylinder heads for light vehicle engines is nearly complete

2006 Light Vehicle Aluminum Cylinder Head Penetration



Aluminum block penetration varies a great deal by OEM and is independent of OEM size and reason

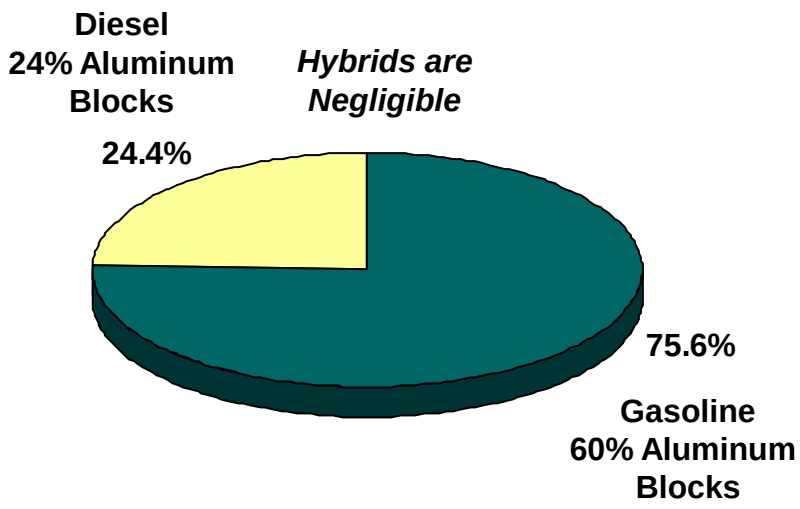
2006 Light Vehicle Aluminum Blocks



2006 Light Vehicle Engines

- Segmented by Fuel Type -

North America, Europe and Japan Engines

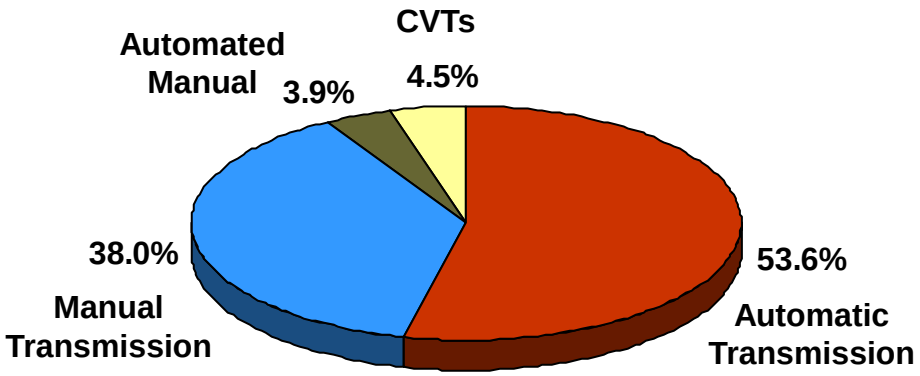


42.91 Million Engines

- **Hybrid engines are actually classified as a gasoline engine, but they are usually smaller than non-hybrid engines for similar vehicles**
- **Diesel engines use less aluminum than gasoline engines because only 24 percent of the blocks for diesel engines are aluminum while 60 percent of the blocks for gasoline engines use aluminum**
- **Aluminum is gradually being adapted and accepted for diesel engine blocks which operate at higher pressures and temperatures than gasoline engines. By 2010, 35 percent of all diesel blocks will be aluminum**

2006 Light Vehicle Transmissions

- Segmented by Type -



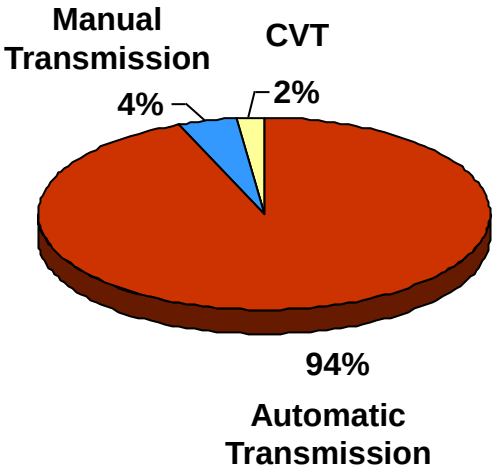
42.91 Million Transmissions

- **Conventional automatic transmissions are popular in North America, but CVTs are growing in Japan and manual transmissions are very popular in Europe**
- **Aluminum content per vehicle is 20 pounds greater in North America than in Europe simply due to transmission type and size**
- **Aluminum content for transmissions is at or near its peak due to the growth of CVTs and the threat of magnesium for cases. So far creep concerns have limited magnesium use to manual cases, but the magnesium creep problem will eventually be solved**

2006 Light Vehicle Transmissions

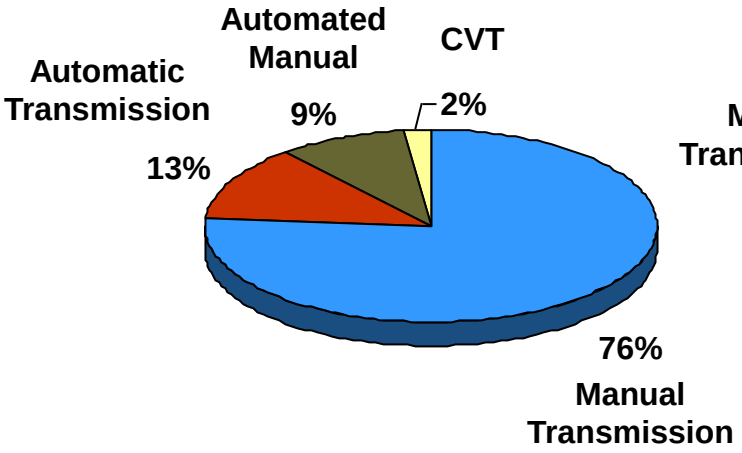
- Segmented by Region and Type -

North America



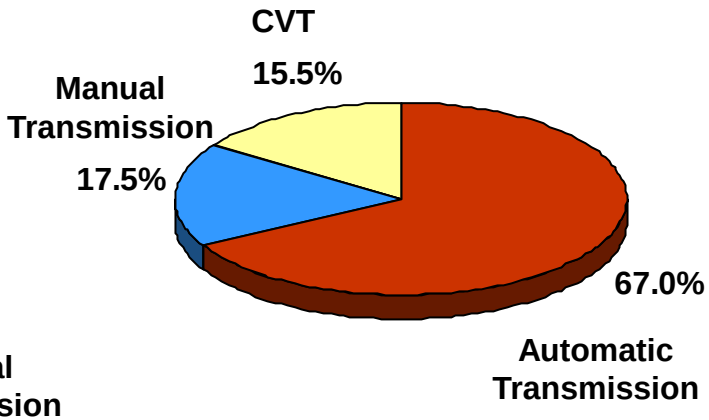
15.75 Million Units

European Union



18.5 Million Units

Japan

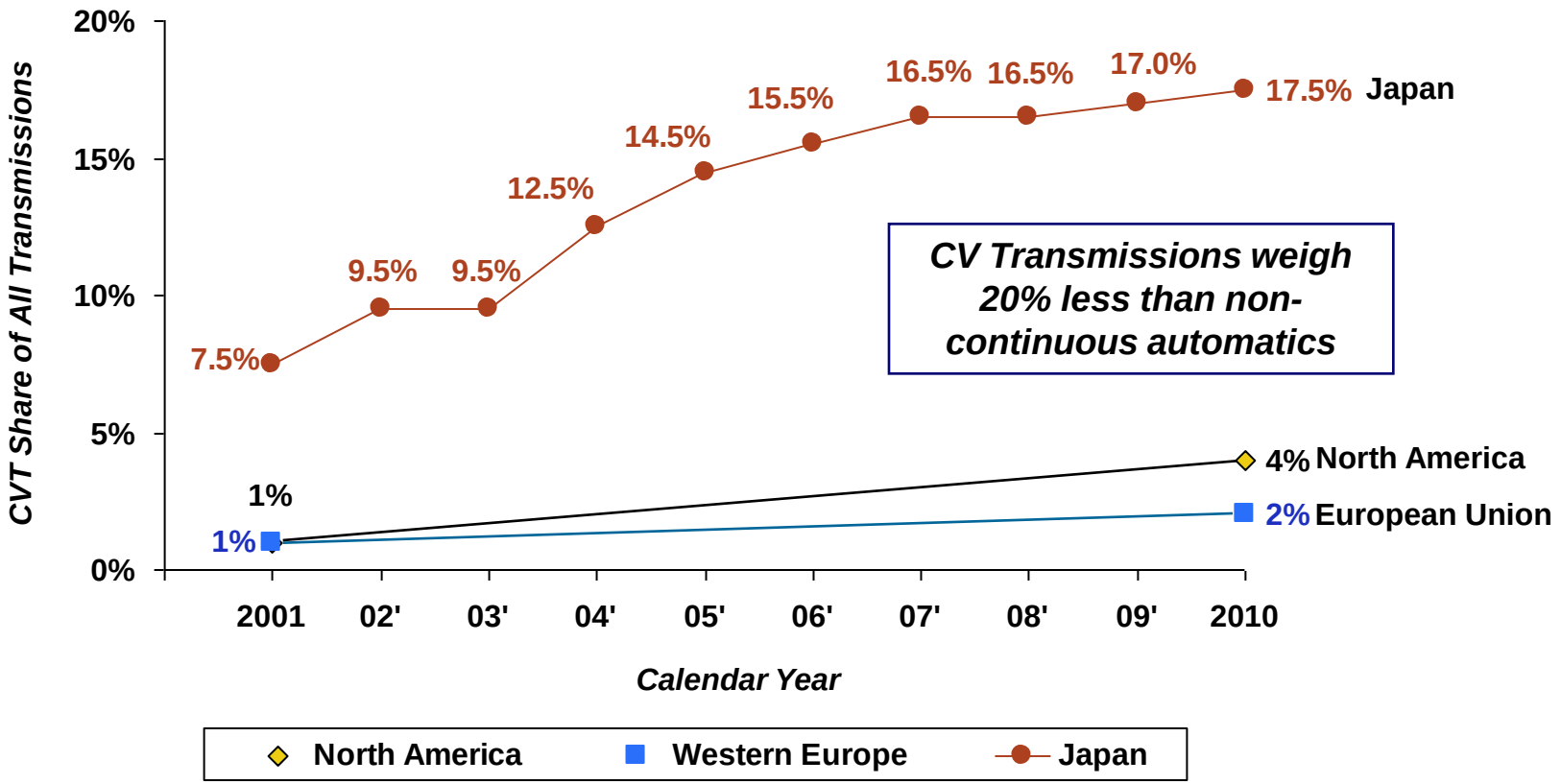


8.67 Million Units

CVT growth outside of Japan is very slow due to cost and low consumer acceptance

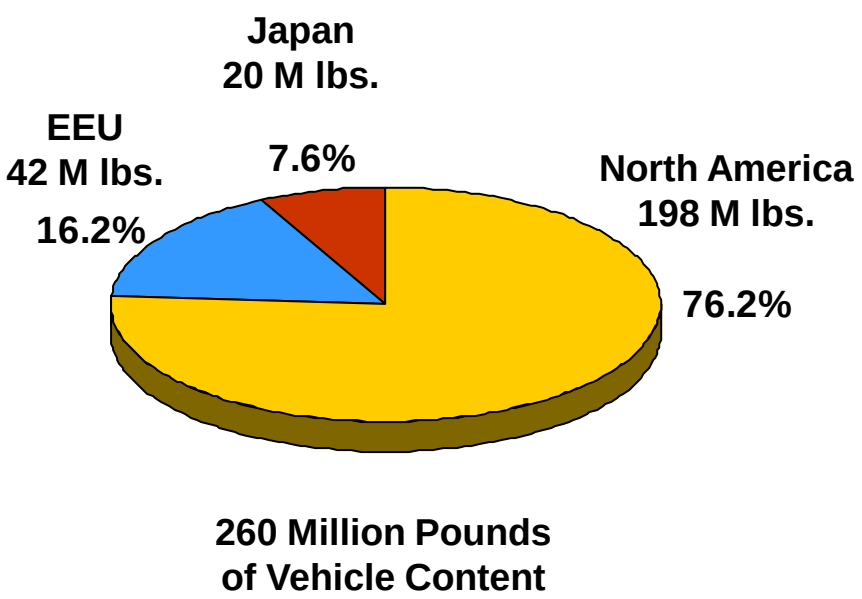
Growth of Continuously Variable Transmissions for Light Vehicles

- By Region -



2006 Light Vehicle Aluminum Content

Drive Shafts, Transfer Cases and Differential Housings
- Segmented by Region -



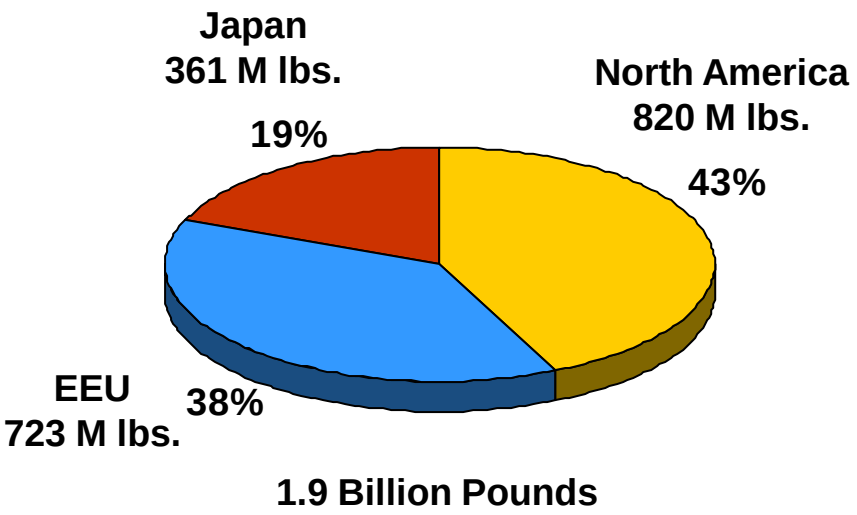
260 Million Pounds of Vehicle Content

- North America will assemble eight million SUVs, pickup trucks, vans and passenger cars that are either rear wheel, all wheel drive all the time or 4-wheel drive on demand in 2006
- These North American vehicles will use 3.0 million aluminum drive shafts, 3.0 million aluminum transfer cases, 1.7 million aluminum front differential cases and 2.0 million aluminum rear differential cases
- In 2006, Europe will assemble 2.5 million vehicles with rear, AWD or 4wd, and Japan will manufacturer 2.0 million vehicles with rear, AWD and 4wd. Many of these vehicles will be for export to the U.S.
- Aluminum drive shafts in North America and Japan are made from drawn tube. Europe uses aluminum shafts made from sheet welded into tube. Europe and Japan use relatively few aluminum transfer cases and differential housings compared to North America.

WHEELS AND BRAKES

2006 Light Vehicle Aluminum Wheels

Weight Segmented by Region



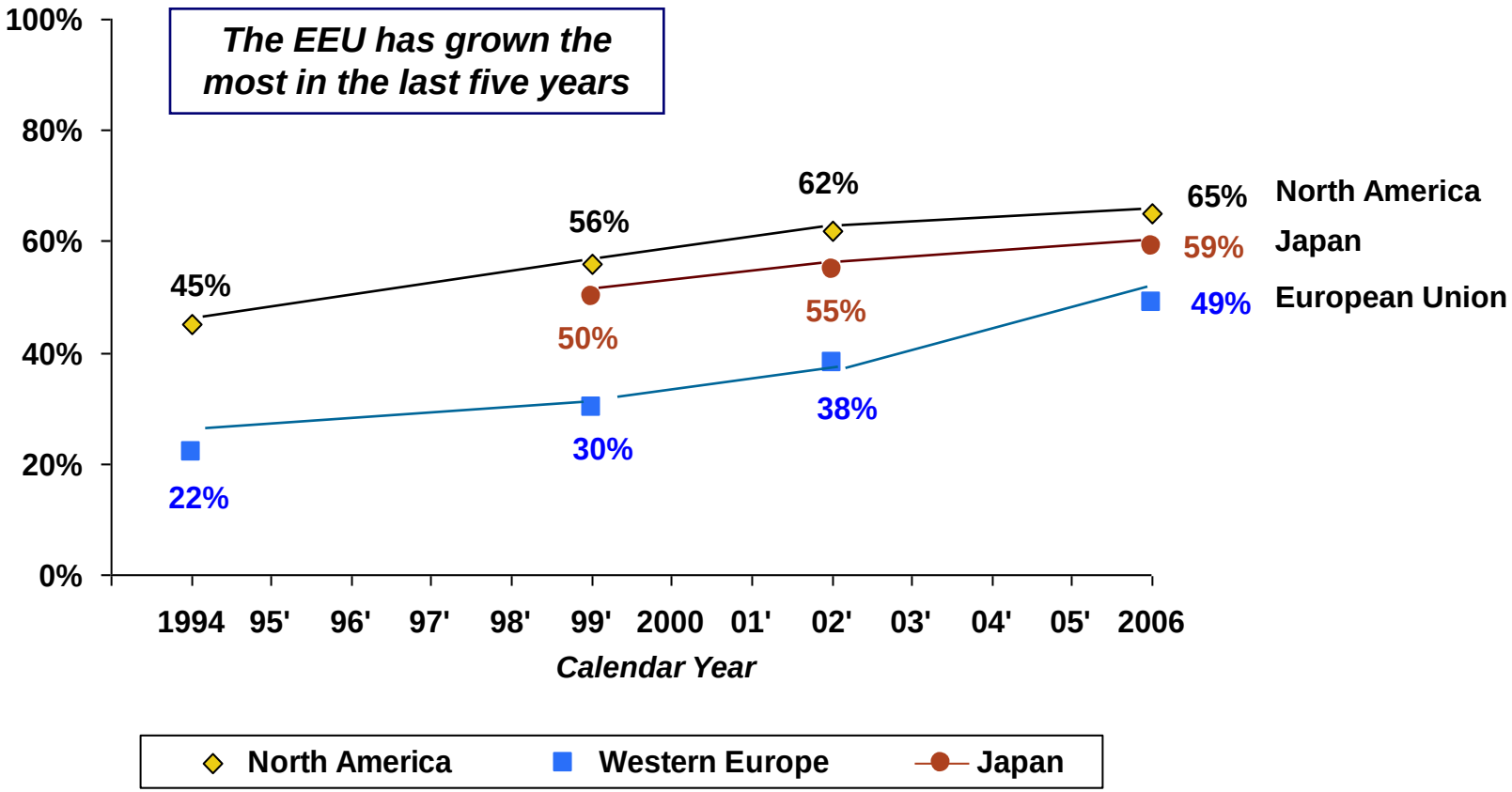
- Aluminum wheel weights range from an average of 17.6 pounds per wheel in Japan to 20 pounds per wheel in North America. Aluminum wheel weights have increased by ten percent over the last five to ten years. Larger diameters and styling changes have led to this increase in weight
- Ninety-four percent of these aluminum wheels are cast using the permanent mold and to a small extent squeeze casting processes
- Forged wheels and wheels fabricated from sheet and plate account for the remaining six percent. Fabricated wheels made from aluminum sheet and plate peaked in North America in 2000, but have declined dramatically in the last five years

WHEELS AND BRAKES

Aluminum wheel penetration has begun to plateau in North America and Japan. In North America, this is due primarily to the success of styled steel wheels made from advanced high strength dual phase steels

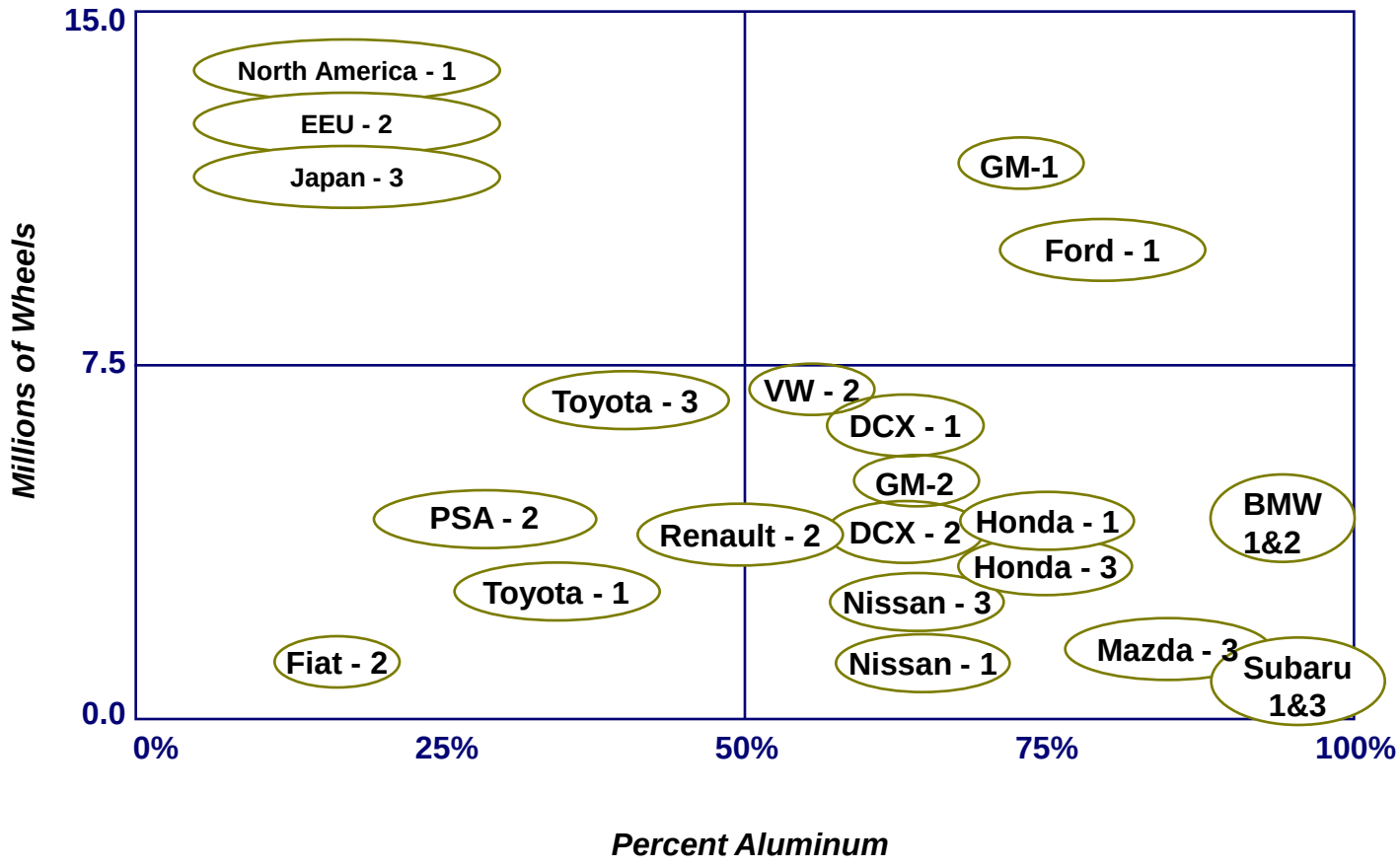
Light Vehicle Aluminum Wheel Penetration

- By Region -



Toyota, PSA and Fiat are the laggards on aluminum wheel adoption

2006 Light Vehicle Wheel Penetration by OEM by Region

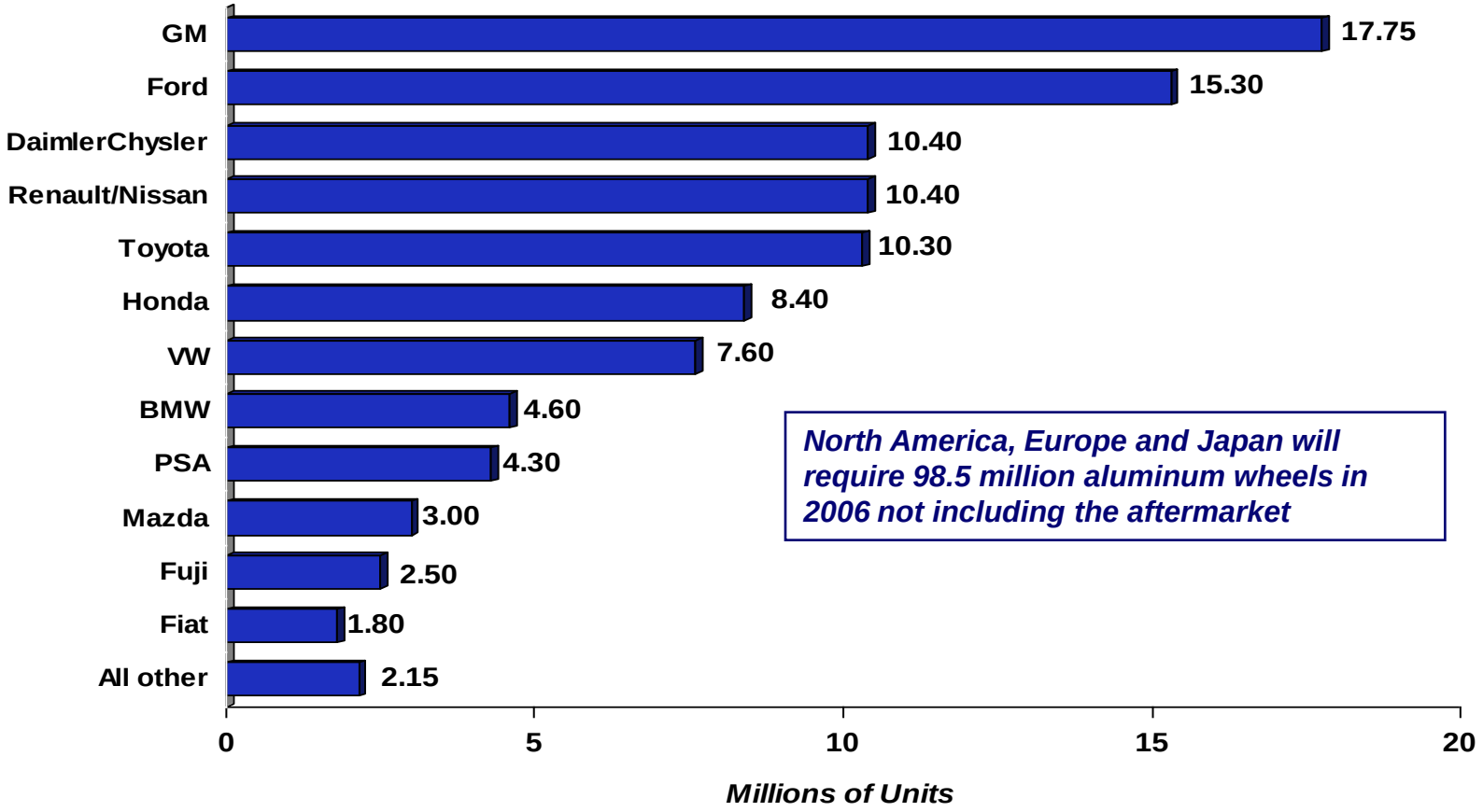


WHEELS AND BRAKES

GM is the largest buyer of aluminum wheels in the world including several million wheels from China

2006 Light Vehicle Aluminum Wheels in North America, Japan and the European Union

(In Millions of Units)



North America, Europe and Japan will require 98.5 million aluminum wheels in 2006 not including the aftermarket

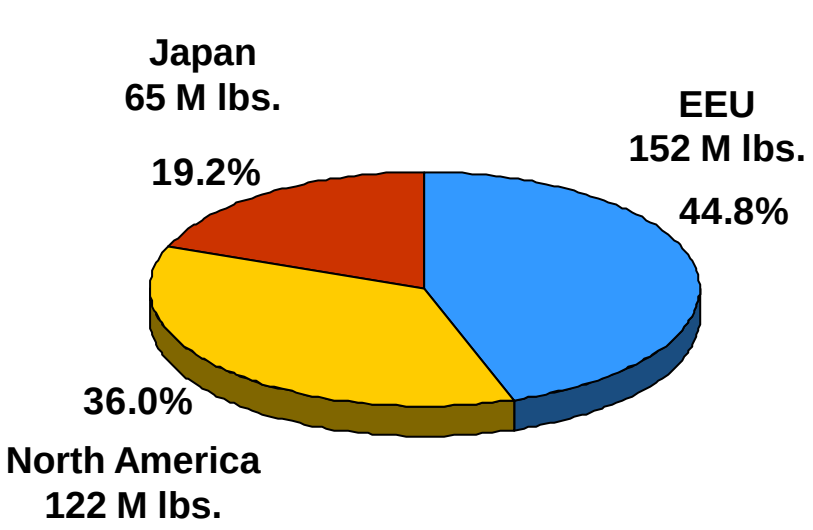
WHEELS AND BRAKES

ABS housings and pistons are large users of extruded aluminum products.

The remaining aluminum brake parts are castings

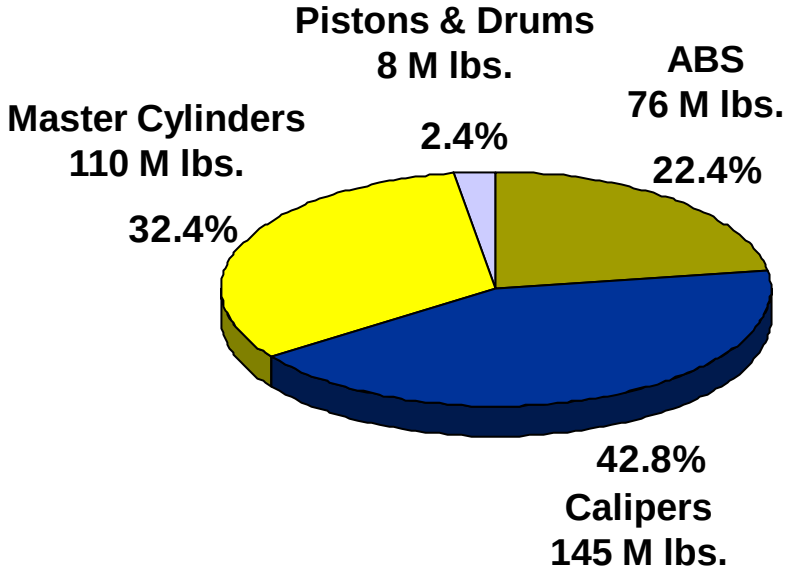
2006 Light Vehicle Aluminum Content for Brakes

Segmented by Region



339 Million Pounds

Segmented by Component



339 Million Pounds

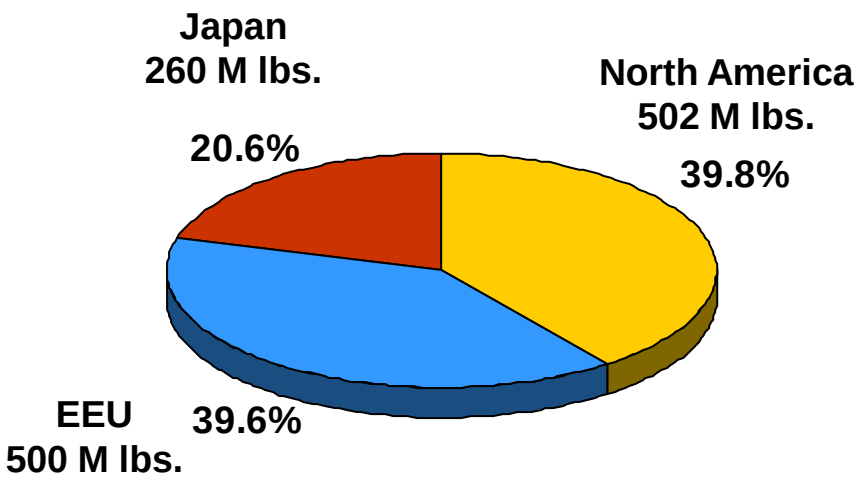
HEAT EXCHANGERS AND HEAT SHIELDS

HEAT EXCHANGERS AND HEAT SHIELDS

2006 Light Vehicle Aluminum Content for Heat Exchangers

Heat Exchanger Content

- Segmented by Region -



1.262 Billion Pounds

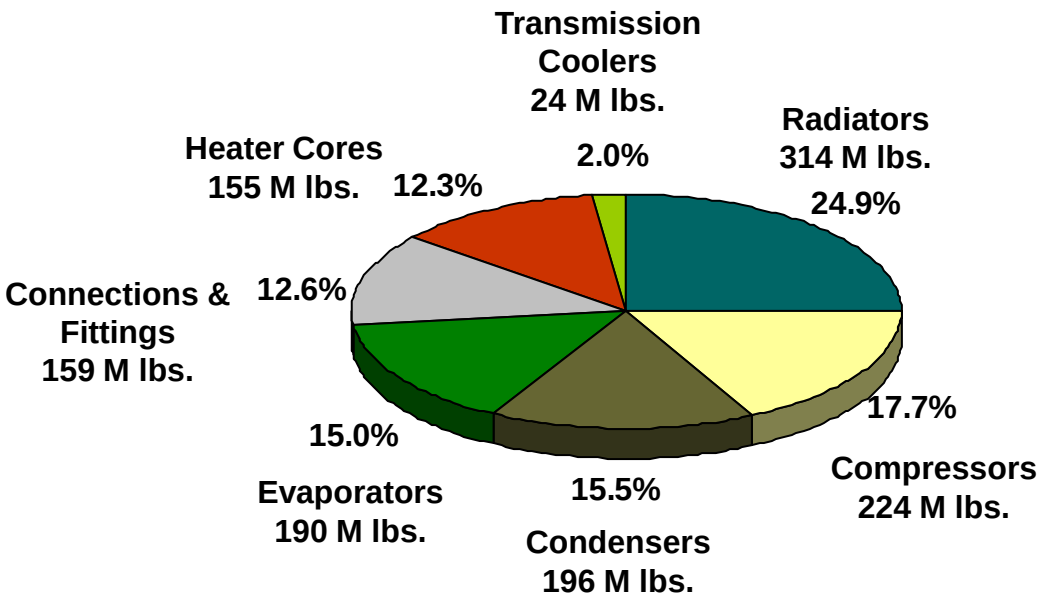
- **Light vehicle heat exchangers are the most aluminum intense components in the vehicle. Aluminum's heat transfer capabilities, low density and resistance to corrosion make it the ideal material for these applications**
- **Heat exchangers include brazed radiators, mechanically assembled radiators, heater cores, transmission coolers, condensers, evaporators and compressors**
- **Every vehicle has a radiator and components for air conditioning are required for essentially all vehicles in North America and Japan, but less than 80% percent of the vehicles in the EEU are air conditioned**

HEAT EXCHANGERS AND HEAT SHIELDS

2006 Light Vehicle Heat Exchangers

Heat Exchanger Aluminum Content

- Segmented by Component -



1.262 Billion Pounds

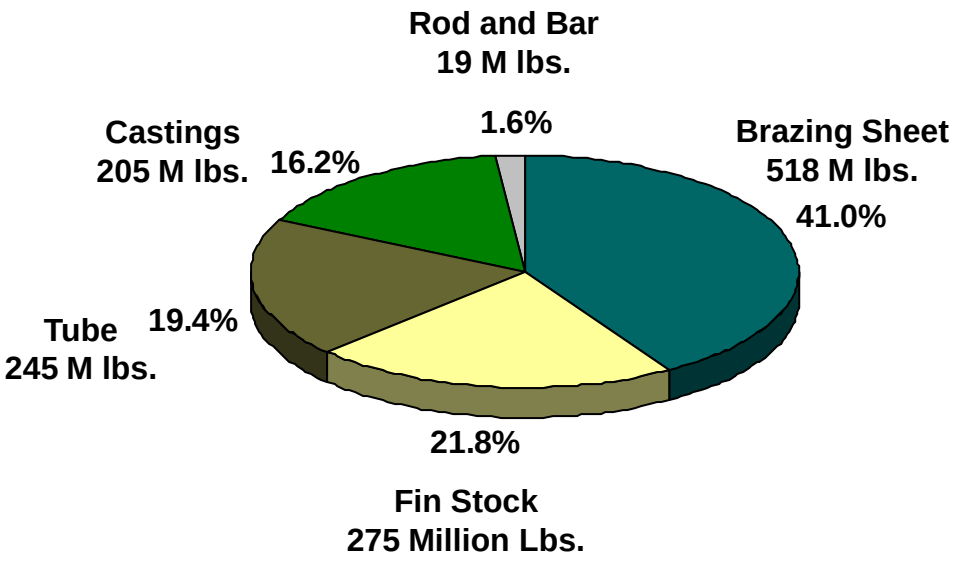
- **Not every vehicle in North America, Europe and Japan has all the components shown in the pie chart**
- **Aluminum shipments for heat exchangers are higher than the content volumes due to in process scrap, spare parts and exports of finished components from Europe and particularly Japan**

HEAT EXCHANGERS AND HEAT SHIELDS

2006 Light Vehicle Heat Exchangers

Heat Exchanger Content

- Segmented by Product Form -



1.262 Billion Pounds

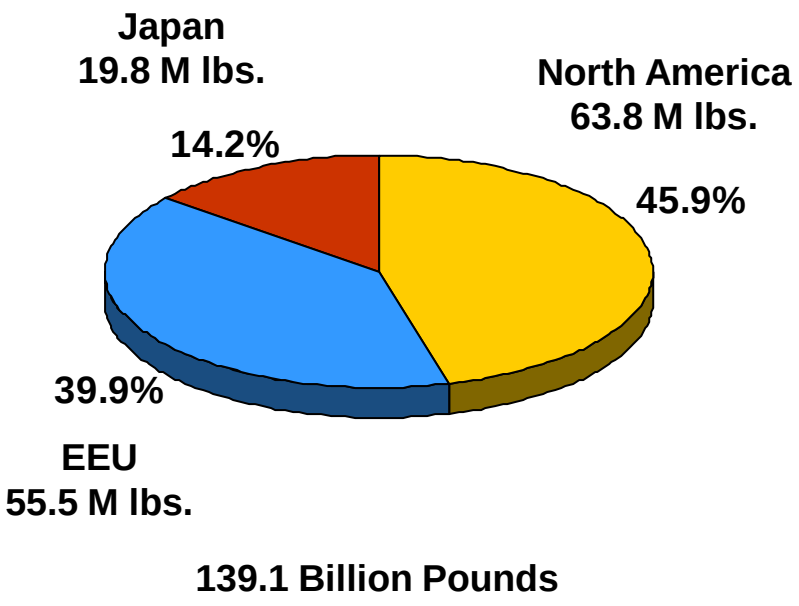
- There is more aluminum in heat exchangers than fin stock and brazing sheet
- Heat exchangers get very little attention, but they are the most aluminum intense system in the average light vehicle
- There is some growth remaining in Europe as air conditioning slowly moves toward 100%
- Copper and polymers continue to bring new propositions to the heat exchanger manufactures, but the aluminum infrastructure and sunk costs are a major deterrent to change

HEAT EXCHANGERS AND HEAT SHIELDS

2006 Light Vehicle Heat Shield Content

Heat Shield Content

- Segmented by Region -



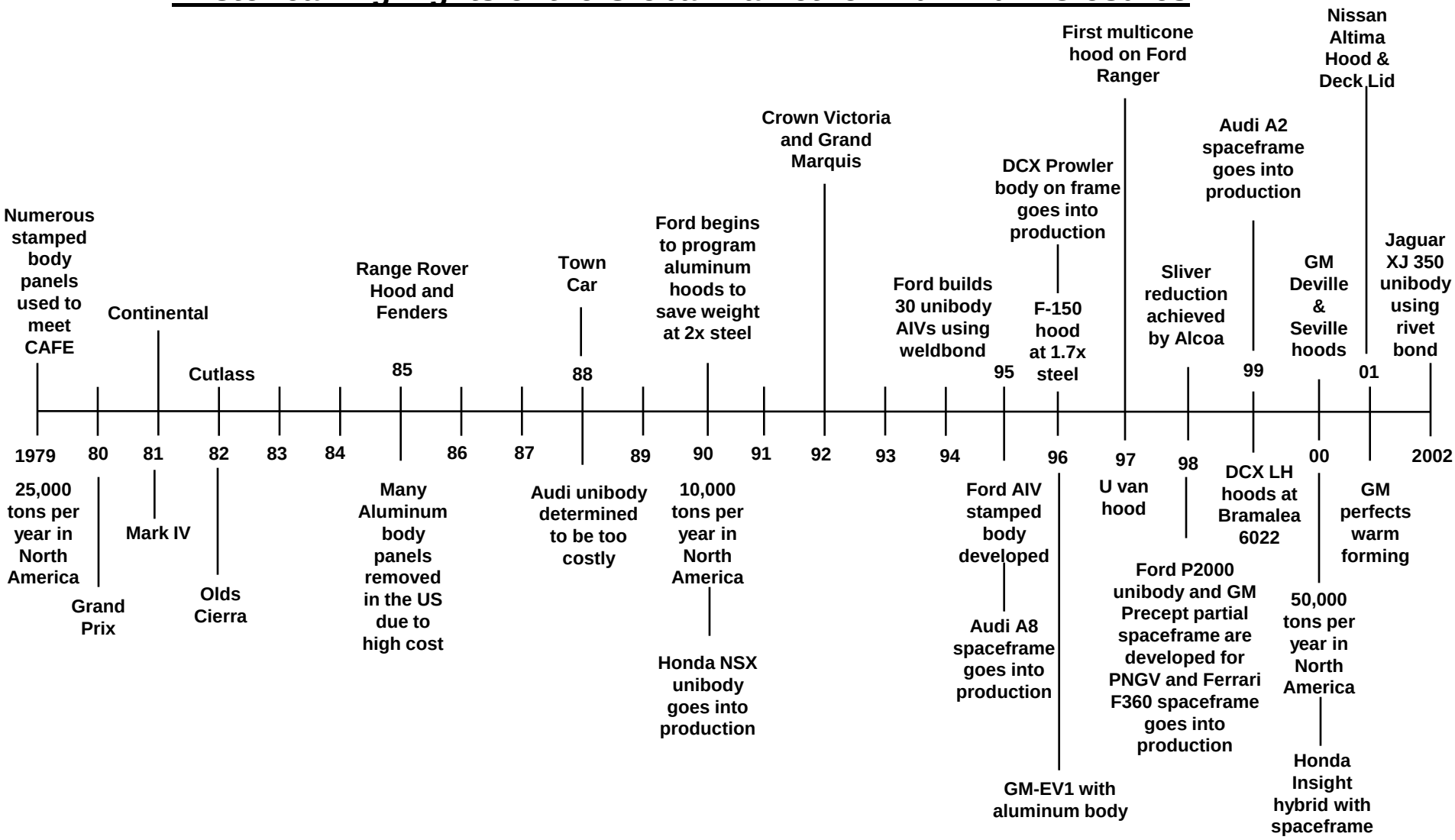
139.1 Billion Pounds

- Like heat exchangers, aluminum high conductivity, low density and corrosion resistance make it an ideal material to control the heat generated under today's light vehicles
- The alternative is aluminized steel which has a higher density and a comparable cost per square meter
- The amount of aluminum heat shield content for total vehicle production is slightly more than three pounds per vehicle worldwide

CLOSURE PANELS

CLOSURE PANELS

Historical Highlights of the Global Market for Aluminum Closures

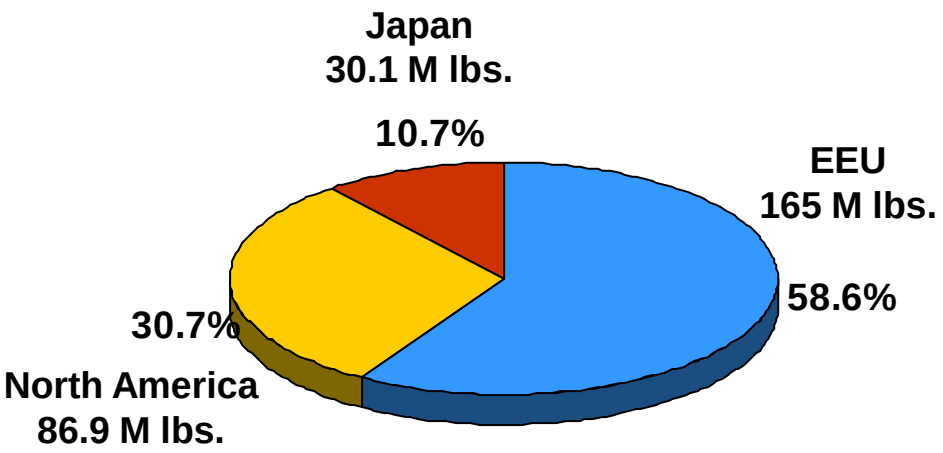


CLOSURE PANELS

2006 Aluminum Closure Content

Content

- Segmented by Region -

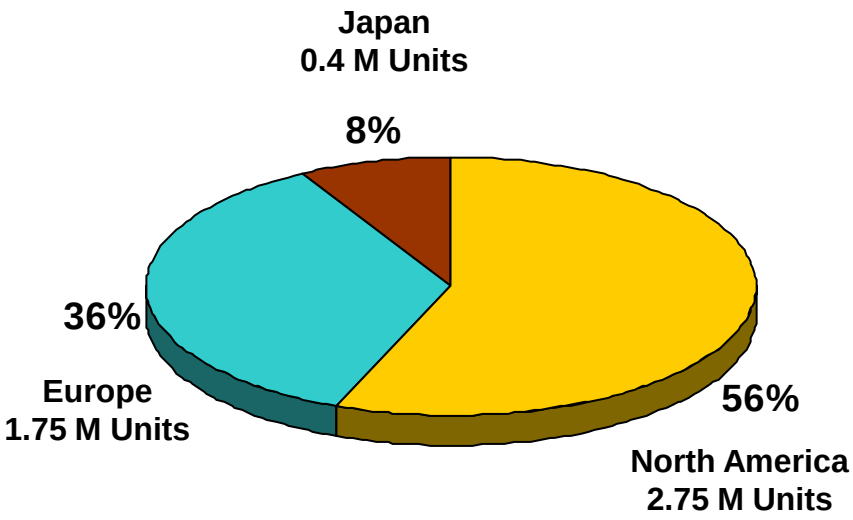


282 Million Pounds

- Aluminum penetration for closures such as hoods, decklids, fenders and doors are considered by many as the best single indicator of aluminum's progress in the battle with steel
- In 2006, 18.5 percent of the hoods in North America, 20 percent of the hoods in the EEU and 12 percent of the hoods in Japan will be made of aluminum sheet
- The EEU has much higher closure content because the EEU will use over four million doors, fenders and decklids in 2006 in addition to 3.8 million hoods

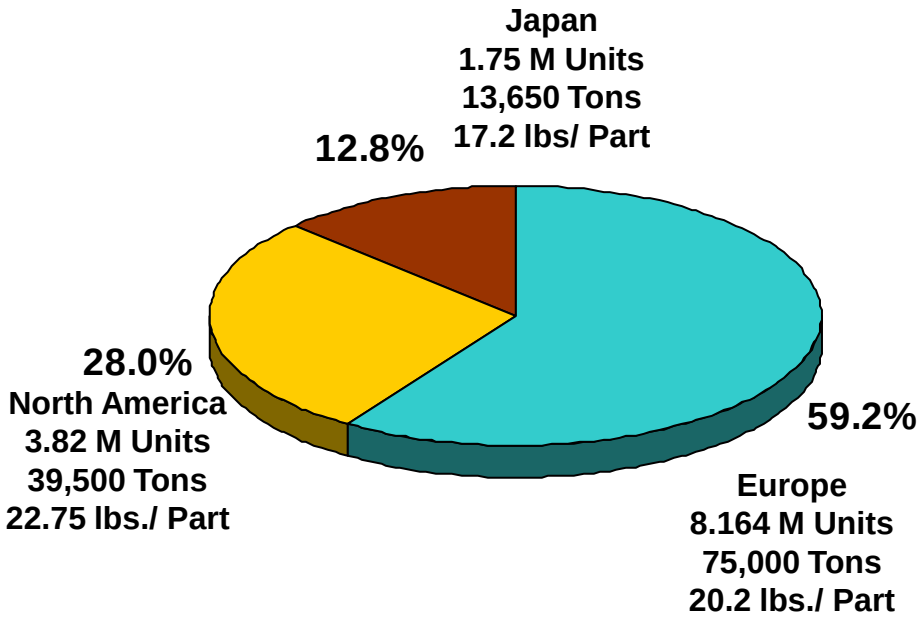
CLOSURE PANELS

2000 Net Production Aluminum Closures



4.9 Million Parts

2006 Net Production Aluminum Closures



13.67 Million Parts

North America was the world leader for aluminum closures until 2002. In the last five years; however, Europe has blown by North America like it was standing still

CLOSURE PANELS

2006 Light Vehicle Aluminum Closure Content

- Number of Programs and Parts -

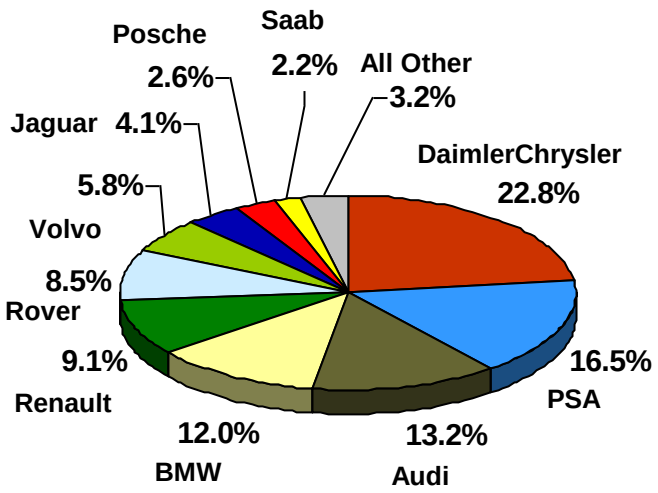
	Hoods	*Doors*	*Fenders*	*Deck Lid/ Lift and Tail Gates*	*Other*	*Total*
EEU						
Number of Programs	63	24	18	23	9	**137**
Parts (Millions)	3.762	1.287	2.176	0.815	0.124	**8.164**
North America						
Number of Programs	29	None	1	9	None	**39**
Parts (Millions)	2.922	None	0.028	0.887	None	**3.820**
Japan						
Number of Program	25	3	4	6	3	**41**
Parts (Millions)	1.100	0.332	0.076	0.207	0.082	**1.797**
Total						
Number of Programs	**117**	**27**	**23**	**38**	**12**	**217**
Parts (Millions)	**7.784**	**1.619**	**2.280**	**1.909**	**0.206**	**13.781**

CLOSURE PANELS

2006 Light Vehicle Aluminum Closure Content

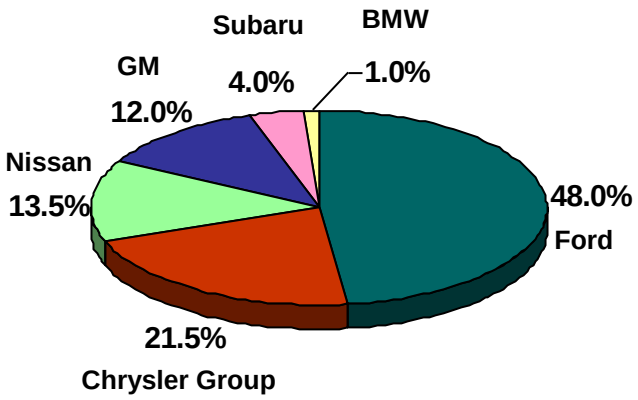
- Segmented by Region and OEM -

European Union



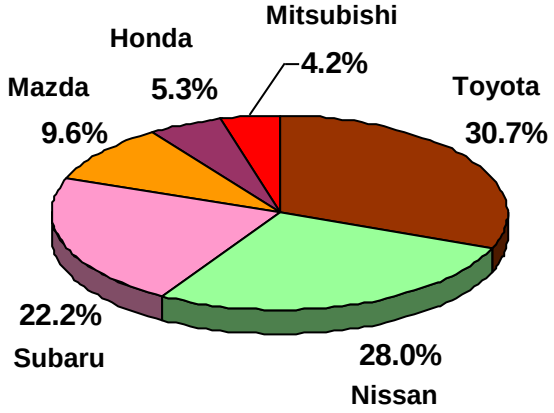
165 Million Pounds

North America



86.9 Million Pounds

Japan



30.1 Million Pounds

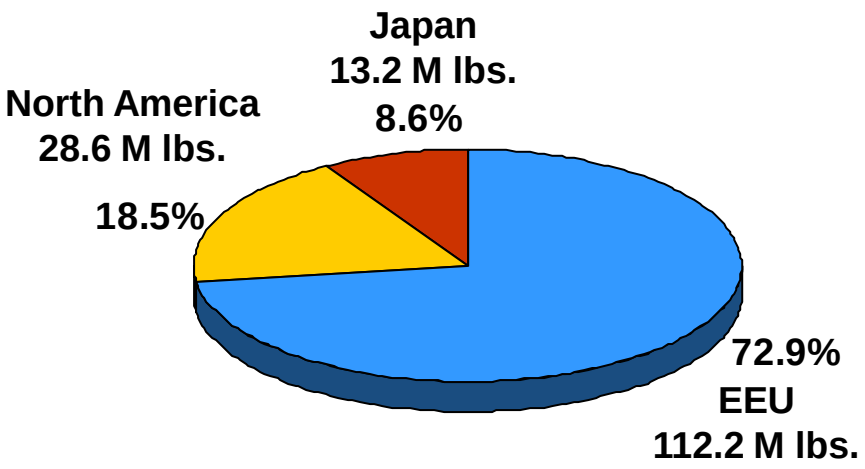
BUMPER BEAMS, INTRUSION BEAMS AND CRASH BOXES

BUMPER BEAMS, INTRUSION BEAMS AND CRASH BOXES

2006 Light Vehicle Aluminum Content

Extruded Beam and Box Aluminum Content

- Segmented by Region -



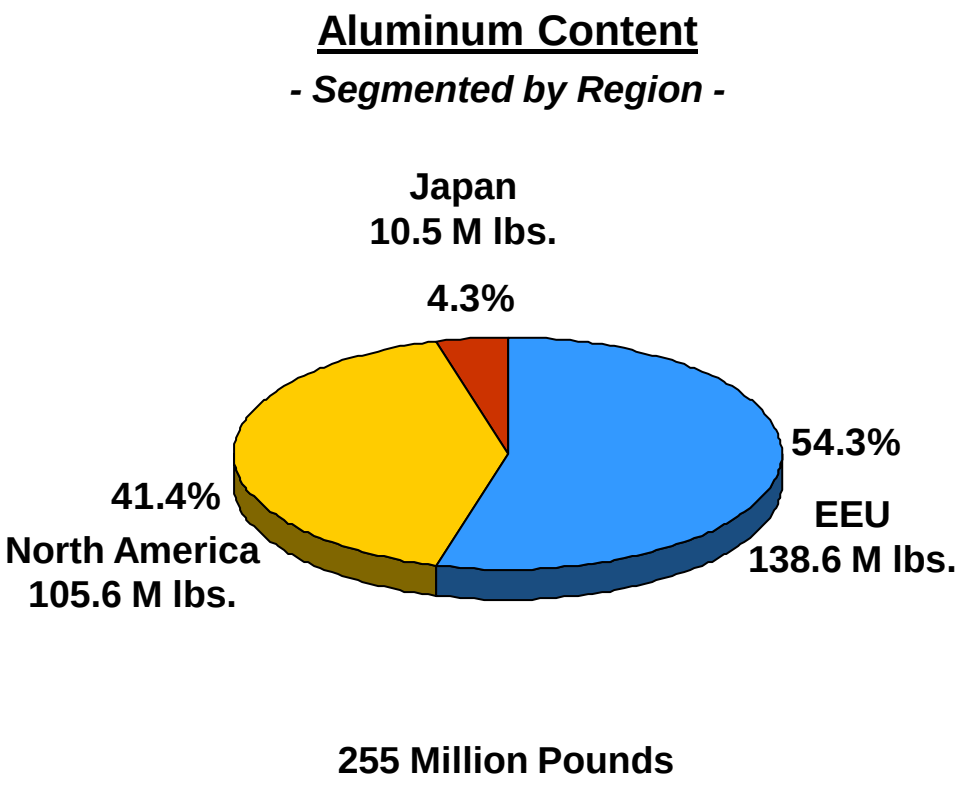
154 Million Pounds

- Europe will be the big user of aluminum for 6.5 million front bumper beams, four million rear bumper beams, 1.5 million crash boxes and four million door intrusion beams in 2006
- North America will use aluminum for 2.1 million bumper beams and Japan will use 1.2 million aluminum bumper beams in 2006
- Aluminum crash boxes and door intrusion beams are only occasionally used in North America and Japan
- Essentially all of these aluminum components are made from extruded shapes including many hollow box beams

SUSPENSION ARMS AND LATERAL LINKS

SUSPENSION ARMS AND LATERAL LINKS

2006 Light Vehicle Aluminum Content



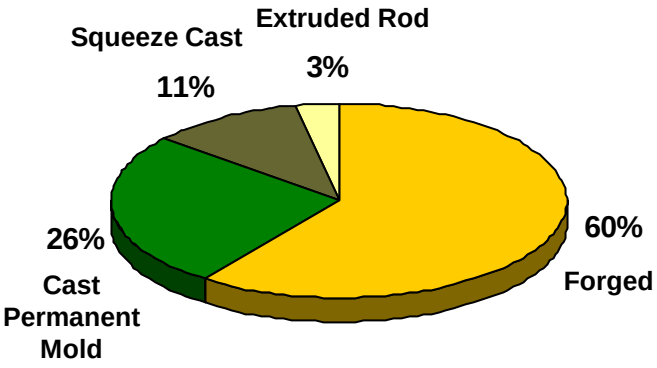
- Suspension arms (control arms) and lateral links are a fast growing aluminum component for light vehicles
- On average, there is one aluminum control arm or link for every light vehicle to be produced in North America, Europe and Japan in 2006
- The average part weighs 5.85 pounds and 57 percent of the parts are forged about equally from cast or extruded rod. The extruded rod is often double counted as both a forging shipment and an extrusion shipment
- Suspension arms are made using a variety of castings processes including gravity PM, low pressure PM, VRC/PRC, pressure counter pressure, squeeze, semi-solid, vacuum HP die cast and Cobapress

SUSPENSION ARMS AND LATERAL LINKS

2006 Light Vehicle Aluminum Suspension Arm and Lateral Link Content

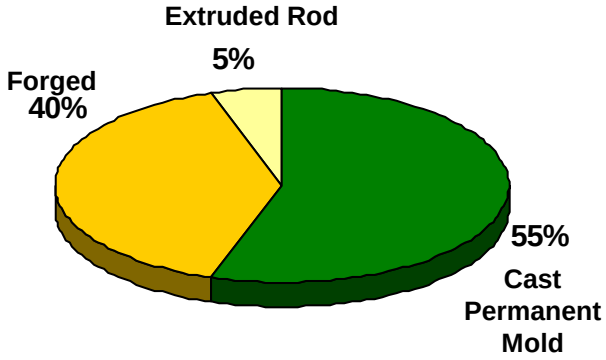
- Segmented by Region and Manufacturing Process -

European Union



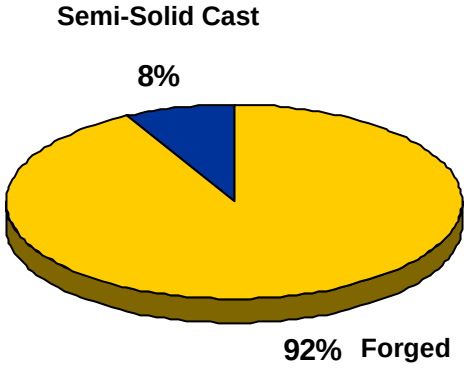
25.2 Million Units

North America



16.5 Million Units

Japan



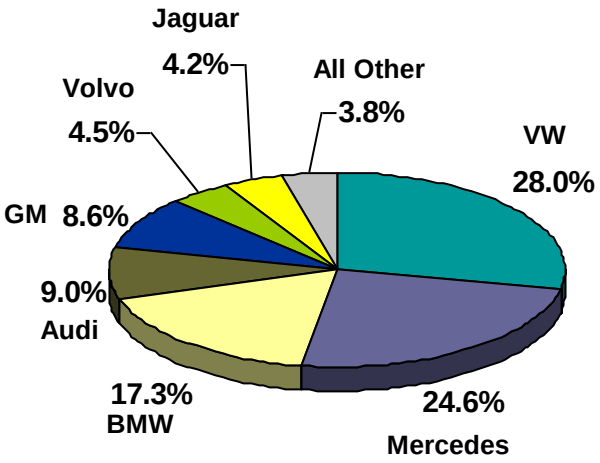
1.75 Million Units

SUSPENSION ARMS AND LATERAL LINKS

2006 Light Vehicle Aluminum Suspension Arm and Lateral Link Content

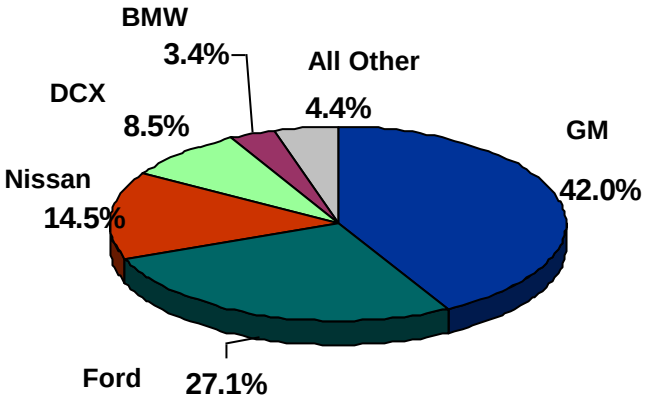
- Segmented by Region and OEM -

European Union



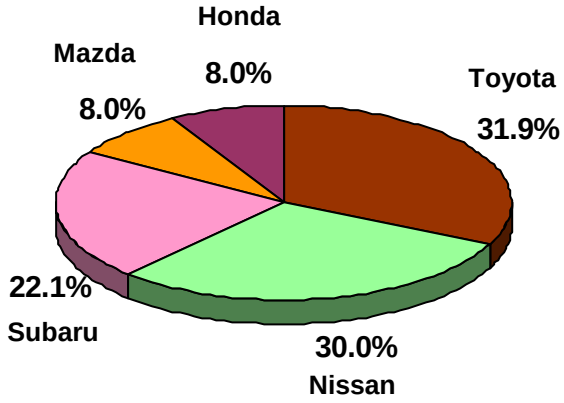
25.2 Million Units

North America



16.5 Million Units

Japan



1.75 Million Units

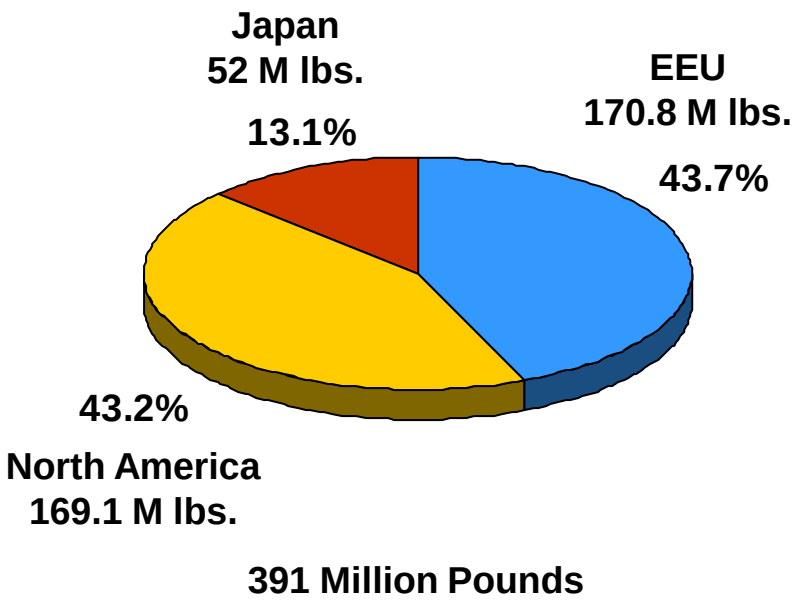
STEERING COMPONENTS

STEERING COMPONENTS

2006 Light Vehicle Aluminum Content

Aluminum Content for Steering Components

- Segmented by Region -



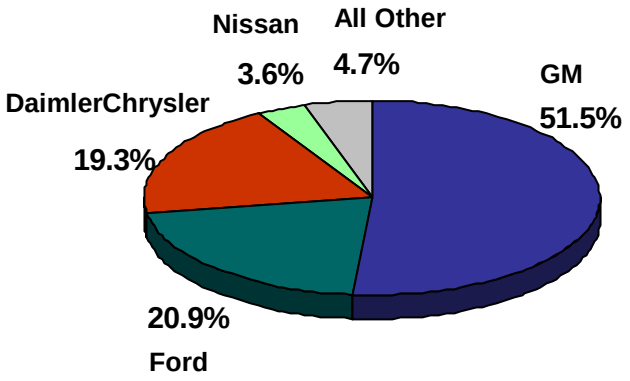
- Nearly 50 percent of the aluminum content for steering components is steering knuckles
- Other aluminum steering components include:
  - Squeeze cast rack and pinion housings
  - Extruded and cast column housings
  - Power steering pump brackets
  - Extruded hydraulic tubing
- Most high pressure die cast aluminum steering wheels have been converted to die cast magnesium

STEERING COMPONENTS

2006 Light Vehicle Aluminum Content

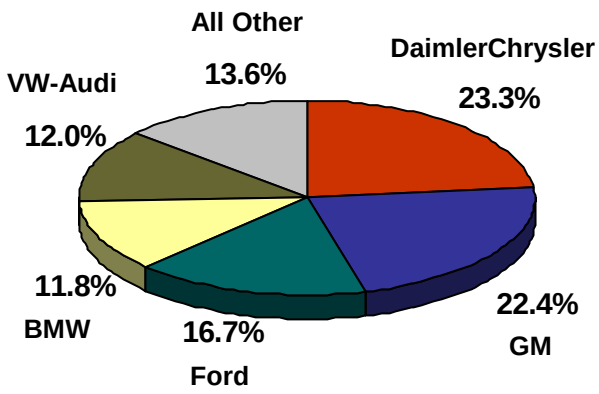
- Knuckles Segmented by Region and OEM -

North America



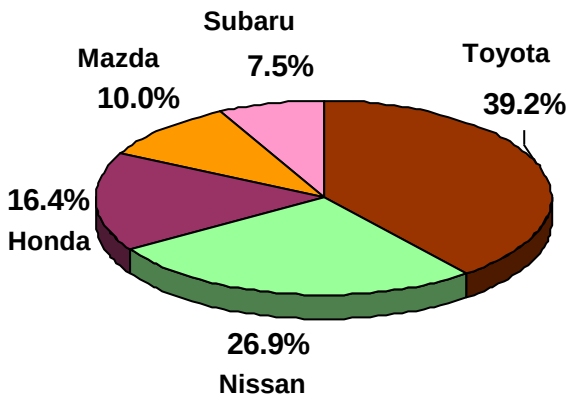
15.0 Million Units

European Union



14.8 Million Units

Japan



2.7 Million Units

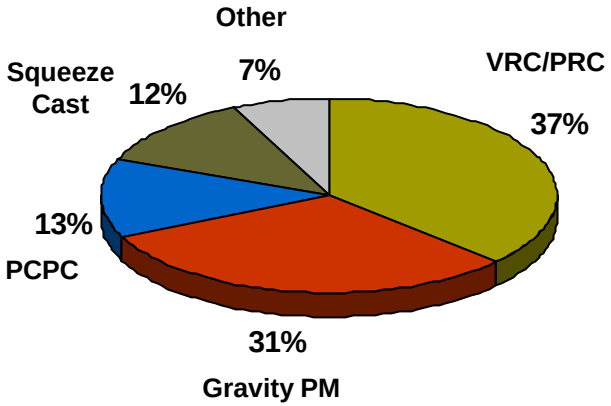
STEERING COMPONENTS

2006 Light Vehicle Aluminum Content

- Knuckles Segmented by Region and Manufacturing Process -

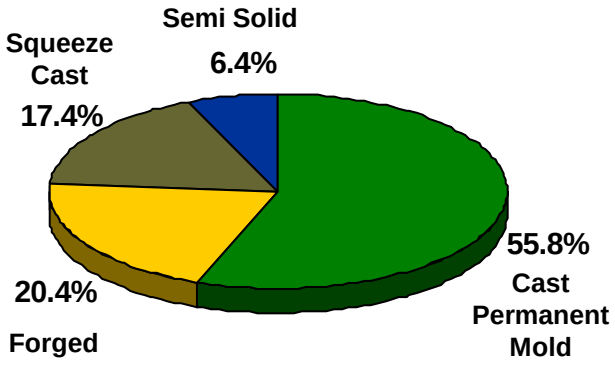
We expect to see some forged knuckles in North America before the end of the decade

North America



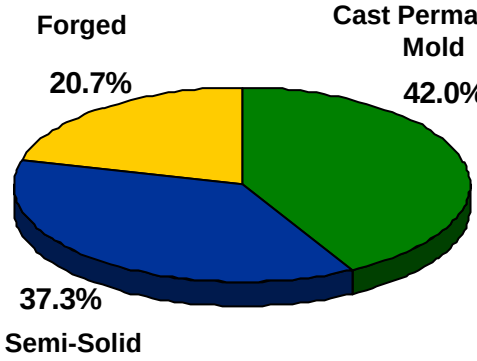
15.0 Million Units

European Union



14.8 Million Units

Japan



2.7 Million Units

STRUCTURAL COMPONENTS FOR BODY AND CHASSIS

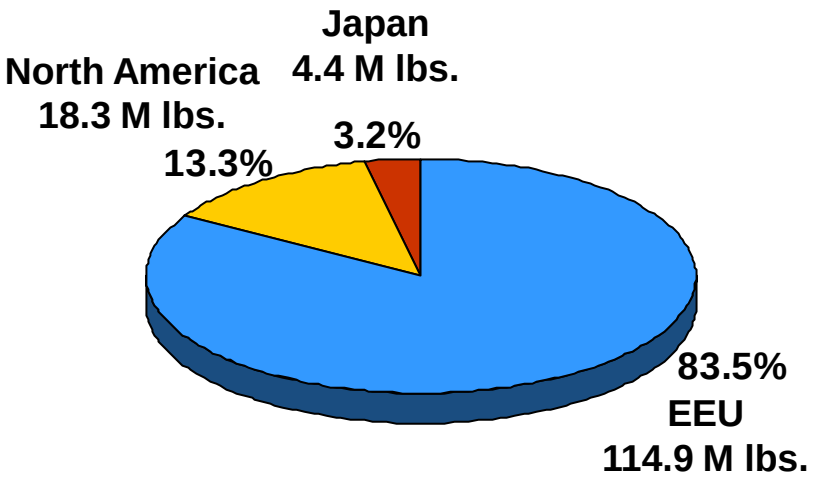
STRUCTURAL COMPONENTS FOR BODY AND CHASSIS

Europe is far and away the biggest user of aluminum for chassis and particularly body components including complete bodies in white to various partial structures including IP beams

2006 Light Vehicle Aluminum Content

Aluminum Body Components

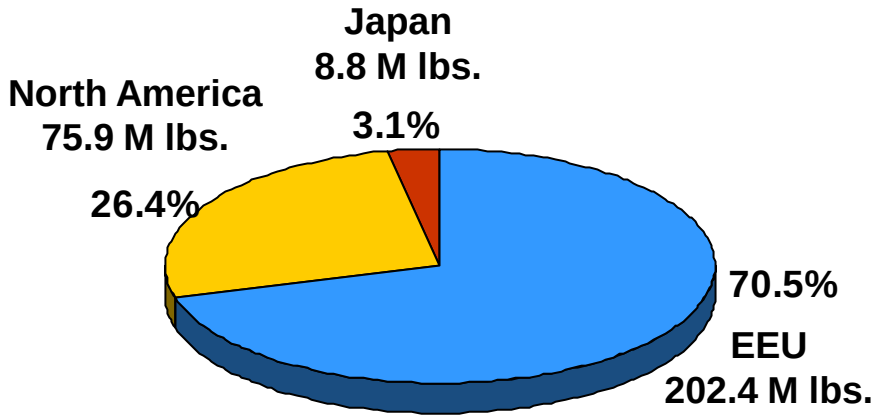
- Segmented by Region -



137.6 Million Pounds

Aluminum Chassis Components

- Segmented by Region -



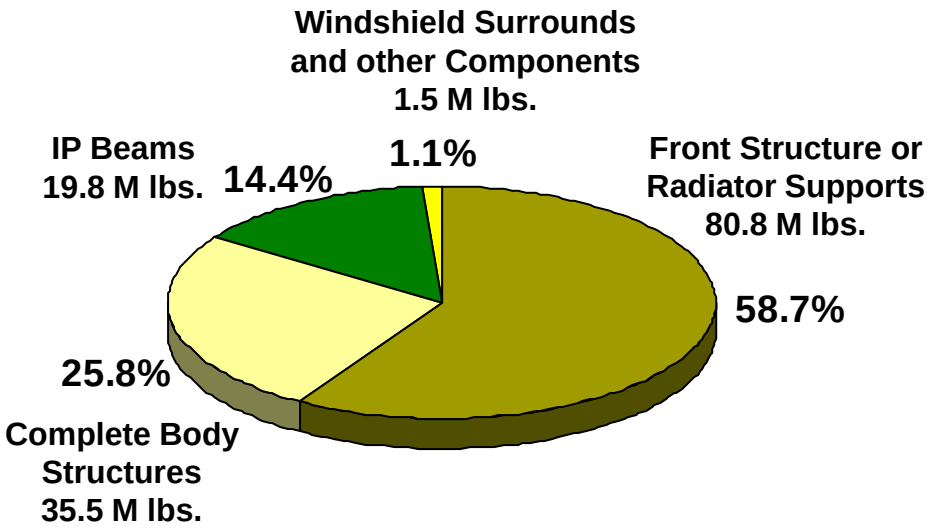
287.1 Million Pounds

STRUCTURAL COMPONENTS FOR BODY AND CHASSIS

2006 Light Vehicle Aluminum Content

Aluminum Body Component

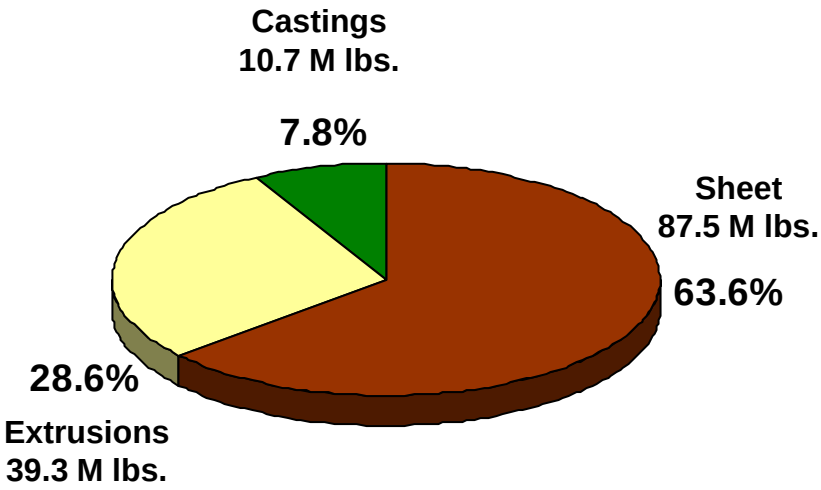
- Segmented by End Use and Product -



137.6 Million Pounds

Aluminum Body Content

- Segmented by Product -



137.6 Million Pounds

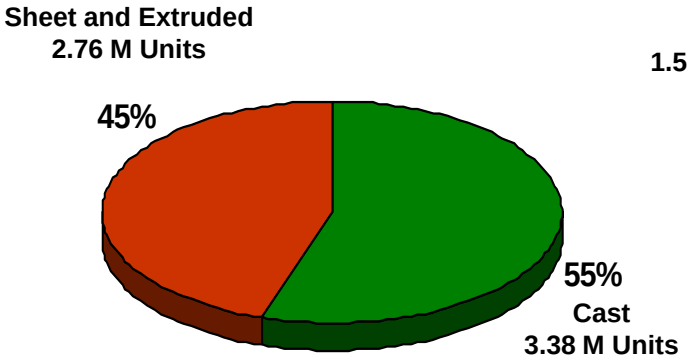
STRUCTURAL COMPONENTS FOR BODY AND CHASSIS

2006 Light Vehicle Aluminum Content

Cradles, Crossmembers and Sub-frames

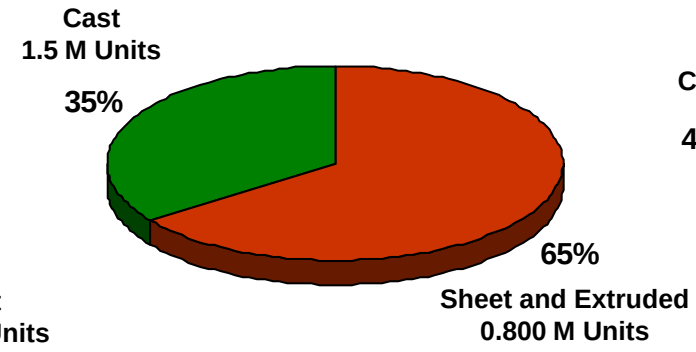
- Segmented by Region and Manufacturing Process -

European Union



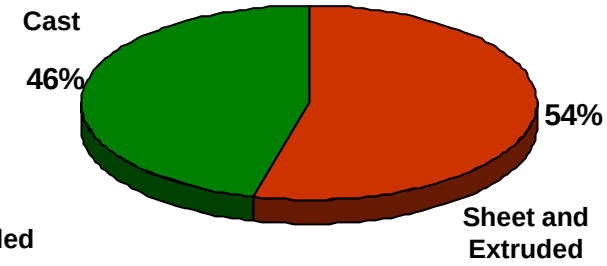
6.140 Million Units

North America



2.3 Million Units

Japan



0.250 Million Units

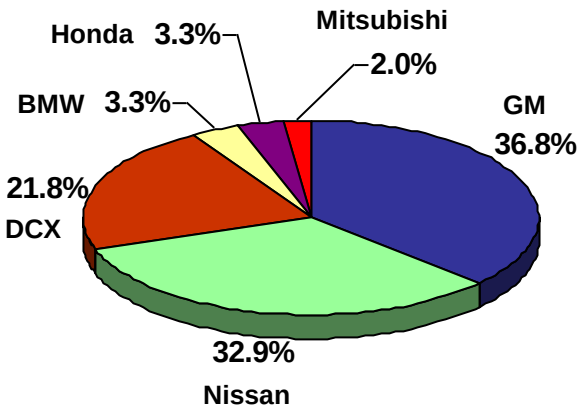
STRUCTURAL COMPONENTS FOR BODY AND CHASSIS

2006 Light Vehicle Aluminum Content

Cradles, Crossmembers and Subframes

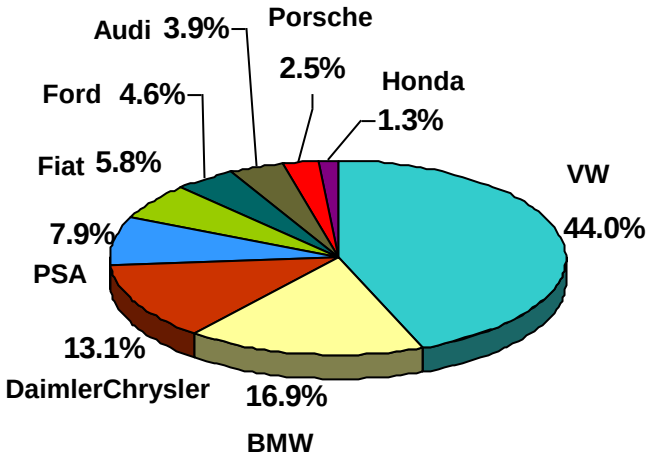
- Segmented by Region and OEM -

North America



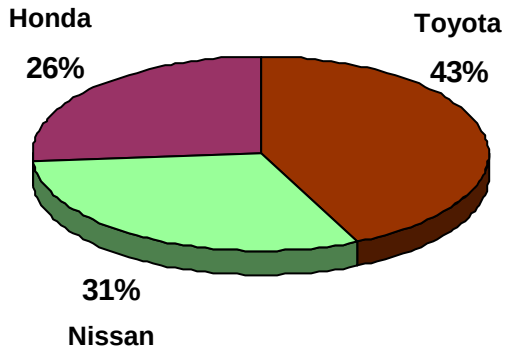
2.292 Million Units

European Union



6.139 Million Units

Japan



0.250 Million Units

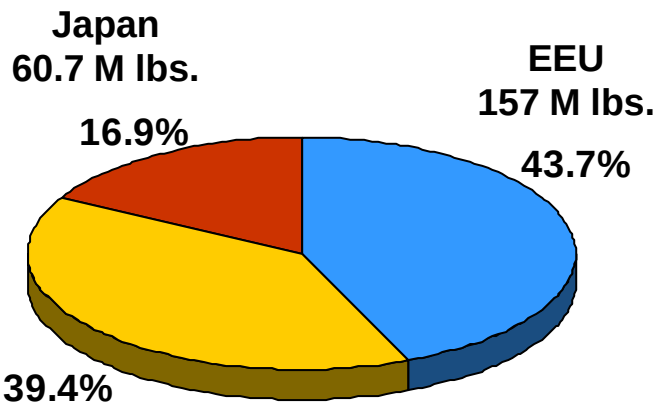
MISCELLANEOUS COMPONENTS

MISCELLANEOUS COMPONENTS

2006 Light Vehicle Miscellaneous Aluminum Components

Miscellaneous Aluminum Content

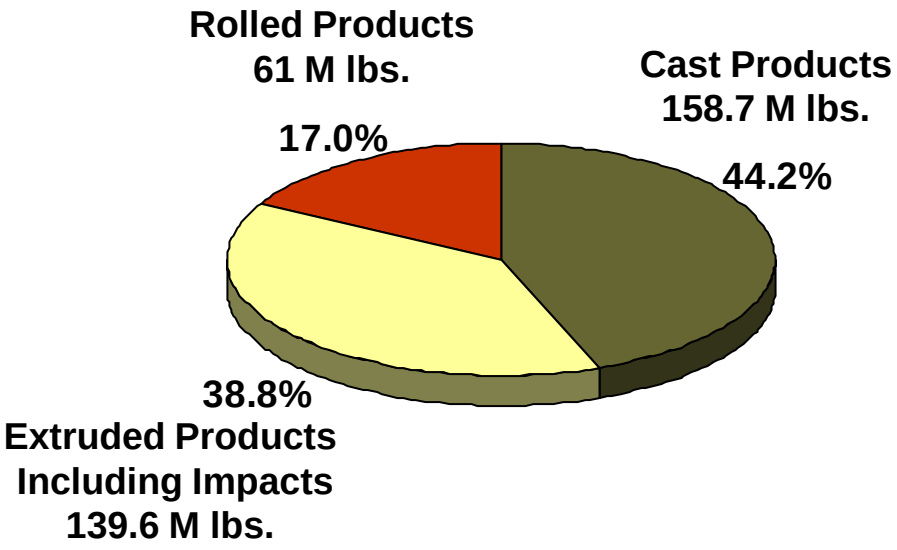
- Segmented by Region -



359.3 Million Pounds

Miscellaneous Aluminum Content

- Segmented by Product Form -

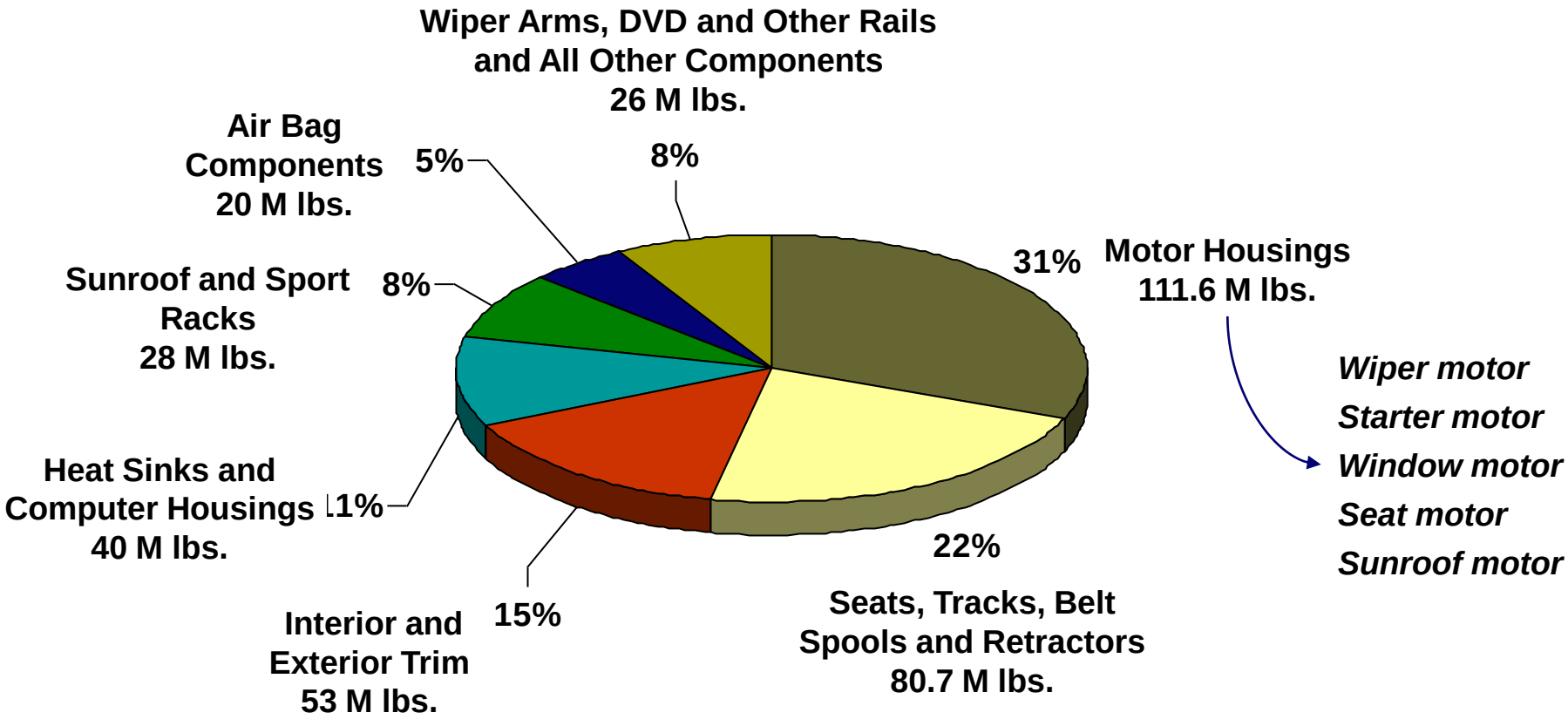


359.3 Million Pounds

MISCELLANEOUS COMPONENTS

2006 Light Vehicle Miscellaneous Aluminum Components

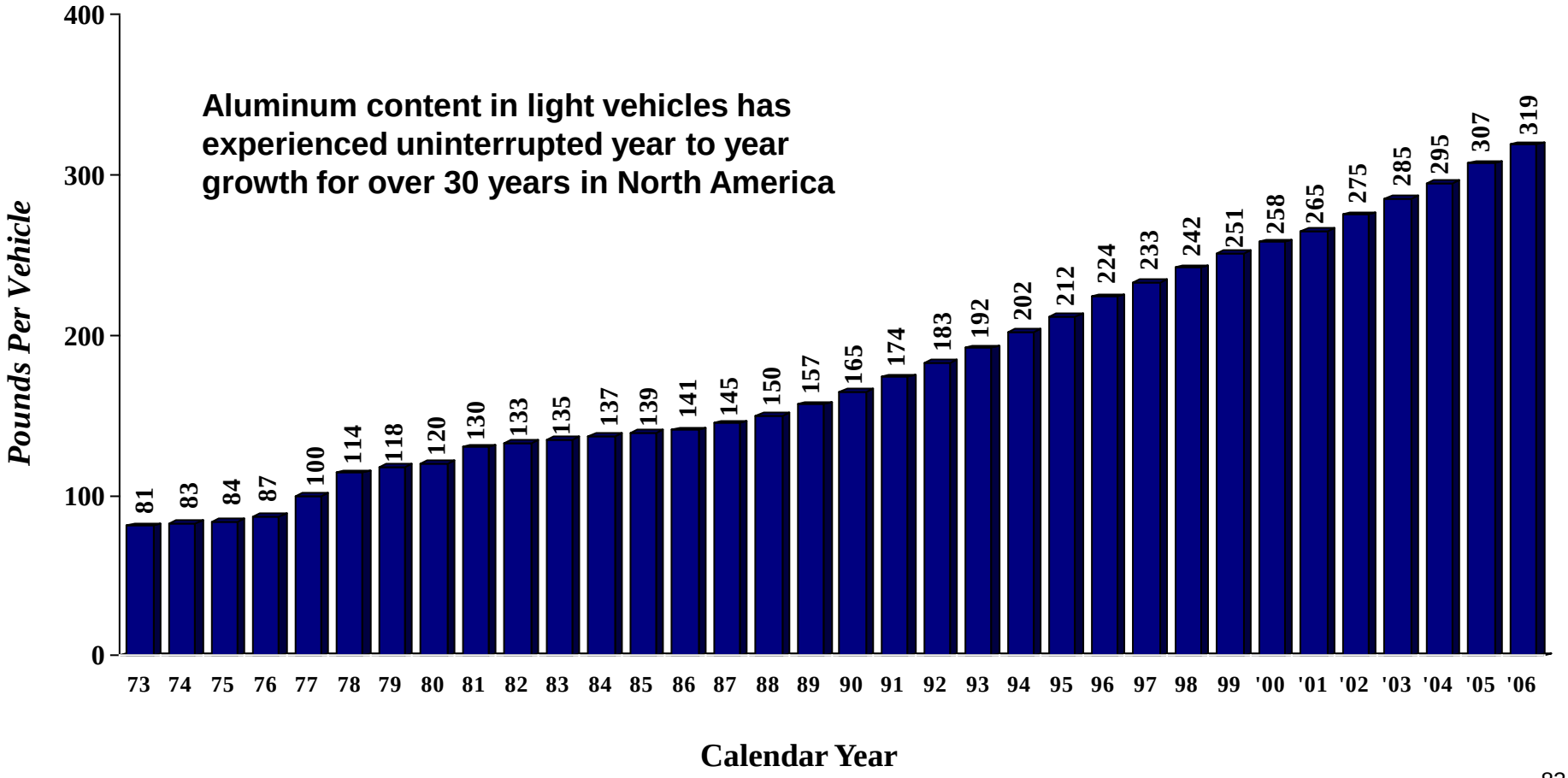
- Content Segmented by Type of Component -



359.3 Million Pounds

REGIONAL SUMMARY NORTH AMERICA

North American Light Vehicle Aluminum Content



REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

2006 List of Large Aluminum Components

(Millions of Units)

Engine blocks	8.10
Cylinder heads	24.30
Intake manifolds	9.10
Oil pans	10.00
Automatic transmission cases	14.86
Transfer cases	3.00
Wheels	41.00
ABS housings	13.60
Brake Calipers	12.10
Bumper Beams	2.1
Closures	3.8
Suspension arms and links	16.5
Steering knuckles	15.0
Cradles, subframes and crossmembers	2.3
Drive shafts and yokes	3.0
Differential cases	3.3
Radiators, evaporators and condensers	47.0

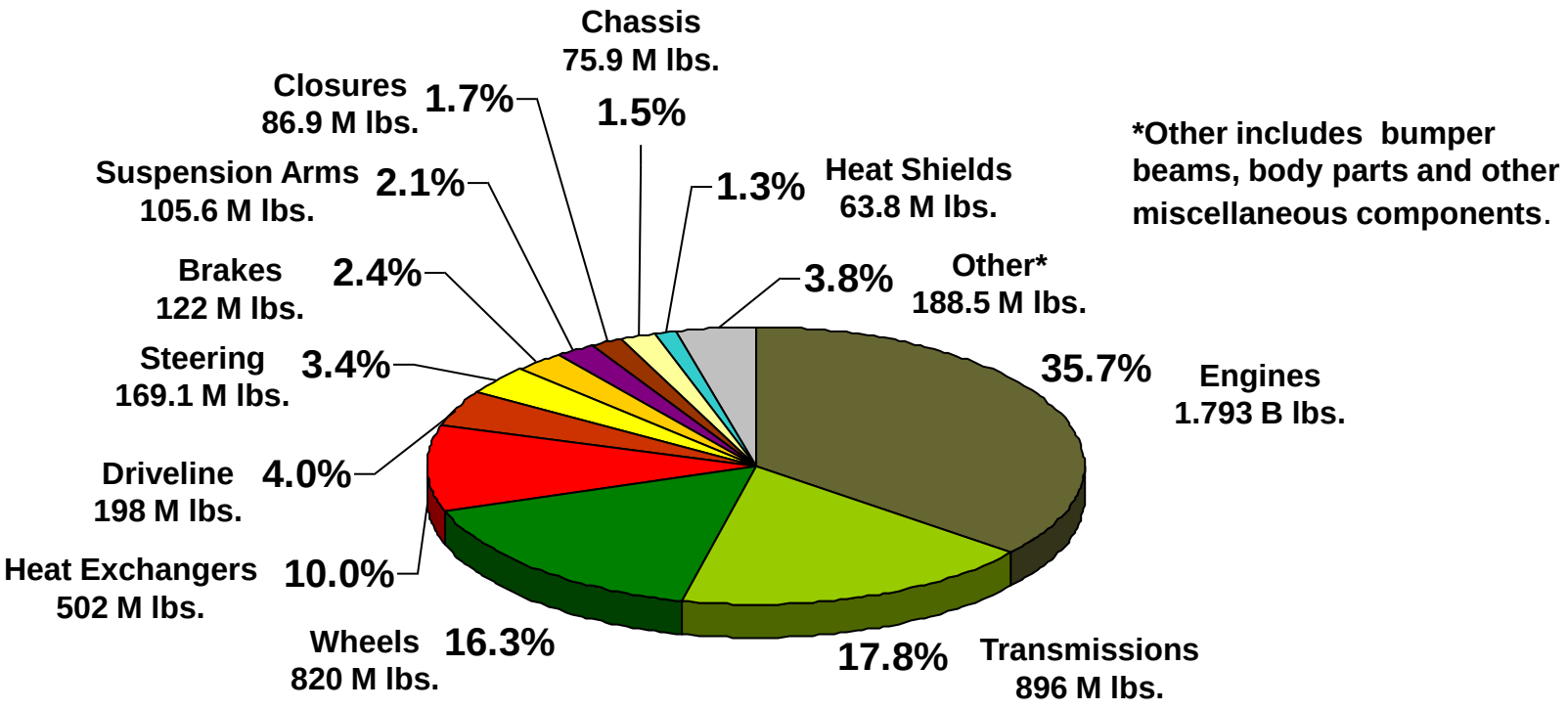
- **The 15.75 million light vehicles to be assembled in North America in 2006 will use over 200 million large aluminum components and over one billion small or miscellaneous aluminum components**
- **4.4 million aluminum transmission cases, nearly one million aluminum cylinder heads and 400,000 aluminum engine blocks will enter North America as finished components for North American assembled vehicles in 2006. These imports come almost exclusively from Europe and Japan**

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- Segmented by Component -

- Light vehicle content should be over 5 billion pounds for the first time in history in 2006 and average 319 pounds per vehicle
- The content is spread over many components, but is concentrated in the powertrain, driveline, wheels and heat exchangers

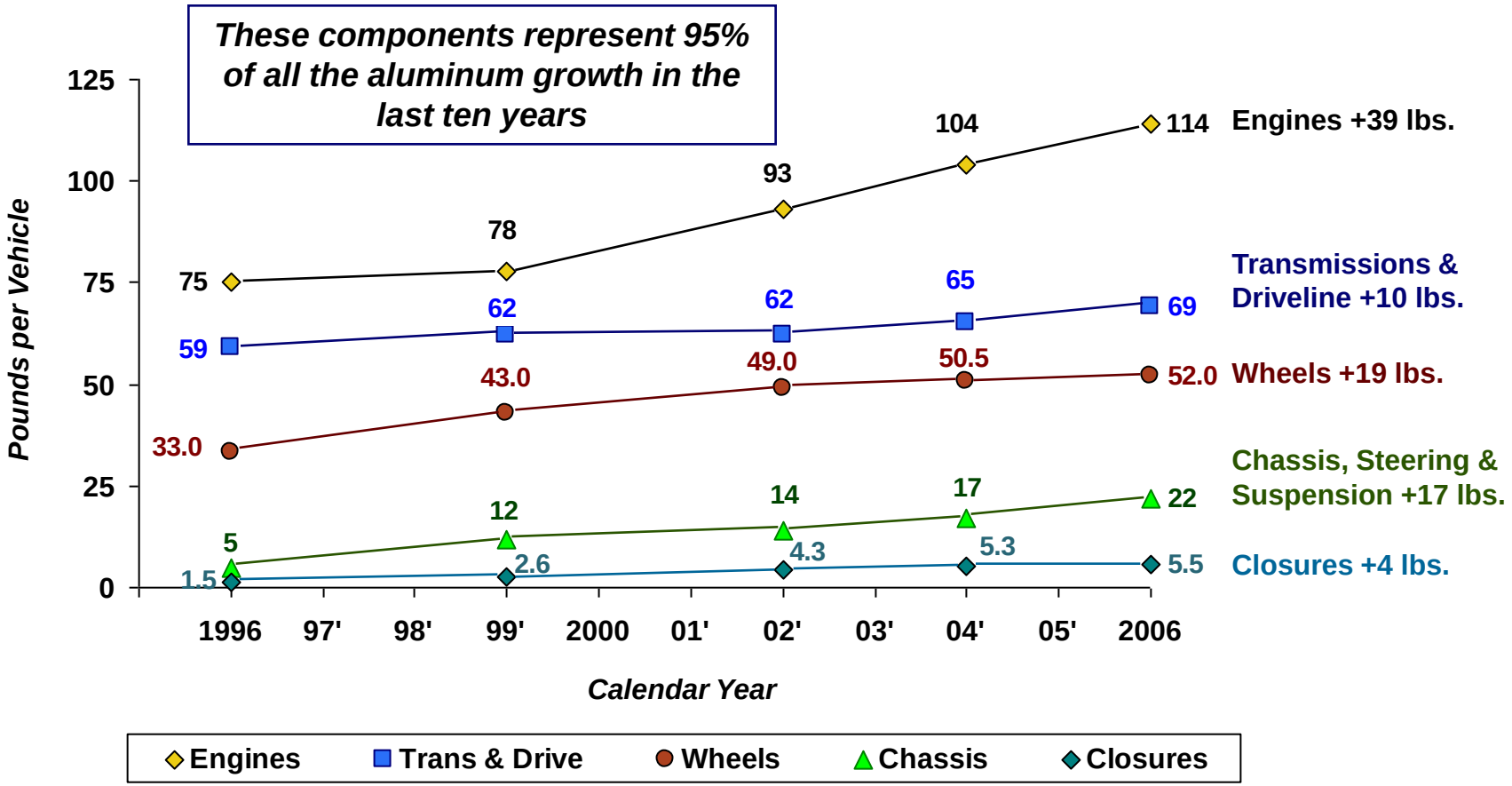


5.02 Billion Pounds for 15.75 Million Vehicles

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- Aluminum Content per Vehicle for Key Components 1996 to 2006 -



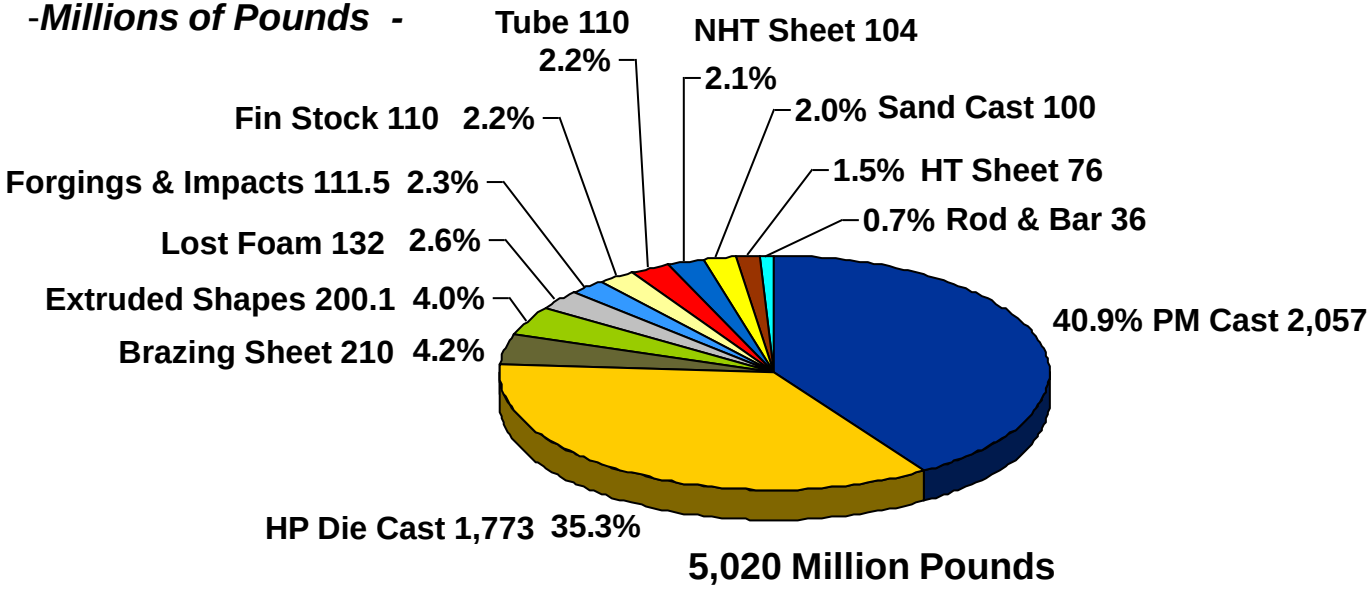
REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- The five billion pounds of content should require at least six billion pounds of aluminum industry shipments in 2006. The 6 billion pounds excludes imported parts but includes scrap and spare parts
- Castings are 80.8% of product content, rolled products are 10%, extruded products are 6.9% and forgings and impacts are 2.3%. The 30 million pounds of stock for ABS housings is reported as an extruded shape rather than extruded bar. Extruded bar stock for forged parts is sometimes counted by the industry as a rod & bar shipment and also as a forging shipment

-***Segmented by Product Form***

-***Millions of Pounds*** -

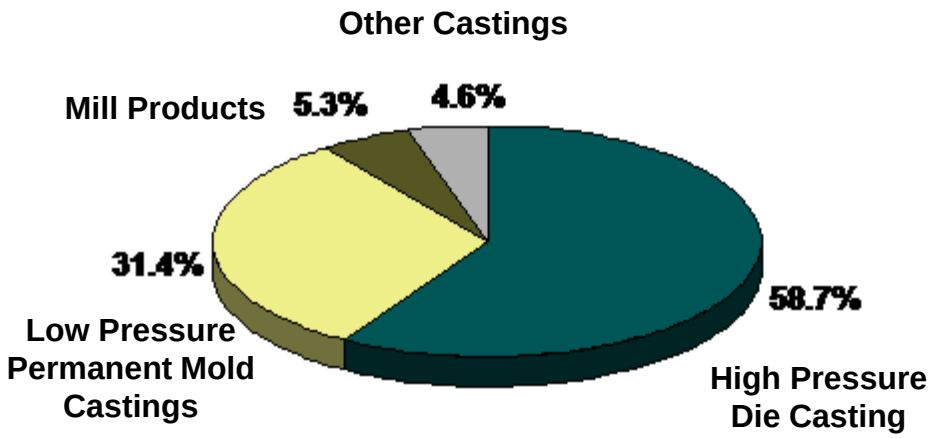


REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

Recycled Aluminum Content

- Segmented by Product Made from Secondary -



2.835 Billion Pounds of Secondary Aluminum Content

- **Fifty-seven percent of the aluminum content in the 2006 light vehicles will be sourced from recycled metal**
- **This is a slight decline from 2002. This change is being driven more by changes at the casting companies than by the increased use of mill products**
- **Some casting companies, particularly GM, are substituting primary for secondary for commercial reasons**
- **The practical limit for recycled aluminum is 60 to 65 percent**
- **Essentially all of the aluminum in the 2006 vehicles will be recovered and reused at the end of the vehicles useful life. The recovered aluminum will be reused, but not necessarily for new vehicles**

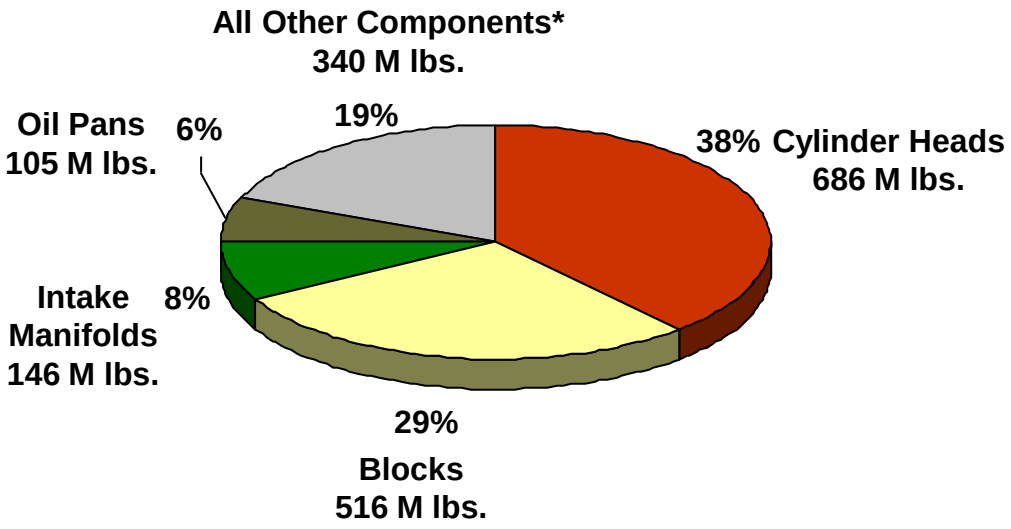
REGIONAL SUMMARY NORTH AMERICA

Nearly 40% of the aluminum content in the average North American light vehicle is in the engine

2006 North American Light Vehicle Engines

- Total Aluminum Content -

Segmented by Component



1.793 Billion Pounds

*A Typical Engine has 21.6 Pounds of Other Aluminum Components

Pistons	Fuel rails
Bed plates	Timing chain covers
Front covers	FEAD brackets
Engine mounts	Rocker/cam covers
Water pump housings	Thermostat housings
Oil filter adapters	Fuel pump inlets
Alternator cases	Water outlet tubes

Not all of these parts are aluminum for every engine, but aluminum has become the predominant engine material in North America

REGIONAL SUMMARY NORTH AMERICA

Aluminum block penetration has experienced steady growth, heads are nearly all aluminum and intake manifolds have held off the threat from reinforced polymers much better than expected. Continued block penetration will be the biggest driver of aluminum content growth over the remainder of this decade

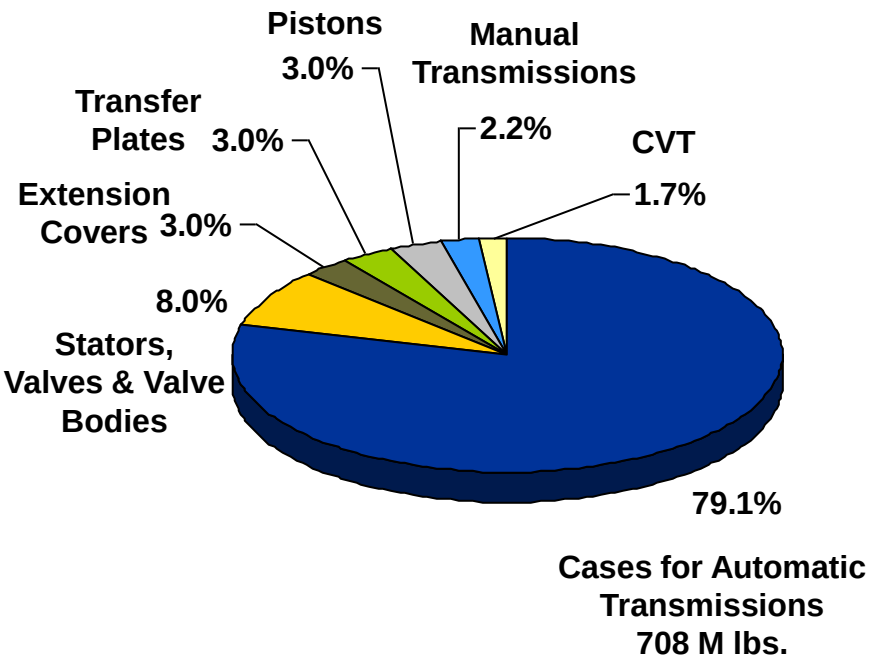
- Light Vehicle Engine Aluminum Component Penetration -

	Engine Blocks			*Cylinder Heads*			*Intake Manifolds*		
OEM	***1999***	***2002***	***2006***	***1999***	***2002***	***2006***	***1999***	***2002***	***2006***
GM	9%	27%	45%	58%	80%	87%	30%	40%	50%
Ford	16%	22%	35%	66%	76%	95%	60%	60%	45%
DCX	14%	18%	15%	52%	82%	90%	60%	35%	35%
Toyota	43%	75%	92%	100%	100%	100%	100%	100%	100%
Honda	100%	100%	100%	100%	100%	100%	100%	100%	100%
Nissan	Neg'l	50%	92%	100%	100%	100%	25%	25%	30%
Subaru	56%	72%	100%	100%	100%	100%	100%	100%	100%
All Others	25%	30%	45%	100%	100%	100%	100%	100%	82%
Total	**23%**	**35%**	**52%**	**69%**	**84%**	**92%**	**58%**	**54%**	**56%**

REGIONAL SUMMARY NORTH AMERICA

2006 North American Light Vehicle Transmissions

- Segmented by Type and Component -

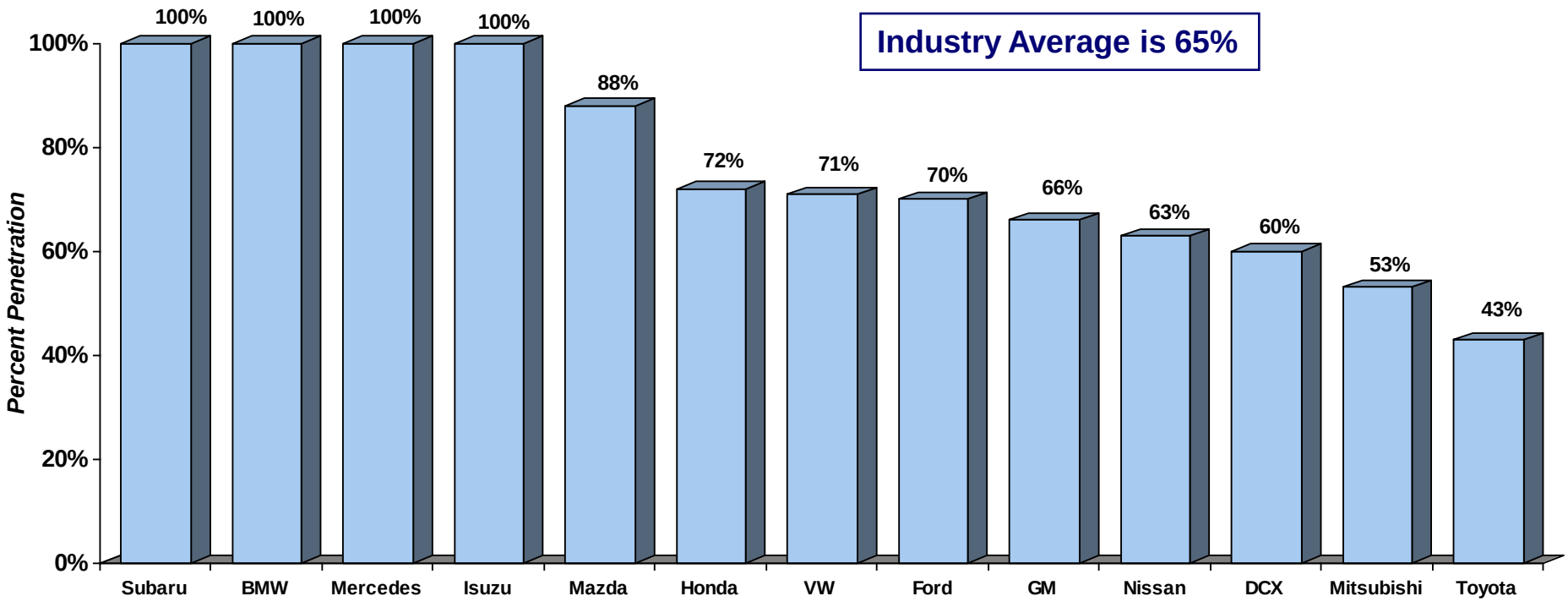


896 Million Pounds of Vehicle Content

- **Continuously variable and manual transmissions are smaller and use less aluminum than automatic transmissions**
- **Ninety-four percent of the transmissions in North America are non-continuous automatics, two percent are continuously variable automatics and four percent are manuals**
- **Twenty-nine percent of all the transmissions for light vehicle assemblies in North America are imported, primarily from Japan and Germany**
- **Ninety-eight and one-half percent of the aluminum components are high pressure die cast**

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content
Aluminum Share of OEM Wheels Not Including Spares

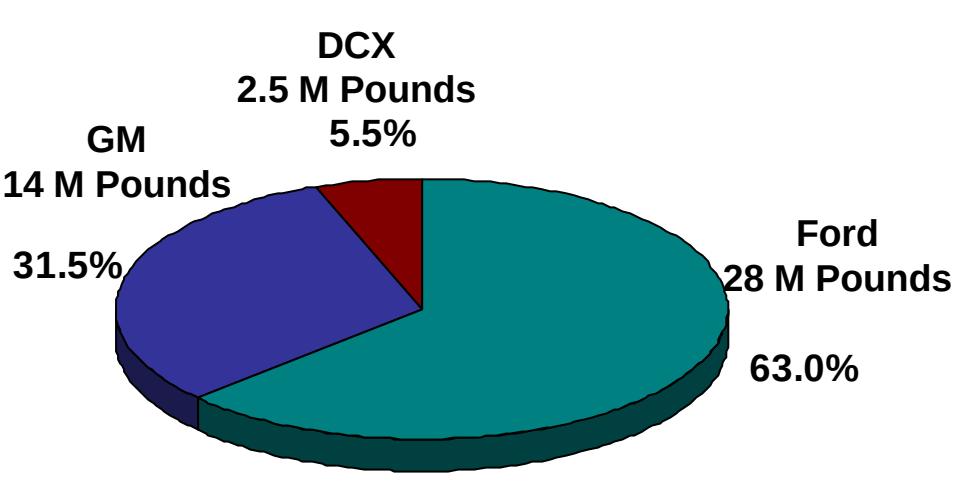


REGIONAL SUMMARY NORTH AMERICA

North America **was** the world leader for aluminum closure sheet applications until 2000, but Europe is the current leader

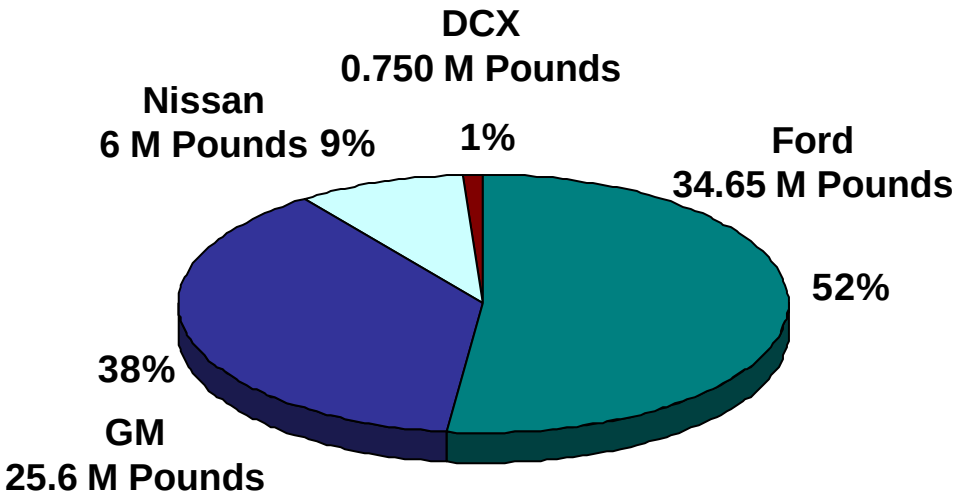
Aluminum Closure Sheet in North America

1999



44.5 Million Pounds of Content
2.6 lbs./Vehicle
90 Million Pounds of Shipments

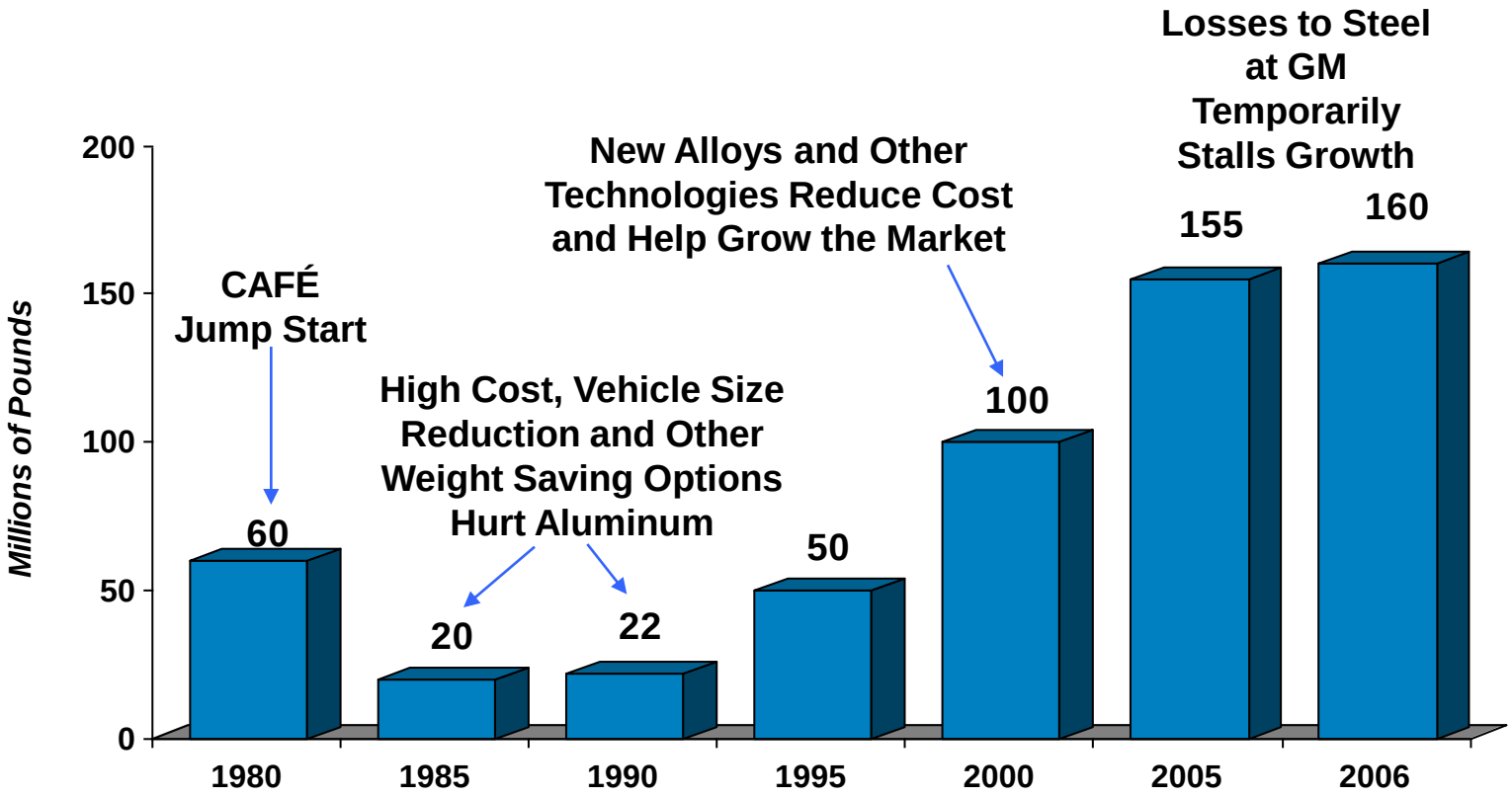
2002



67.0 Million Pounds of Content
4.32 lbs./Vehicle
135 Million Pounds of Shipments

REGIONAL SUMMARY NORTH AMERICA

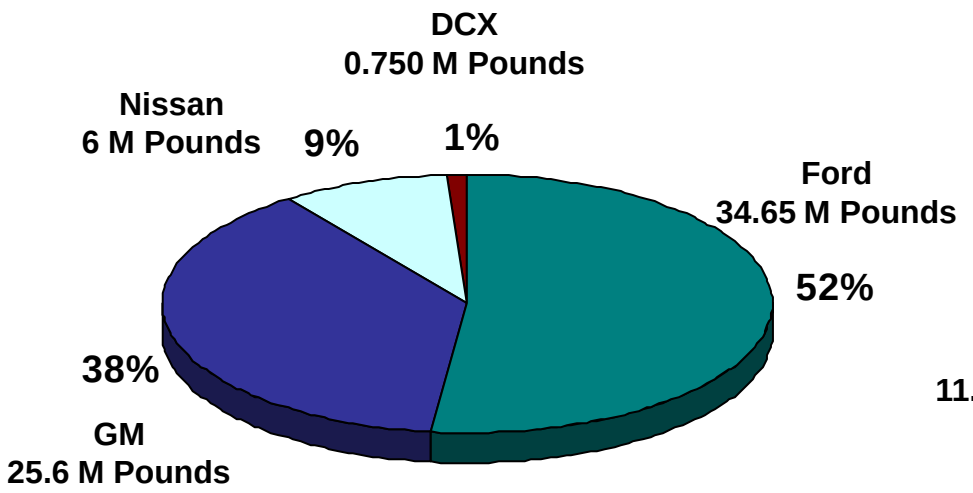
North American Aluminum Shipments for Vehicle Closures



REGIONAL SUMMARY NORTH AMERICA

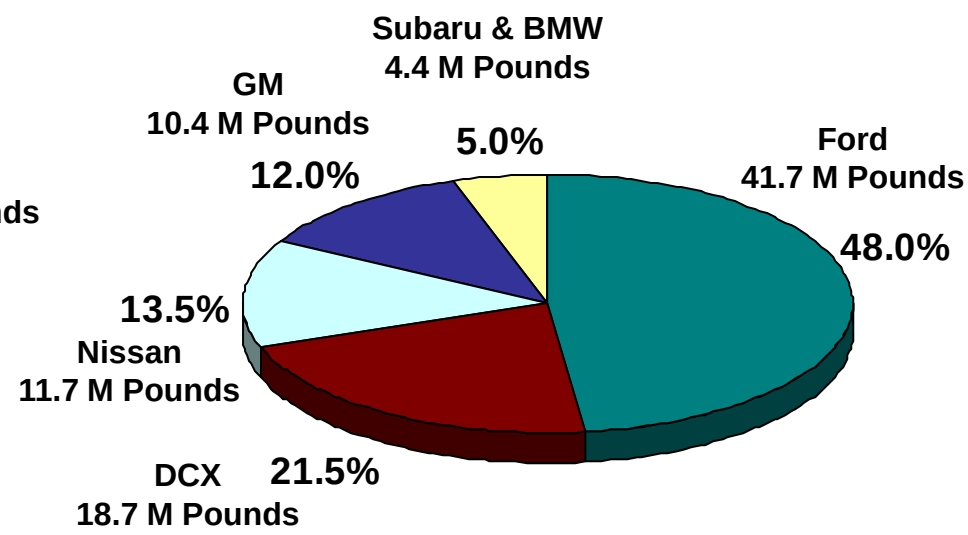
Aluminum Closure Sheet Content in North America

2002



67.0 Million Pounds of Content
4.32 lbs./Vehicle

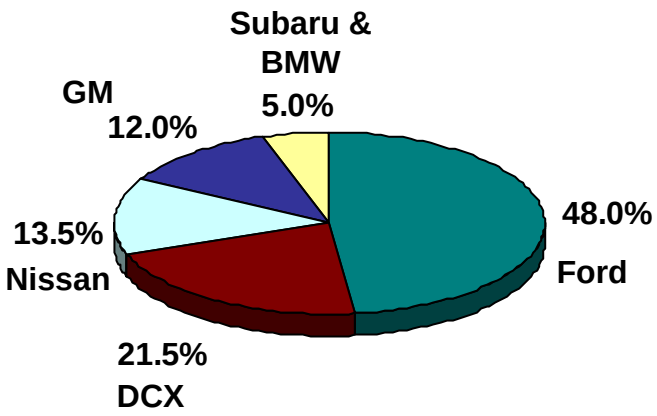
2006



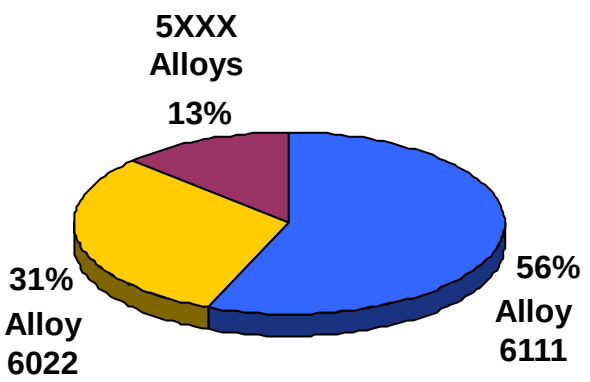
86.9 Million Pounds of Content
5.52 lbs./Vehicle

REGIONAL SUMMARY NORTH AMERICA

Segmented by OEM



Segmented by Alloy

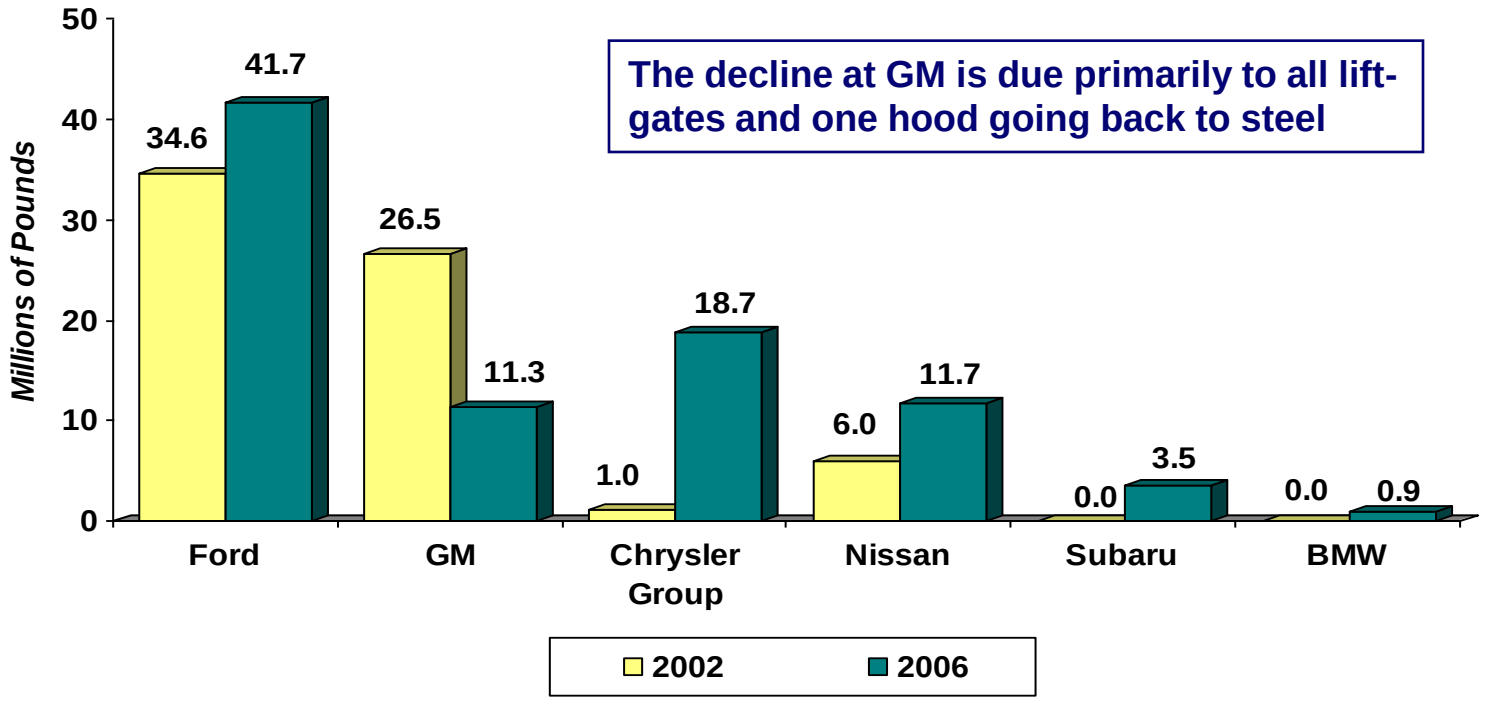


- The 87 million pounds of closure sheet for light vehicles assembled in North America in 2006 are shown above segmented by OEM and alloy
- The 2006 content would be 15 million pounds higher if GM had not cut their use of aluminum closure sheet by over 50 percent since 2002. GM did this do to severe cost pressures and **could** shift back to their former level of aluminum use by the end of the decade

REGIONAL SUMMARY NORTH AMERICA

2002 Versus 2006 Aluminum Sheet Content for Body and Closures

- Segmented by North American OEM -



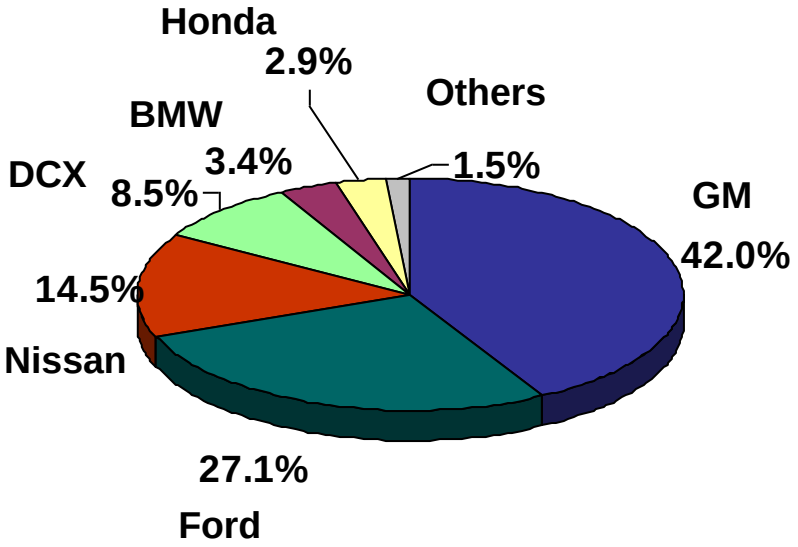
REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- Suspension Arms and Lateral Links -

Aluminum Units

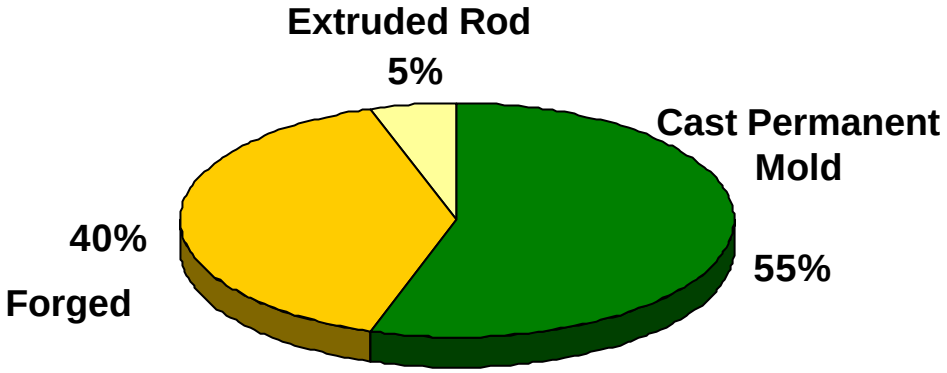
- Segmented by OEM -



16.5 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



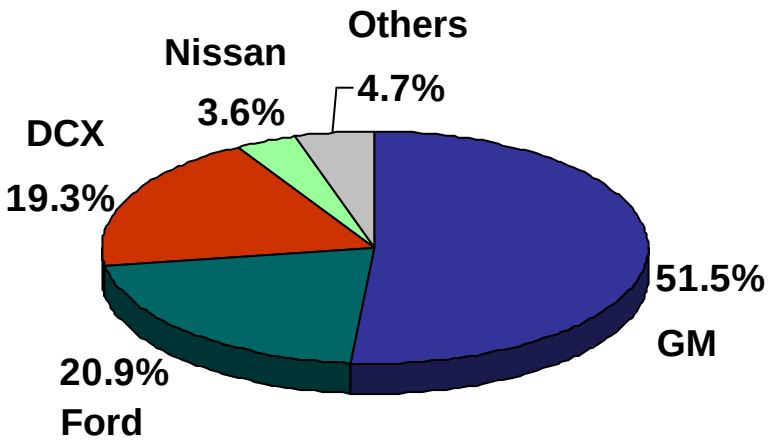
16.5 Million Units

2006 Light Vehicle Aluminum Content

- Steering Knuckles -

Aluminum Units

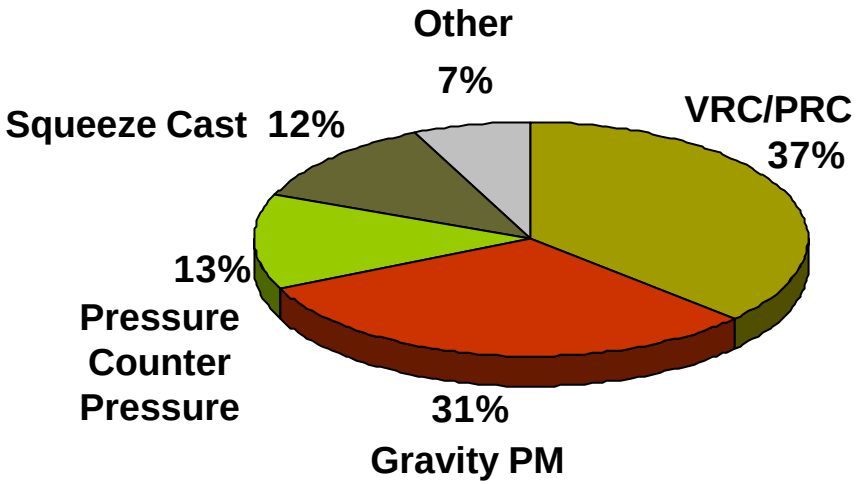
- Segmented by OEM -



15.0 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



15.0 Million Units

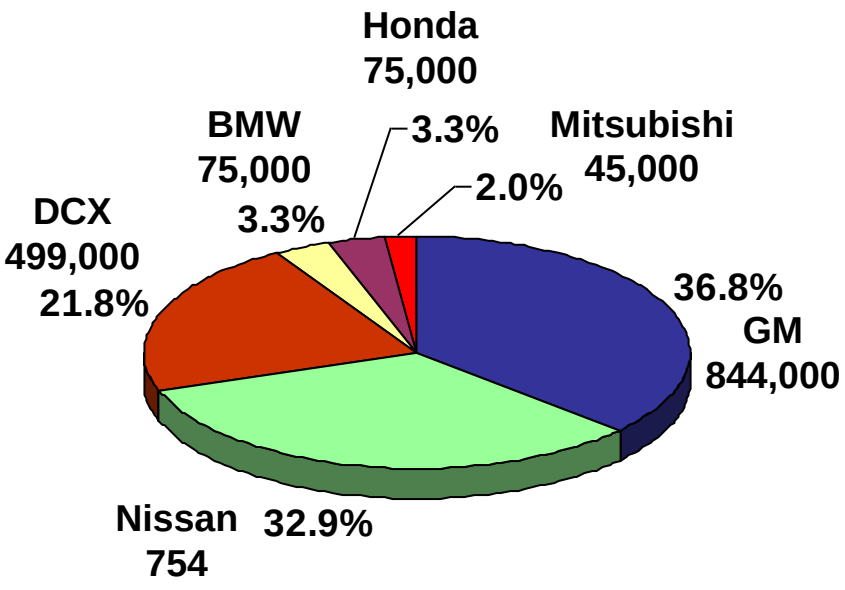
REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- Subframes, Crossmembers and Cradles -

Aluminum Units

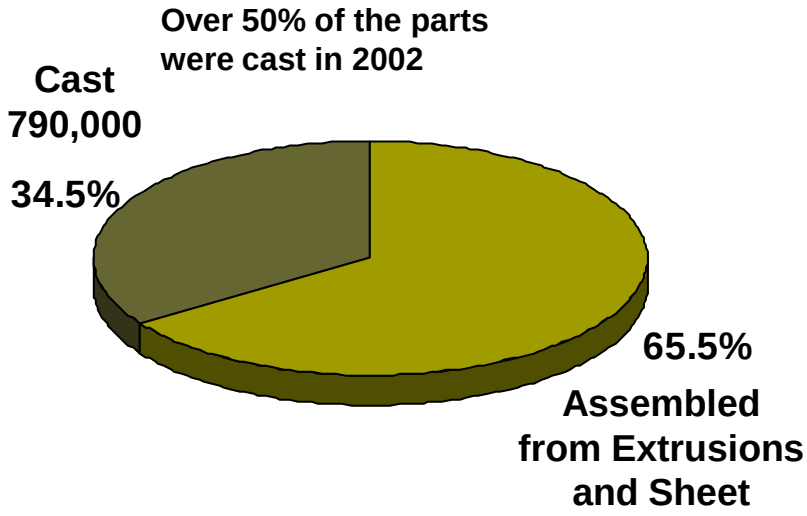
- Segmented by OEM -



2.292 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



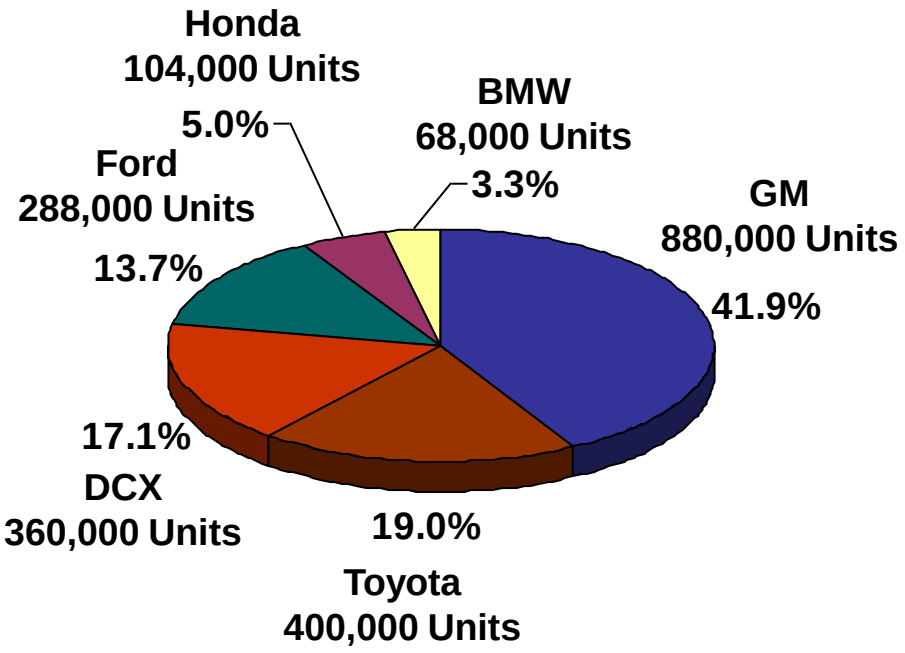
2.292 Million Units

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

Extruded Aluminum Bumper Beams

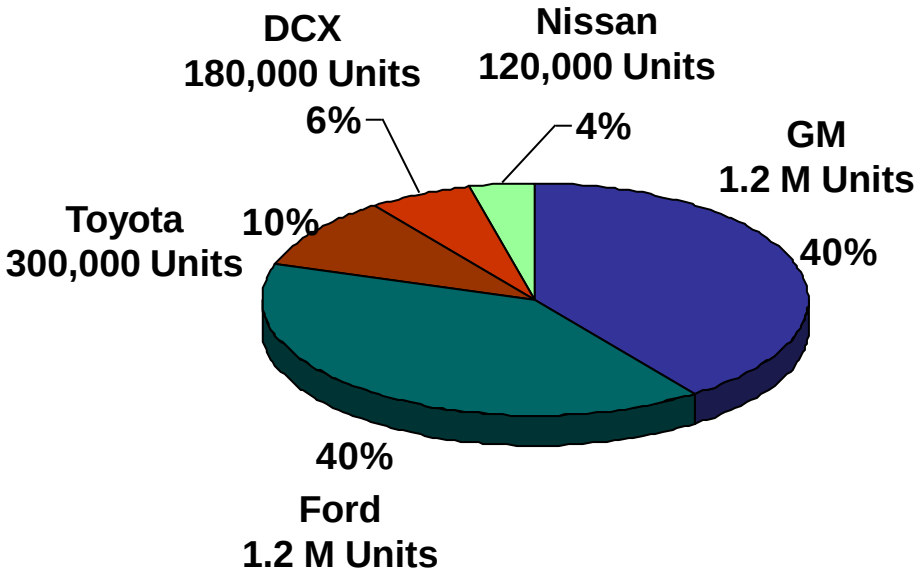
- Segmented by OEM -



2.1 Million Units

Aluminum Drawn Tube Drive Shafts

- Segmented by OEM -



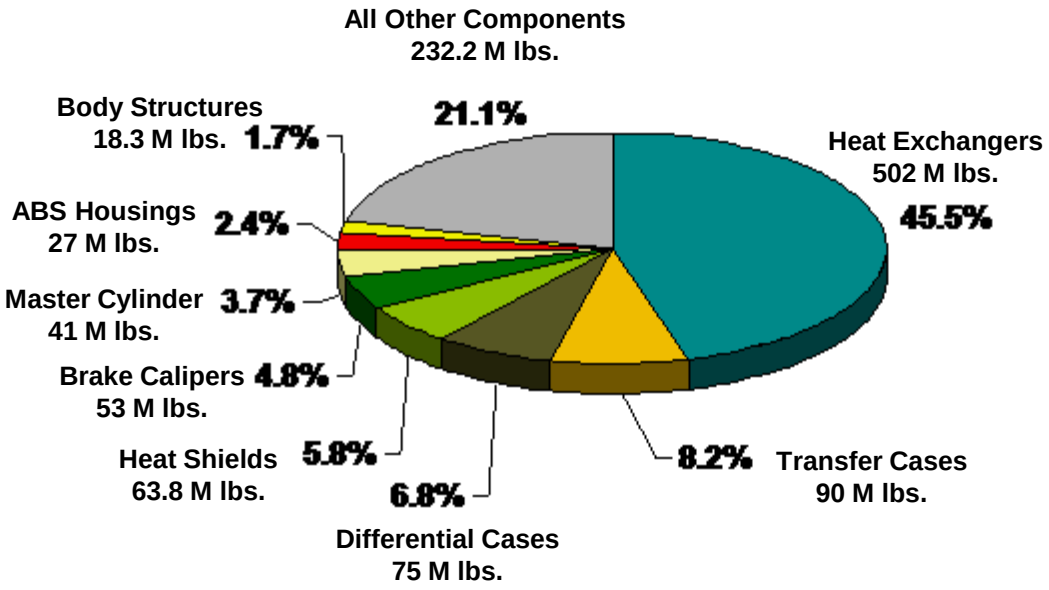
3.0 Million Units

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

Body Parts and Other Miscellaneous Components

- Segmented by Component -



1.102 Billion Pounds

- **There are many interesting facts that accompany the many miscellaneous components:**
  - **The movement of transfer cases from aluminum to magnesium and back to aluminum at GM**
  - **The rapid growth and shift of ABS housings from castings to extrusions**
  - **The lack of growth for body structures. All the current body structures are at GM**
  - **The use of extruded overhead rails and brackets for DVD players and other infotainment devices**

REGIONAL SUMMARY NORTH AMERICA

Light Vehicle Aluminum Content Per Vehicle

(Pounds per Vehicle)

	2002	*2006*	*Change*	*Comments*
Engine	92.66	113.84	21.18	2.6 million more blocks
Transmission and Driveline	62.04	69.46	7.42	More drive shafts, differential carriers and GMT 900 transfer cases.
Chassis, Suspension and Steering	13.76	22.18	8.42	More suspension arms, steering knuckles and extruded subframes.
Wheels and Spares	49.32	52.06	2.74	Growth has reached a plateau, but wheel weights have gone up.
Heat Exchangers	32.00	31.87	(0.13)	Slight gauge reduction for rolled products.
Brakes	5.48	7.75	2.27	ABS growth spurt and more calipers.
Closures	4.32	5.52	1.2	Losses at GM will cost the industry nearly one pound per vehicle.
Body Structures	1.00	1.16	0.16	New Z06 Corvette spaceframes weigh 278 pounds with 7,000 expected units
Heat Shields	3.82	4.05	0.23	Slow steady growth.
Bumper Beams	1.35	1.82	0.47	Transplant growth more than offset losses at Big 3
All Other Components	9.03	8.99	(0.04)	Parts come and go with little change.
Totals	274.78	318.70	43.92	16 percent growth is higher than expected.

REGIONAL SUMMARY NORTH AMERICA

2006 Light Vehicle Aluminum Content

- Final Comments on North America -

- In the 1980's transmissions, heat exchangers and wheels drove aluminum content growth in light vehicles
- In the 1990's wheels, cylinder heads, closures and heat shields drove the growth
- Since 2000, the growth of engine blocks, driveline components, suspension components, steering components, brake components and assembled subframes have been the driver
- Closures have temporarily stalled due to losses at GM, but 18 percent of the hoods in 2006 will be aluminum and 25 percent of the hoods could be aluminum by 2010 in North America
- Overall aluminum content at 319 pounds per vehicle in 2006 has exceeded most analyst expectations, but mill products content lags Europe

2006 Light Vehicle Aluminum Content

- Final Comments on North America -

- Europe uses ten more pounds of sheet and extrusion in their vehicles, particularly passenger cars, than North America excluding heat exchangers
- Aluminum engine content should increase by at least 12 more pounds in this decade to an average of 125 pounds per vehicle in 2010
- Chassis, suspension, steering and brakes should add another ten pounds, but bodies, bumpers and closures are not likely to add more than a few pounds. These components will need to reach the current levels in Europe to add the pounds needed to get aluminum content in North America over the 350 pound per vehicle level early in the next decade

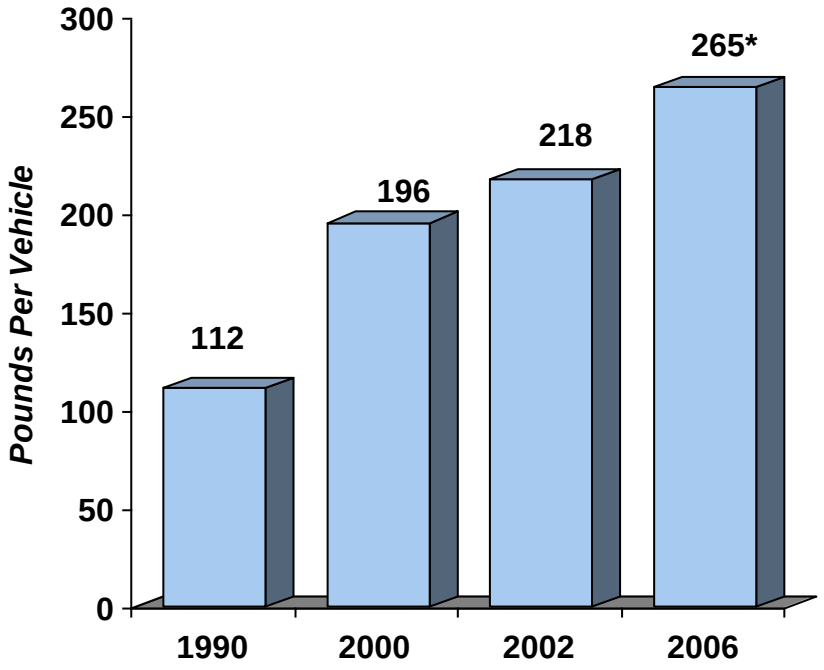
REGIONAL SUMMARY EUROPEAN UNION

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Western Europe Passenger Car Aluminum Content -

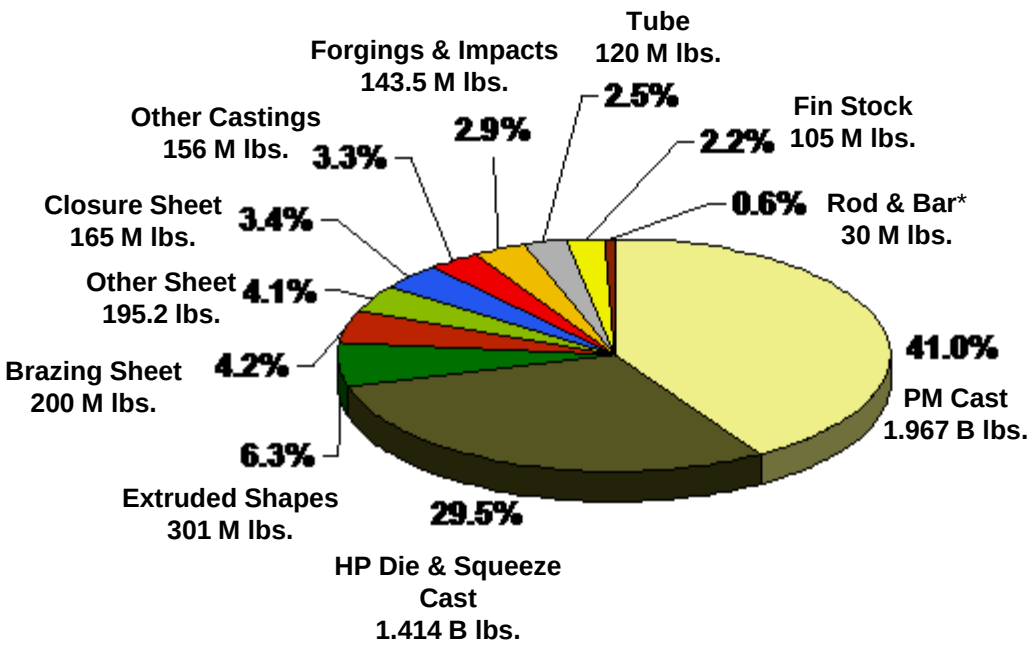
Europe Passenger Car Only Aluminum Content



- Prior to 2006, Ducker only compiled content data for passenger cars assembled in Western Europe
- For 2006, we broadened our view and studied the larger European Union including countries such as Hungary, Poland and the Czech Republic. We also looked at all non commercial passenger vehicles including vans and SUVs. The 2006 aluminum content value with the broader definition will be 259* pounds per vehicle compared to the 265 pounds per vehicle for only passenger cars as shown on the chart

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content



4.797 Billion Pounds

- The nearly five billion pounds of aluminum content will require over six billion pounds or 2.7 million tons of industry shipments in 2006, not including spares and exported parts
- *Rod and bar content does not reflect the shipments of rod used as forging stock for much of the 100 million pounds of forged suspension arms and steering knuckles to be made for light vehicles
- Castings represent 73.8% of the aluminum content, 13.9% is rolled products, 9.4% is extruded products and forgings and impacts are 2.9%. Mill product use is much higher in Europe than Japan or North America

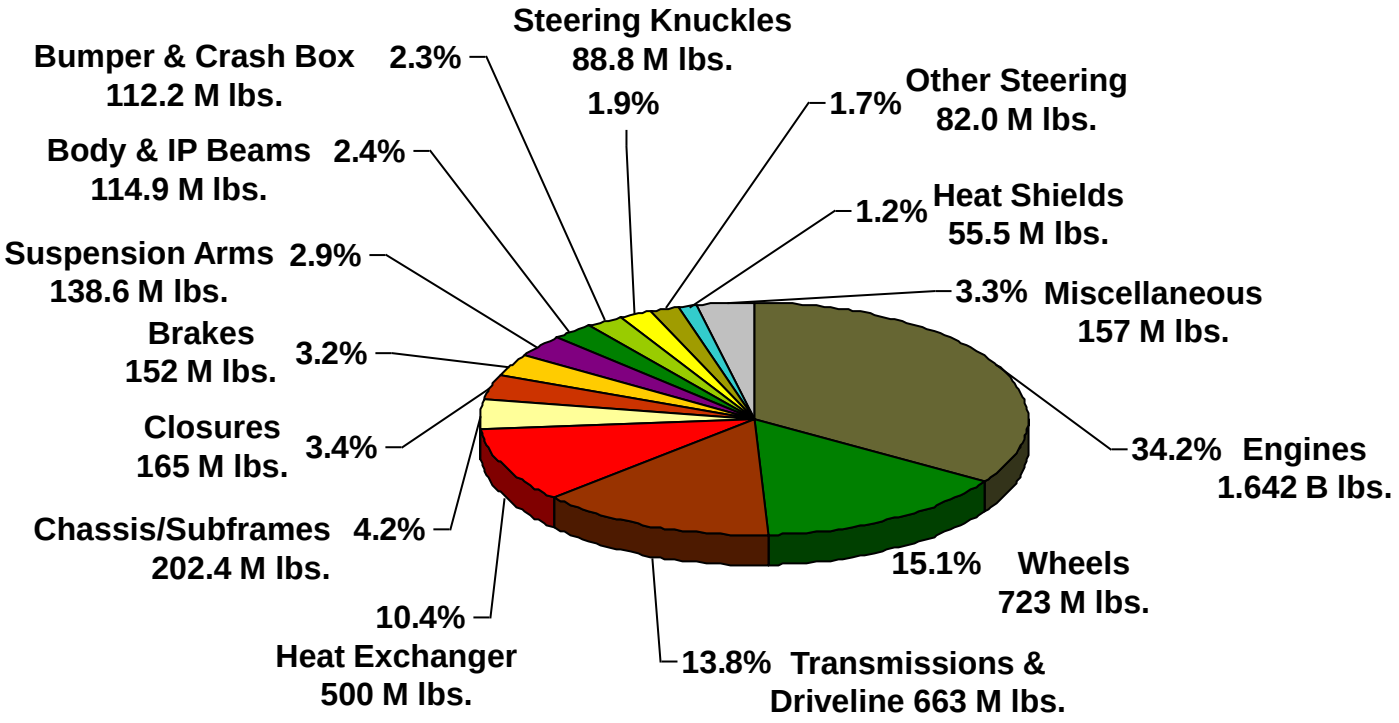
REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Light vehicle content will approach five billion pounds in Europe in 2006
- The average content of 259 pounds per vehicle is for 18.5 million non commercial passenger cars, vans, SUVs and pickup trucks

2006 Aluminum Content

- Segmented by Component -



4.796 Billion Pounds

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

2006 List of Large Aluminum Components

(Millions of Units)

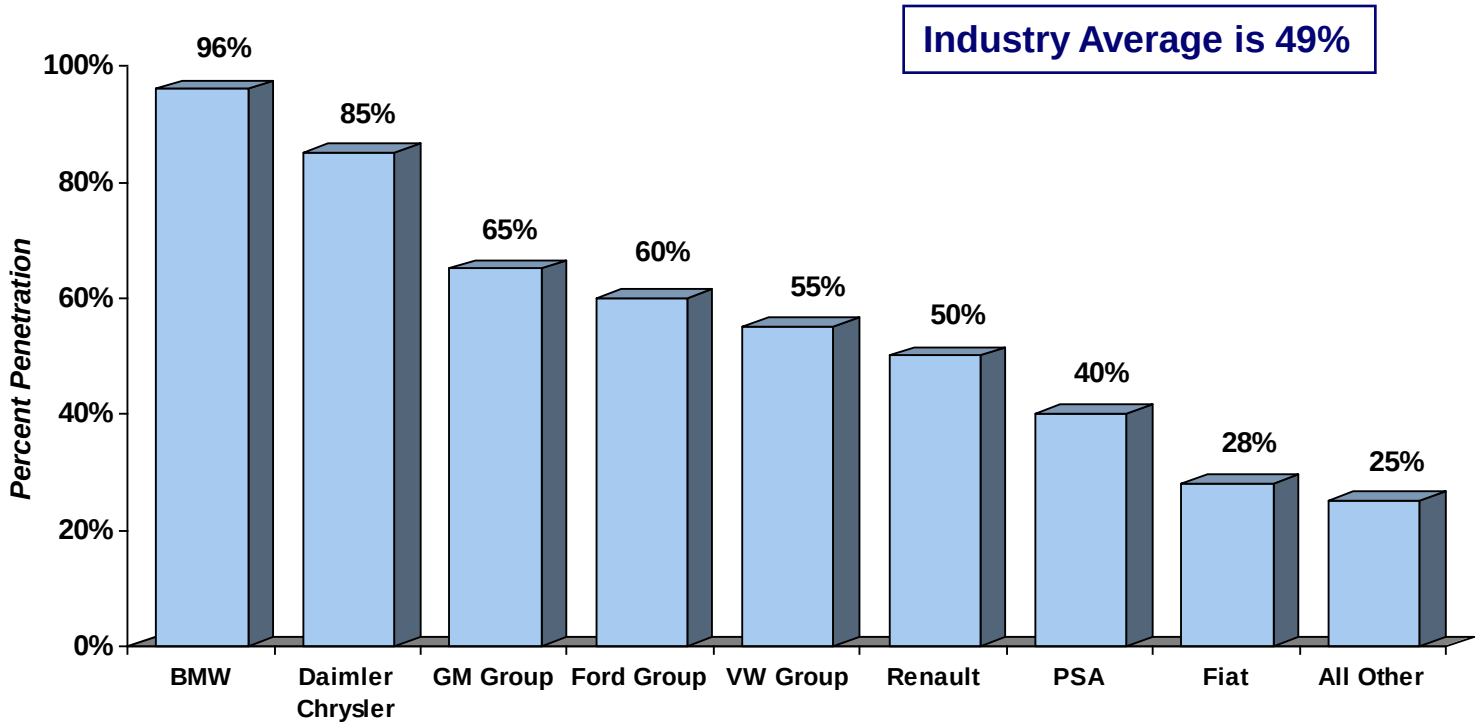
Engine blocks	7.850
Cylinder heads	20.015
Automatic transmission cases	2.780
Manual transmissions	15.720
Wheels	37.000
Radiators, evaporators & condensers	48.000
Bumper beams	10.500
IP beams	2.000
Intrusion beams	4.000
Front structures/radiator supports	0.950
Complete BIW	0.093
Closures	8.164
Cradles, subframes & crossmembers	6.139
Suspension arms & links	25.200
Steering knuckles	14.800
Crash boxes	1.500

- **The 18.5 million vehicles to be assembled by the members of the European Union in 2006 will use over 200 million large aluminum components and over one billion small or miscellaneous components**
- **The total quantities are similar to North America, but the types of components are significantly different in Europe. There are a lot fewer automatic transmissions, V6 and V8 engines, drive shafts differential housings and transfer cases. There are a lot more bumper beams, IP beams, closures, front structures, BIWs, suspension arms and subframes**

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Aluminum Share of OEM Wheels Not Including Spares -



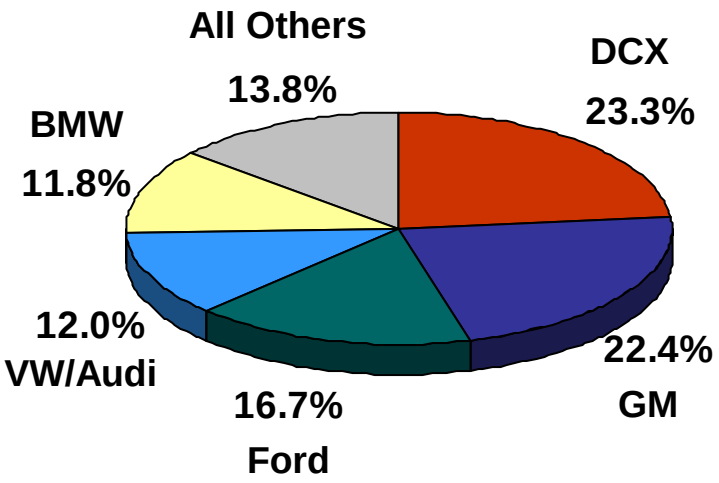
REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Steering Knuckles -

Aluminum Units

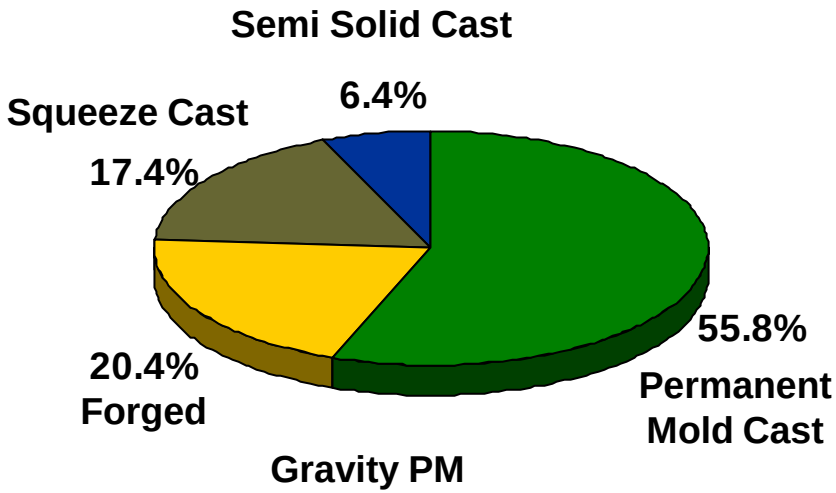
- Segmented by OEM -



14.8 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



14.8 Million Units

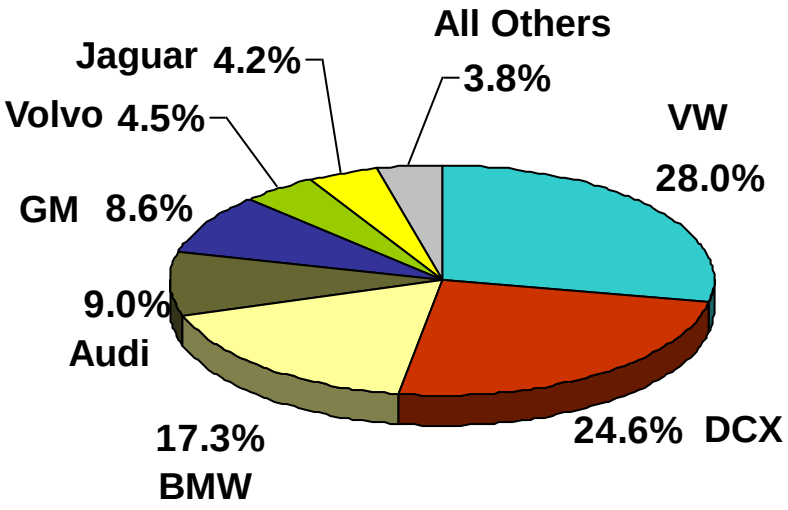
REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Suspension Arms and Lateral Links -

Aluminum Units

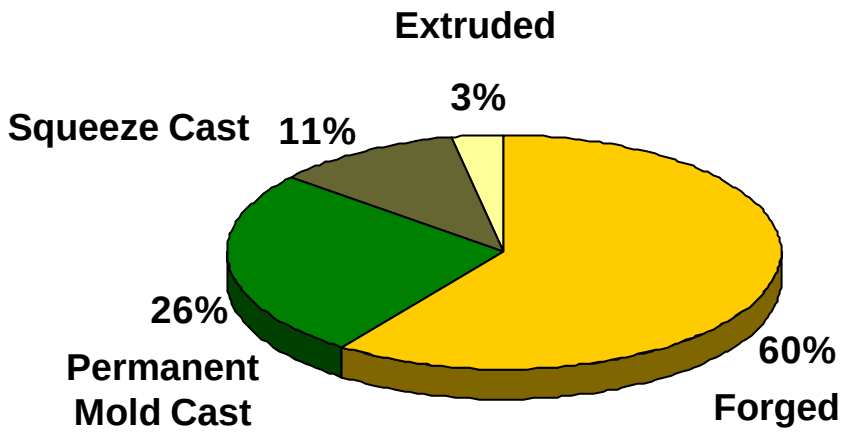
- Segmented by OEM -



25.2 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



25.2 Million Units

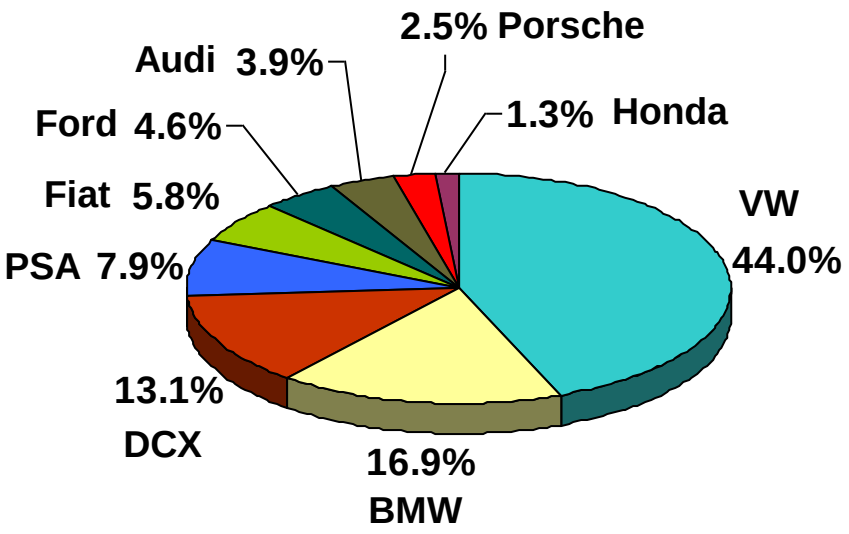
REGIONAL SUMMARYEUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Cradles, Crossmembers and Subframes -

Aluminum Units

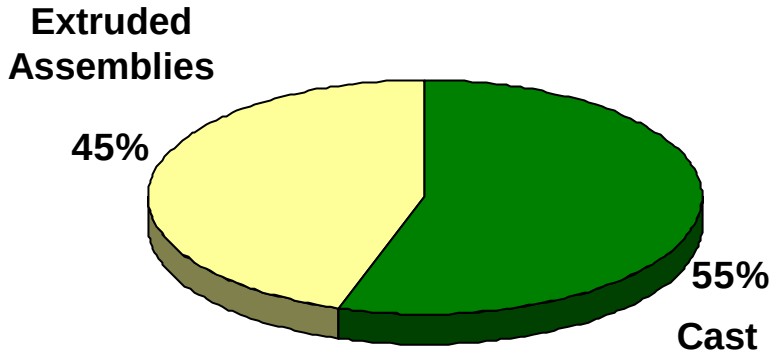
- Segmented by OEM -



6.139 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



6.139 Million Units

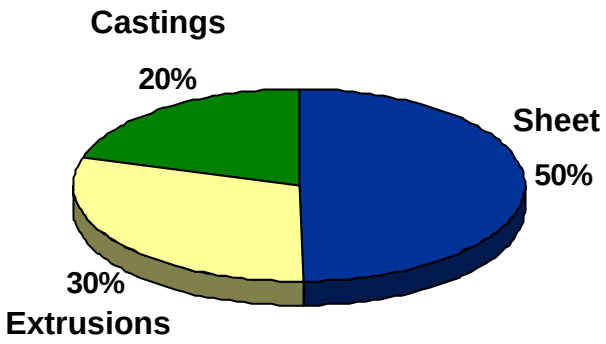
REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Body Structures -

Aluminum Content Complete Body in White

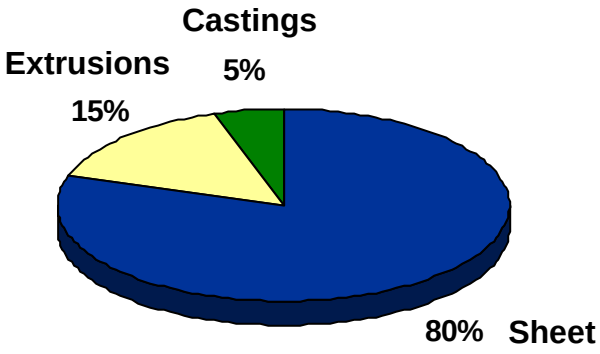
- Segmented by Product -



33.493 Million Pounds
92,800 Units

Aluminum Content Partial Body Structures

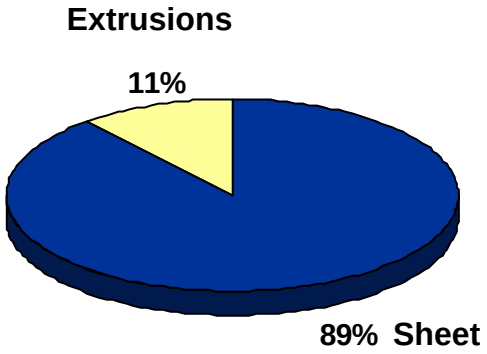
- Segmented by Product -



61.650 Million Pounds
950,000 Units

Aluminum Content Instrument Panel Support Beams

- Segmented by Product -



19.800 Million Pounds
2 Million Units

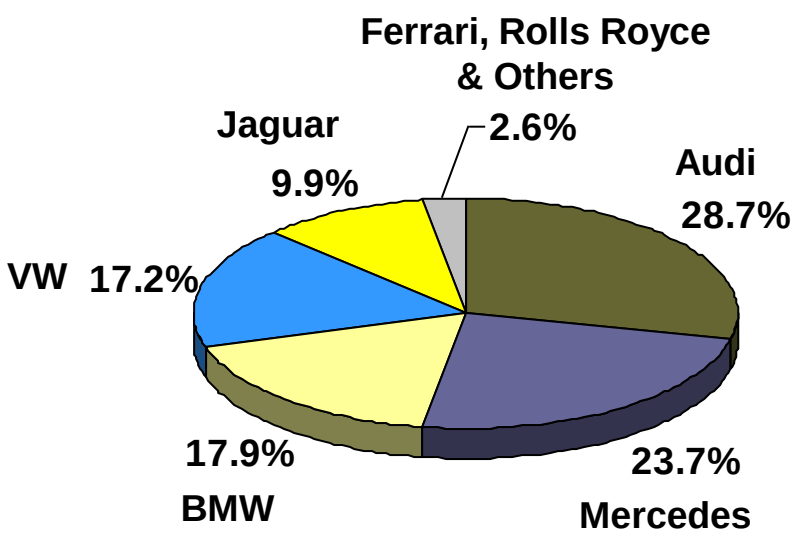
REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Body Structures -

Aluminum Content

- Segmented by OEM -



114.9 Billion Pounds

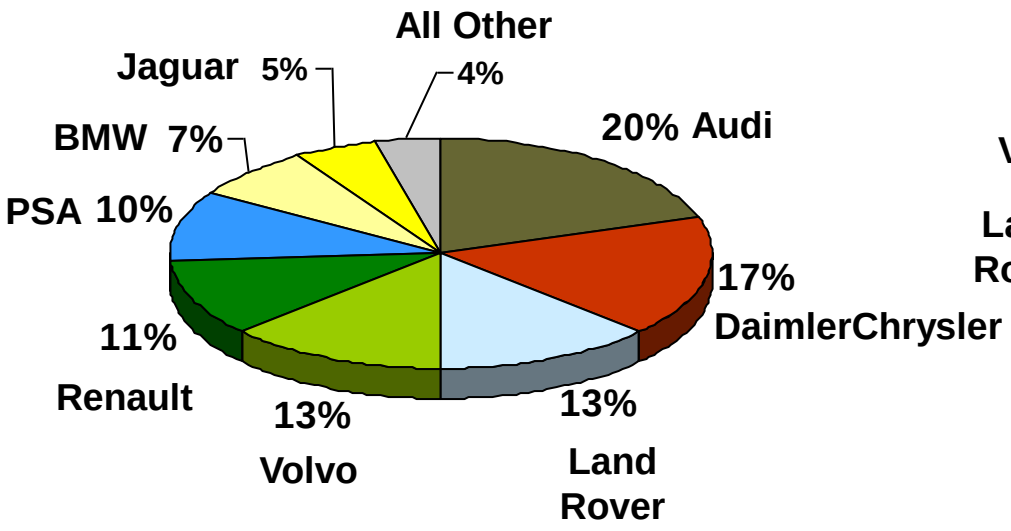
- Although Mercedes and BMW have no complete aluminum body structures, they now rival Audi in the use of aluminum for body structures with over 700,000 partial frames
- VW is 100 percent instrument panel support structures
- Jaguar will produce 32,000 aluminum BIWs in 2006, but they are only ten percent of the aluminum body structure market due to their low volume of production. Audi and others will produce 60,800 aluminum BIWs in 2006

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content
- Closures -

2002 Content

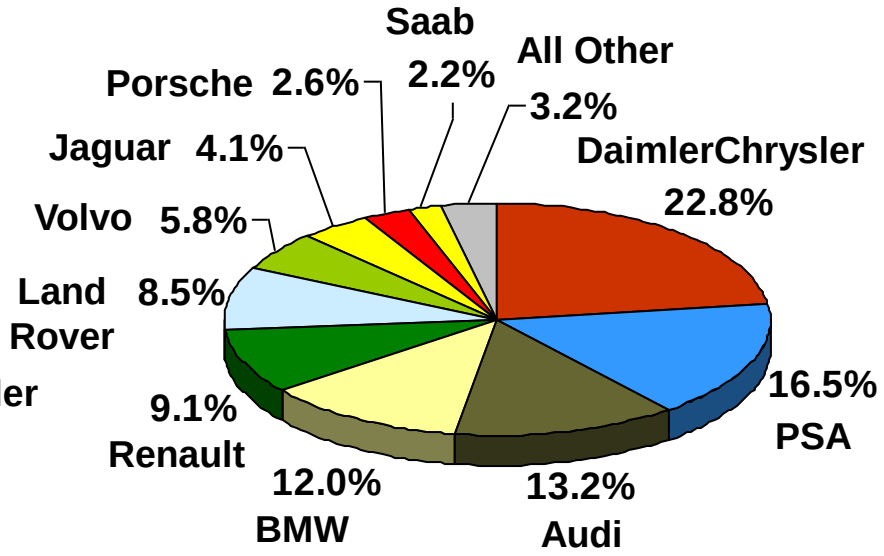
- Segmented by OEM -



82.5 Million Pounds
70 Percent Hoods

2006 Content

- Segmented by OEM -

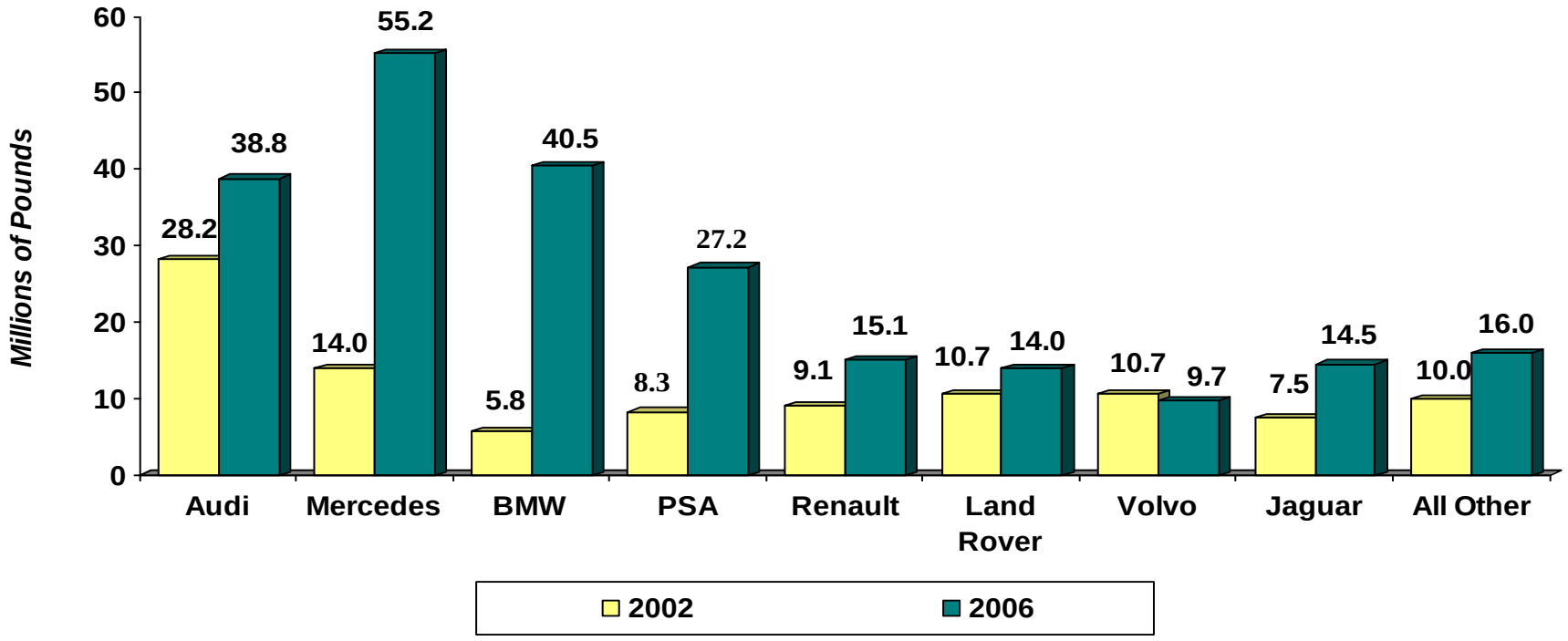


165 Million Pounds
55 Percent Hoods

REGIONAL SUMMARY EUROPEAN UNION

2002 and 2006 Aluminum Sheet Content for Body and Closures

- Segmented by European OEM -



REGIONAL SUMMARY EUROPEAN UNION

Light Vehicle Aluminum Content Per Vehicle

(Pounds per Vehicle)

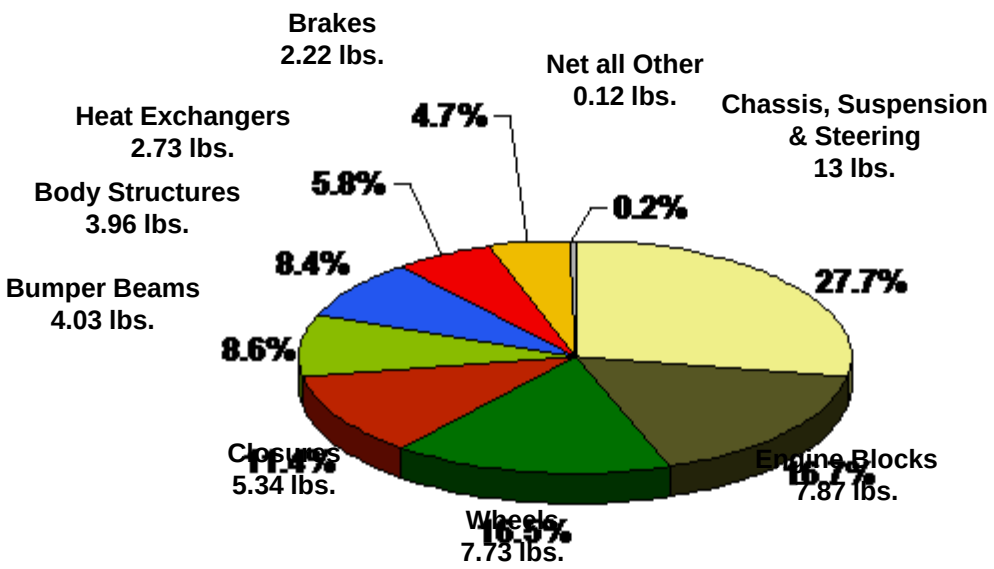
	2002	*2006*	*Change*	*Comments*
Engine	80.60	88.76	8.16	20 percent of diesel blocks are now aluminum.
Transmission and Driveline	34.00	35.84	1.84	Manual transmission still rule, but automatics have grown a little.
Chassis, Suspension and Steering	18.10	27.66	9.56	More suspension arms, more steering knuckles and more cradles.
Wheels and Spares	31.35	39.08	7.73	More wheel growth than expected particularly for lower end vehicles.
Heat Exchangers	24.30	27.03	2.73	AC installations are now over 75 percent.
Brakes	6.00	8.22	2.22	More calipers and ABShousings
Closures	5.3	8.92	3.62	Tremendous growth in the last five years with 137 current programs.
Body Structures	2.90	5.13	2.23	Good growth at Mercedes and BMW for partial structures.
Instrument Panel Support Structure	1.00	1.07	0.07	Growth is a disappointment with only VW using significant quantities.
Heat Shields	2.60	3.00	0.40	Slow steady growth
Bumper Beams	3.13	6.07	2.94	Big growth spurt in the last few years, but rear beams going to plastic.
All Other Components	8.50	8.49	(0.01)	No significant net change.
Totals	217.78	259.28	41.50*	19 percent growth, * 47 pounds or 21.6% for passenger cars (see next page)

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

EEU Content Increases per Vehicle for "Passenger Cars"

- Segmented by Component and System -



47 Pounds EEU Passenger Cars Only

- **EEU passenger cars with forecasted production of 14.56 million units in 2006 will contain an average of 265 pounds of aluminum per vehicle**
- **This will be a 21.6 percent increase over 2002**
- **The EEU passenger cars will add 2.4 million aluminum blocks, 8 million control arms, 8 million steering knuckles, 3.5 million closure panels, 4.5 million bumper beams and 5.6 million wheels in 2006 versus 2002**

REGIONAL SUMMARY EUROPEAN UNION

2006 Light Vehicle Aluminum Content

- Final Comments on Europe -

- In the last five years, Europe has become the worldwide leader in aluminum use for light vehicles. The content per vehicle lags North America by 60 pounds per vehicle, but there is a 70 pound per vehicle advantage for North America due to aluminum castings in the powertrain and driveline
- If Europe had all the large V6 and V8 gasoline engines, automatic transmissions and 4-wheel drive pickup trucks and SUVs we have in North America, light vehicle aluminum content would be close to 330 pounds per vehicle in Europe
- Leadership in Europe is associated more with the high growth rates for aluminum use in the body, closures, chassis and suspension compared to North America and Japan

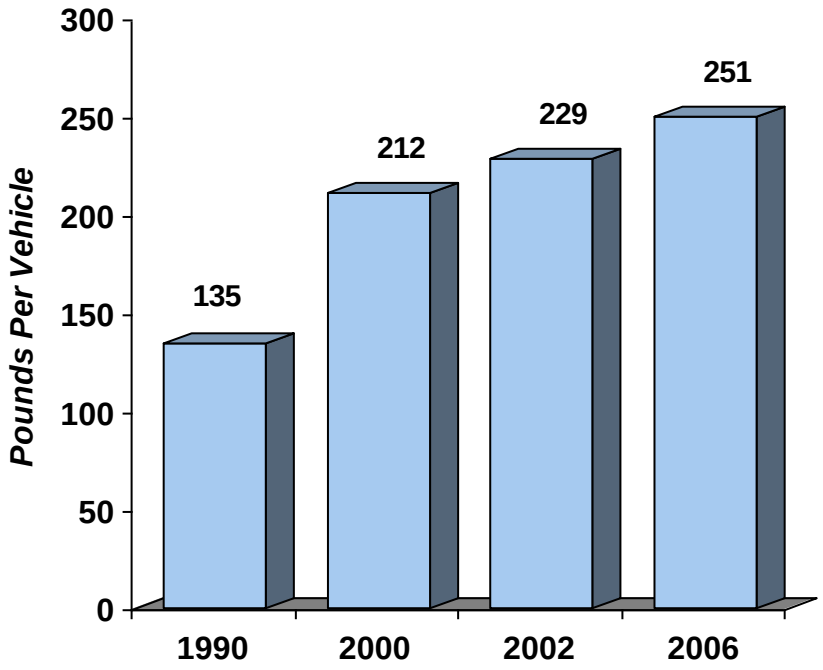
REGIONAL SUMMARY JAPAN

REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

Light Vehicle Aluminum Content

- Growth in Japan -



- Prior to 2002, the aluminum content estimate was based only on passenger cars. In 2002 and 2006 we collected data on all non commercial cars, vans, SUVs and pickup trucks assembled in Japan
- Like North America and Europe, aluminum content in Japan has been steadily growing for the past 25 years
- The 251 pounds per vehicle, while very significant, is 50 to 100 pounds lower than experts were predicting in the early 1990s

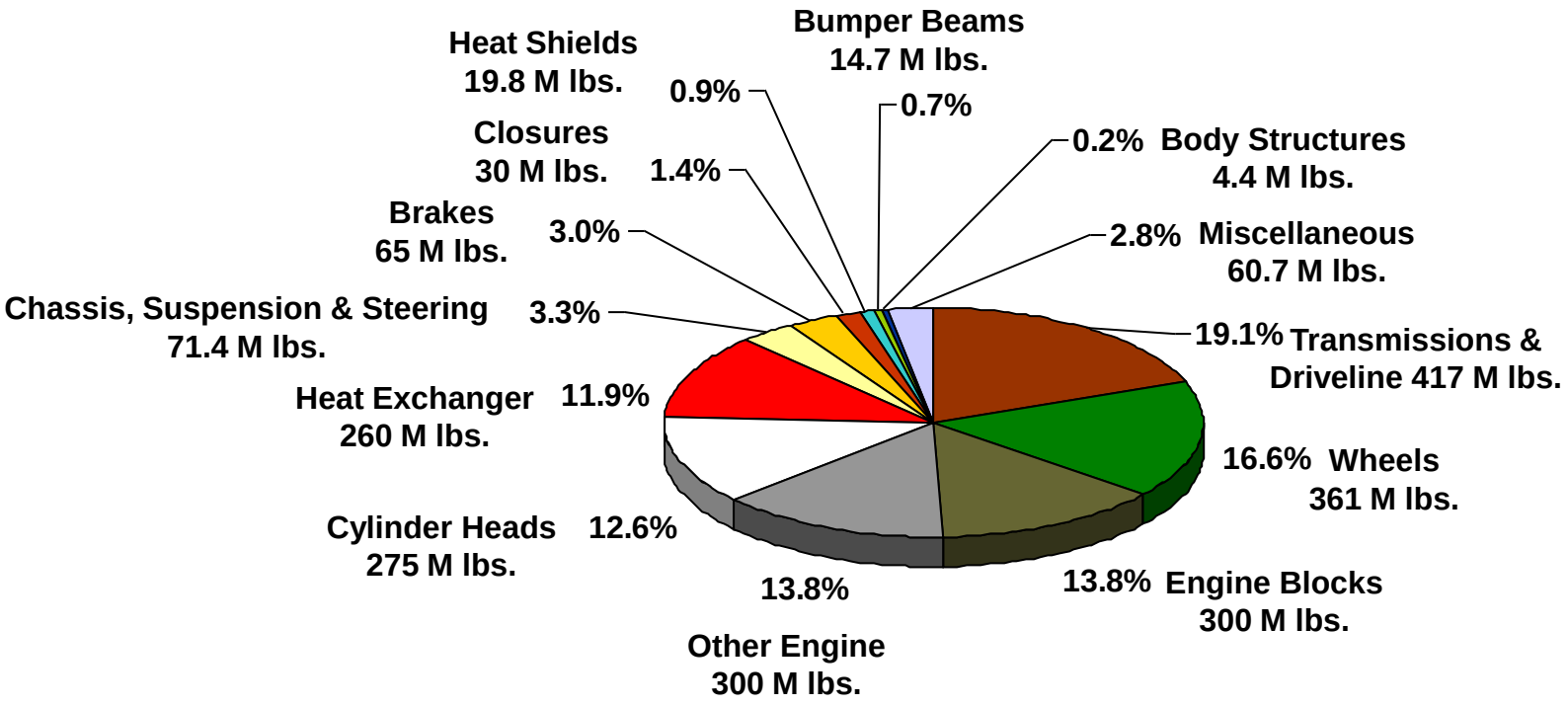
REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

- Light vehicle aluminum content will be nearly 2.2 billion pounds or one million metric tons in 2006

2006 Aluminum Content

- Segmented by Component -



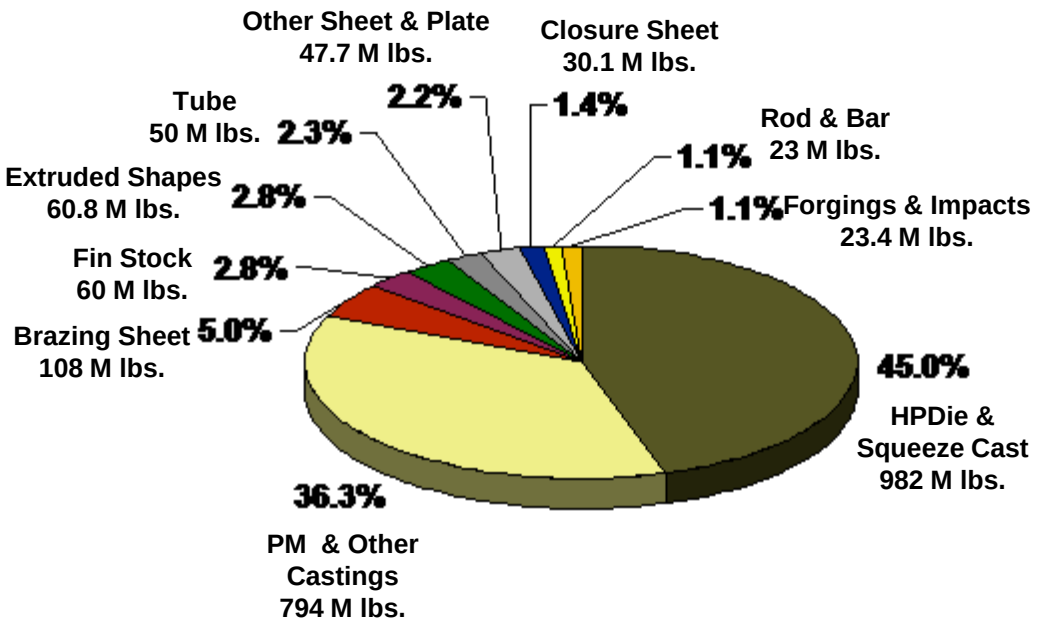
2.179 Billion Pounds

REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

Aluminum Content

- Segmented by Product Form -



2.179 Billion Pounds

- The 2.2 billion pounds of light vehicle aluminum content will require 2.6 billion pounds or 1.18 million tons of aluminum shipments including 40,000 tons of imports
- Japan will also ship 100,000 tons of aluminum for motorcycles and commercial trucks and buses
- Japan will consume an additional 100,000 tons of aluminum for exported engines, transmissions and heat exchangers for light vehicles around the world

REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

2006 List of Large Aluminum Components

(Millions of Units)

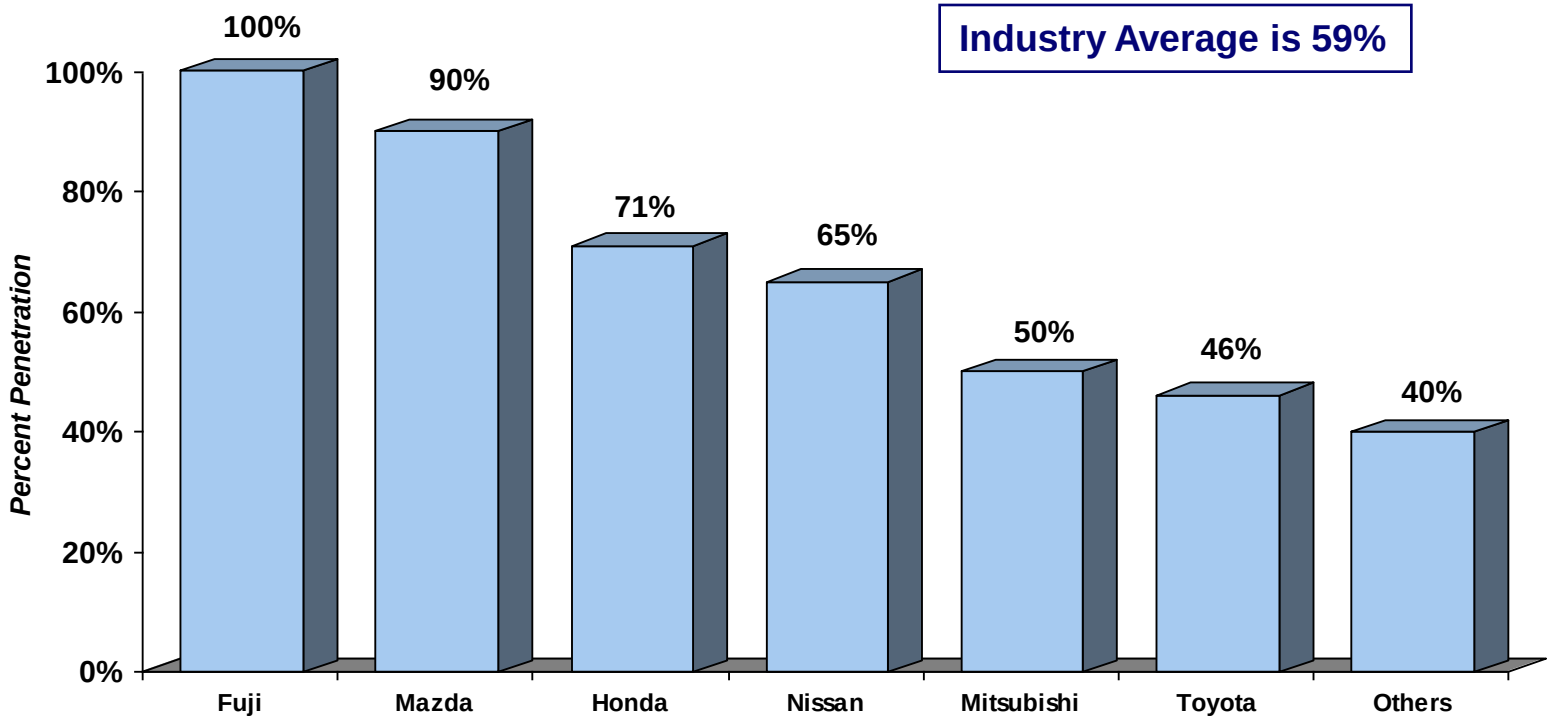
Engine blocks	6.074
Cylinder heads	10.041
Automatic transmission cases	7.153
Manual transmissions	1.517
Wheels	20.500
Radiators, evaporators & condensers	25.870
Bumper beams	1.200
Closures	1.797
Cradles, subframes & crossmembers	0.250
Suspension arms & links	1.750
Steering knuckles	2.700

- **The 8.67 million light vehicles for passenger use to be assembled in Japan in 2006 will use 80 million large aluminum parts and 500 million miscellaneous aluminum parts**
- **Proportionately, there are fewer large aluminum parts in Japan than in North America and Europe. Japan should eventually match North America and Europe on a proportional basis. There has been a great deal of progress in the last four years**

REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

- Aluminum Share of OEM Wheels Not Including Spares -



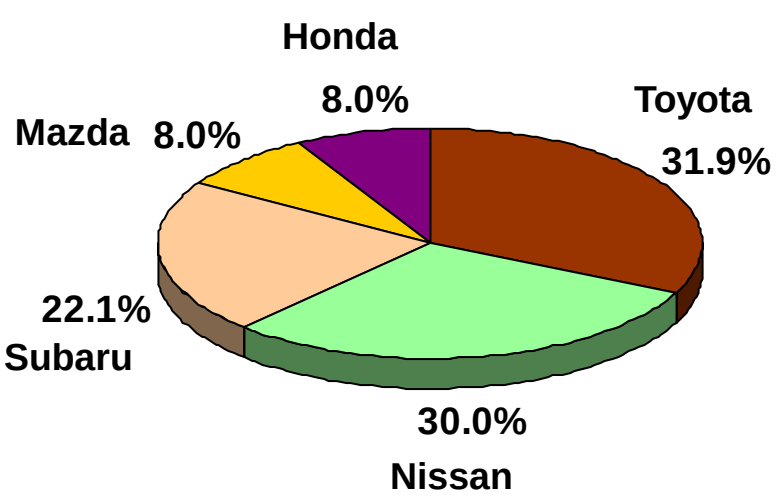
REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

- Suspension Arms and Lateral Links -

Aluminum Units

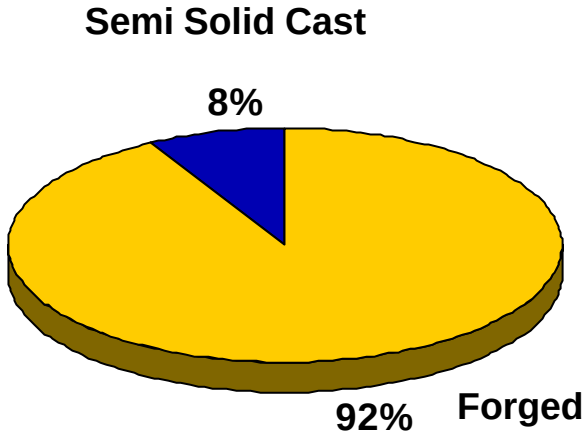
- Segmented by OEM -



1.75 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



1.75 Million Units

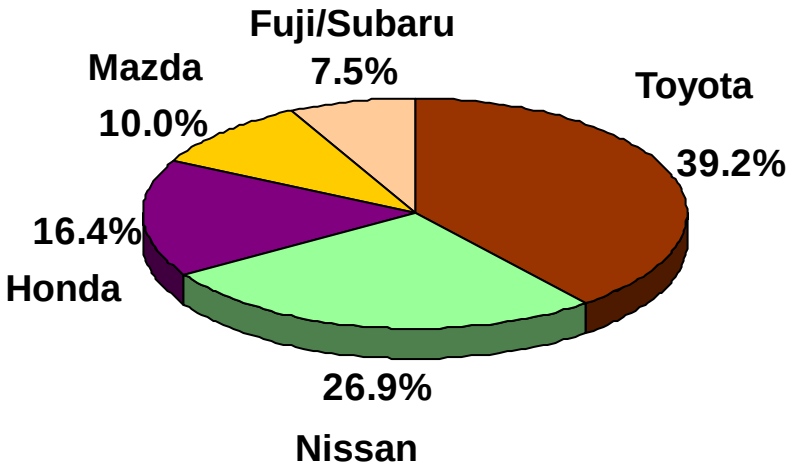
REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

- Steering Knuckles -

Aluminum Units

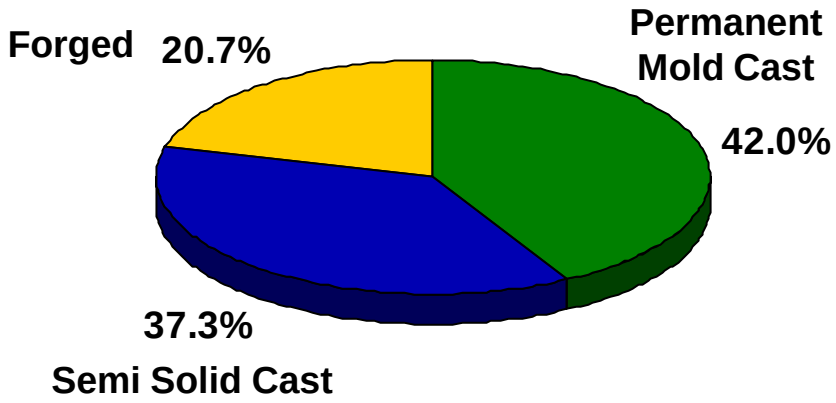
- Segmented by OEM -



2.7 Million Units

Aluminum Units

- Segmented by Manufacturing Process -



2.7 Million Units

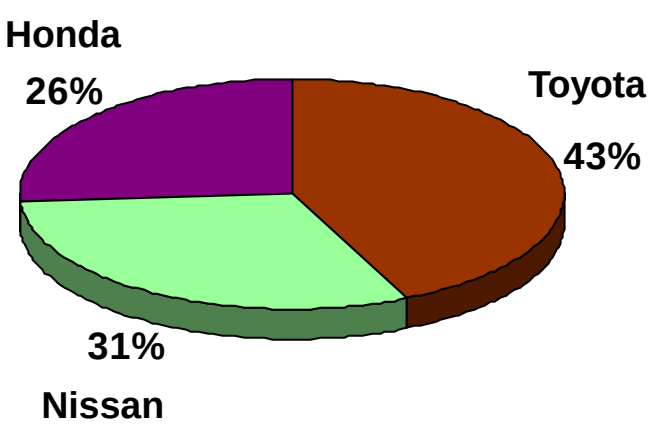
REGIONAL SUMMARY JAPAN

2006 Light Vehicle Aluminum Content

- Cradles, Crossmembers and Subframes -

Aluminum Units

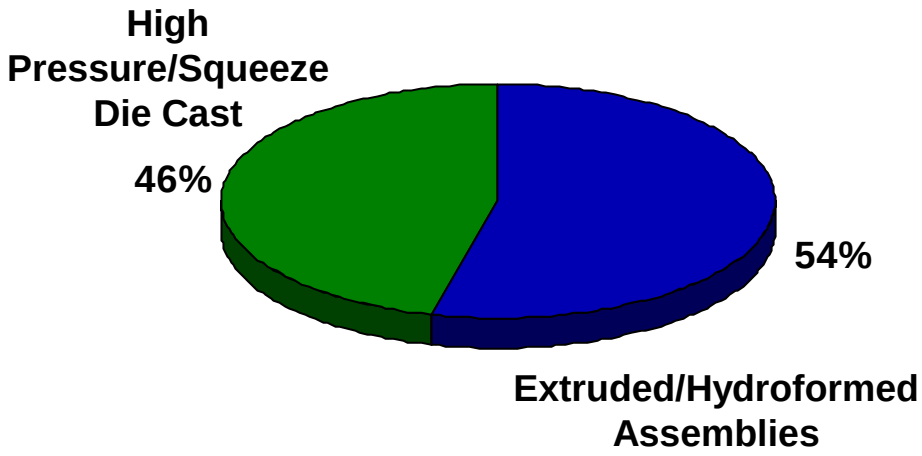
- Segmented by OEM -



0.250 Million Units

Aluminum Units

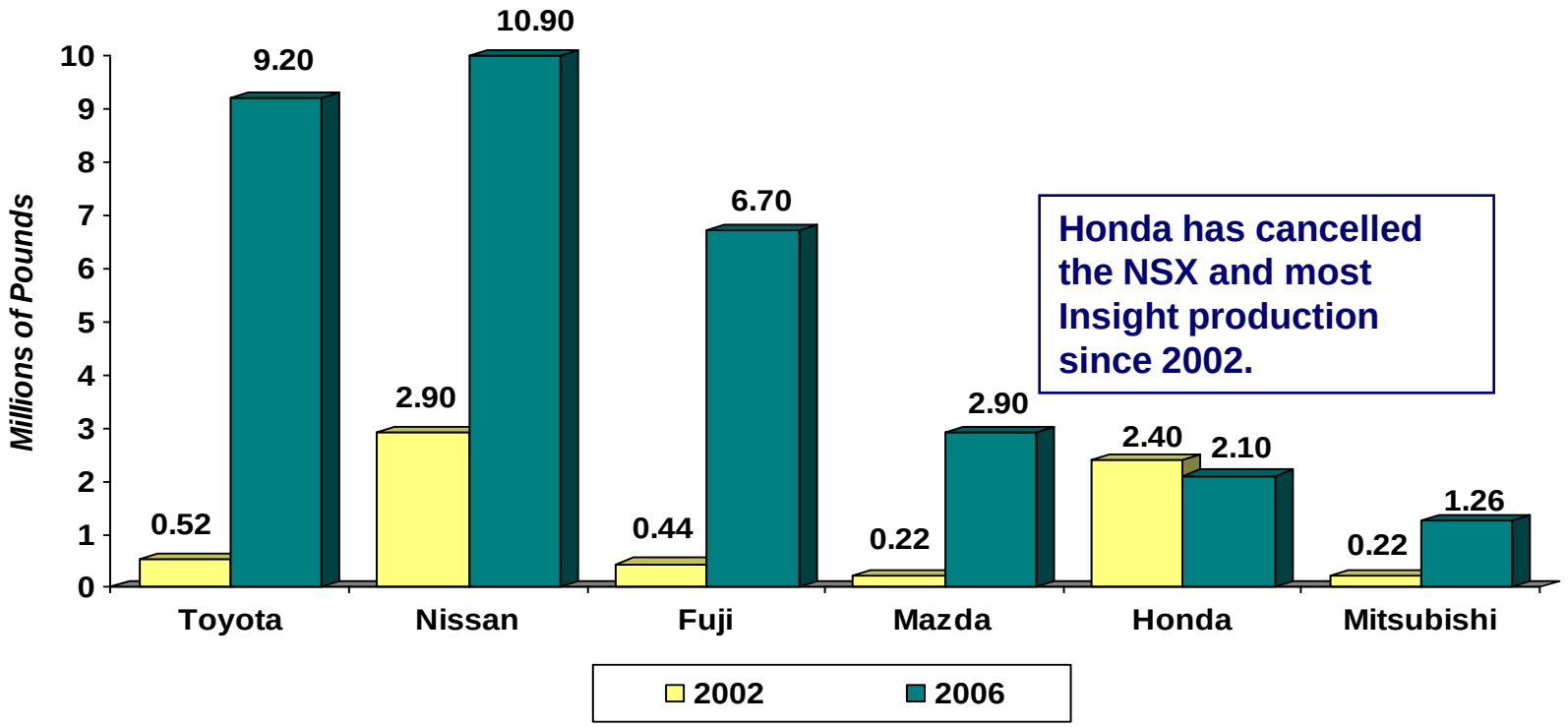
- Segmented by Manufacturing Process -



0.250 Million Units

2002 Versus 2006 Aluminum Sheet Content for Body and Closures

- Segmented by OEM -



Light Vehicle Aluminum Content Per Vehicle

(Pounds per Vehicle)

	2002	*2006*	*Change*	*Comments*
Engine	98.00	100.92	2.92	70 percent of all blocks are now aluminum.
Transmission and Driveline	45.30	48.10	2.80	In spite of 17 percent CVT use, transmission weights went up with vehicle weight.
Chassis, Suspension and Steering	6.50	8.23	1.73	Suspension arms and knuckles together have finally grown to over four million parts.
Wheels and Spares	39.20	41.64	2.44	59 percent of all wheels except spares are now aluminum. Five million wheels are imported.
Heat Exchangers	26.40	29.99	3.59	The last of the copper radiators are gone.
Brakes	3.69	7.50	3.81	ABS and calipers keep growing.
Closures	0.60	3.47	2.87	In the last four years aluminum closures have grown beyond expectation.
Body Structures	0.30	0.51	0.21	The NSX is gone. The Insight is nearly gone, but Nissan has added some potential structure in the Fuga front end
Heat Shields	1.20	2.28	1.08	Japan has finally given up on aluminumized steel.
Bumper Beams	1.71	1.69	(0.02)	Essentially no net change.
All Other Components	6.10	7.00	0.90	More trim, sunroofs, computer housings and interior rails and brackets.
Totals	229.00	251.00	22.33	Ten percent growth is in line with our expectations in 2002

2006 Light Vehicle Aluminum Content

- Final Comments on Japan -

- Japan has finally begun to adopt the European and North American philosophy on aluminum use for light vehicle closures, suspension components, steering components and brake components. The ten percent growth in aluminum content per vehicle over the last four years was driven by this change in philosophy
- Nevertheless, Japanese aluminum use outside of the powertrain, wheels and heat exchangers lags Europe by 37 pounds per vehicle and North America by 31 pounds per vehicle
- Japan is unlikely to reach the content levels of North America or Europe anytime in the next ten years, but for some vehicles like the Acura RL/Legend and Nissan M45/Fuga aluminum content is between 600 and 800 pounds per vehicle with volumes each at 50,000 vehicles
- Some of the innovations on these vehicles like the use of continuous cast aluminum sheet for hoods, HP die cast subframes and blow molded aluminum fenders are ground breaking not only for Japan, but for the world

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

2006 Light Vehicle Aluminum Content

- Aluminum content in light vehicles for passenger use has experienced over 30 years of uninterrupted growth. The current growth rate of 3.6% should drive developed world aluminum content to 330 pounds per vehicle early in the next decade
- Europe is the current leader in the innovative use of aluminum in light vehicles, but experience shows that technically and financially sound innovations will eventually be adopted throughout the various automotive producing regions of the world. Aluminum heat exchangers and power trains developed at different rates in different regions, but eventually these sound innovations have been adopted worldwide. This doesn't mean that the threat from other materials can be ignored. China is considering copper for their auto heat exchangers and magnesium is a constant threat to aluminum for powertrain components. Some current aluminum parts will undoubtedly be lost to new materials, but new applications for aluminum will take their place

SUMMARY AND CONCLUSIONS

2006 Light Vehicle Aluminum Content

- The growth in light vehicle aluminum content over the last four years has exceeded our forecasts. We found more suspension arms, steering knuckles, closure panels, bumper beams and body structure and chassis components than we expected. The highest numbers are concentrated in Europe, but there are also many success stories in North America and Japan
- Steel has put forth a concentrated and well funded effort to slow down the penetration rate for aluminum wheels. They are launching an attack on aluminum hoods and front end structures on the issue of pedestrian and occupant safety. High strength steels are a formidable competitive material (see Appendix I), but they don't save enough weight to completely stop aluminum's growth. They can only slow it down
- This study has confirmed that aluminum continues to make great progress against steel and other materials for light vehicle applications. The progress is uneven and there can be set backs, but the two million vehicles with high aluminum content (over 500 pounds) and the over 14 billion pounds of 2006 anticipated shipments are testimony that the acceptance of aluminum continues to grow at an astounding rate

This concludes our report.

Thank you.

APPENDIX I
HIGH STRENGTH STEEL

APPENDIX I

Defining High Strength Steel:

- After discussions with several steel producers and several OEMs, we found that the dividing line between mild steel and medium high strength steel is defined differently depending on the source. There were also some minor differences in the definition of Conventional HSS versus Medium HSS. Some OEMs call Boron and Martensitic Steels Ultra HSS. After much discussion, we settled on the matrix shown below for our definitions in an attempt to provide some consistency in our data collection

HSS Definitions Used for Data Collection

Common Designation	*Yield MPa*	*Tensile MPa*	*Type of Steel*
EDDQ	150	300	Mild Steel
DQSK	200	330	Mild Steel
Bake Hardenable	180	350	Mild Steel
Bake Hardenable	190	360	Mild Steel
Bake Hardenable 210	210	370	**Medium HSS**
HSLA/BH250	250	340	**Medium HSS**
HSLA 340	340	440	**Conventional HSS**
Dual Phase 600	370	600	**Advanced HSS**
Dual Phase 980	500	980	**Advanced HSS**
Boron and Martensitic	900 to 1300	1000 to 1500	**Advanced HSS**

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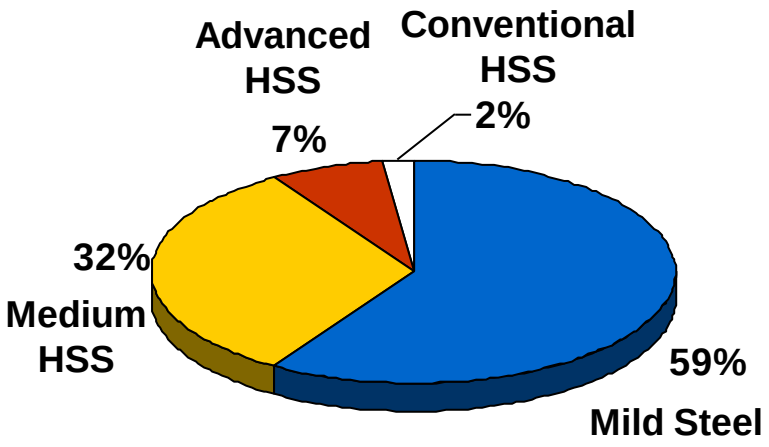
APPENDIX I

- High strength steel, defined as steel with a yield strength of 210 MPa or greater, will represent over 400 pounds of material content in the light vehicles to be produced in North America in 2006
- This estimate is based on a sample of 5.7 million vehicles or 37 percent of the expected light vehicle production for 2006
- The majority (77 percent) of the HSS use will be for body, frame and closure components. High strength steels are also used for bumpers and bumper beams, wheels, control arms, stabilizer bars, springs and seat components
- Over 70 percent of the steel used for bodies, frames and closures is coated with zinc for corrosion protection
- The average amount of steel contained in the BIW, frame and closures is close to 800 pounds per vehicle. 40% of the 800 pounds is high strength steel

The Pontiac G6 is Representative of GM's Current HSS Philosophy

2005
Pontiac G6



BIW 745 Pounds
Essentially 100%
HD or Electrogalvanized

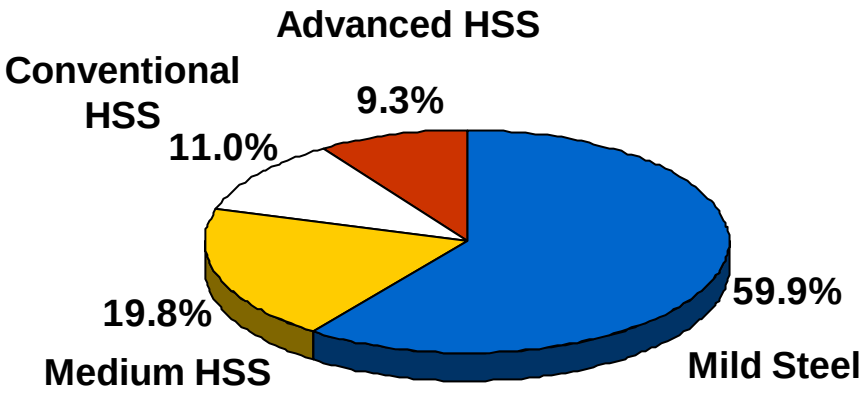
Steel Detail

AHSS	Duel Phase 590 UTS	51.3 lbs.
CHSS	CR 420 TYS	16.6 lbs.
Medium HSS	CR 340 TYS	25.2 lbs.
	HR 340 TYS	47.4 lbs.
	CR 300 TYS	23.3 lbs.
	CR 270 TYS	24.5 lbs.
	CR 210 TYS	115.5 lbs.
	Mild Steel	441.2 lbs.
	Total	745.0 lbs.

Source: GM

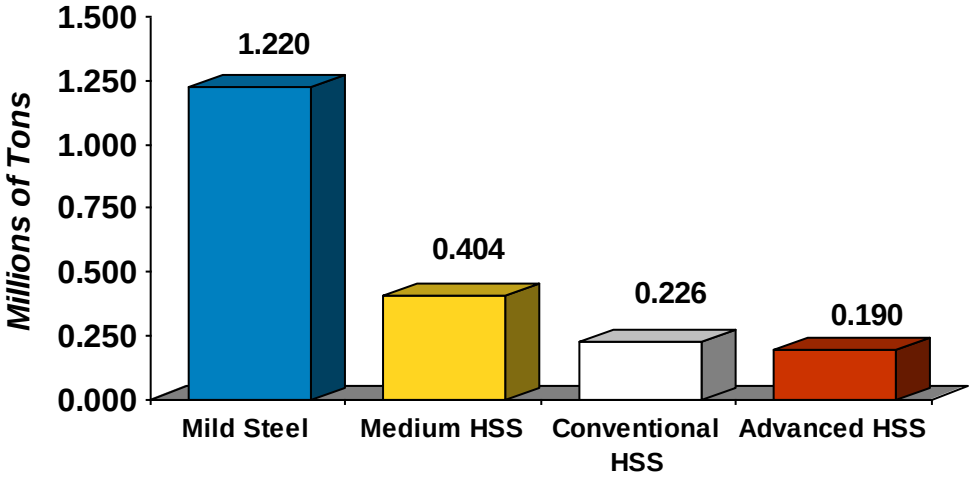
2006 BIW with Closures Steel Content by Type

5.7 Million Vehicle Sample



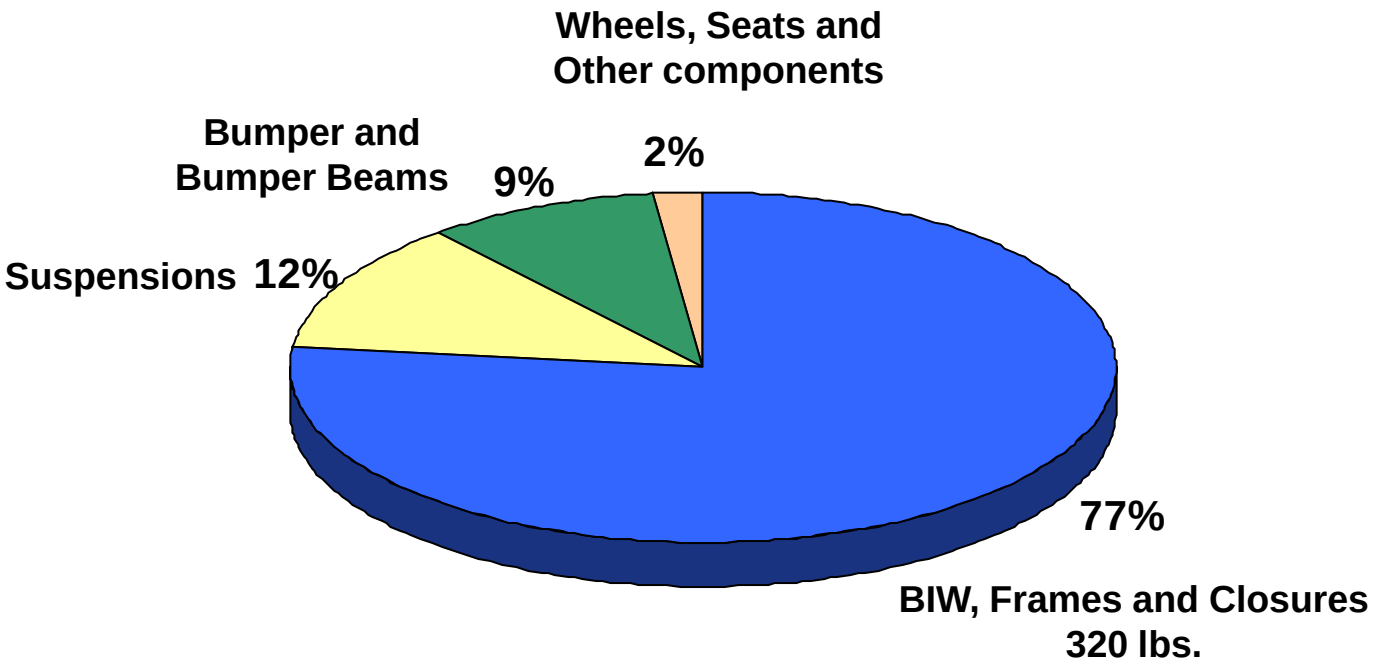
788 Pounds per Vehicle

Steel content in Millions of Tons for the 2006 BIW & Closure Sample



2.04 Million Metric Tons in Total

2006 High Strength Steel Content Per Light Vehicle



Total = 415 Pounds Per Vehicle

Note: This estimate is not directly comparable with estimates used by Ward's and the American Metal Market. Those estimates of material content use a slightly different and broader definition of HSS.

APPENDIX I

- The vehicles in the sample that contained more than 200 pounds of high strength steel are ranked from highest to lowest in the bar chart on the next page. The next Lambda and Delta platforms for GM are also shown under future vehicles on this chart
- Of the vehicles studied, the Ford F-150 Super Cab truck with styled steel wheels contains over 1,000 pounds of HSS, by our definition. 648 pounds of HSS is contained in the body, frame and closures. The majority of this HSS is medium HSS with yield strengths in the range of 225 MPa to 300 MPa. The use of advanced HSS on the F150; however, is zero.
- The AHSS leader, based on our 38 vehicle sample, is the Honda Ridgeline at 190 pounds of AHSS content not including the bumper beams and any suspension components

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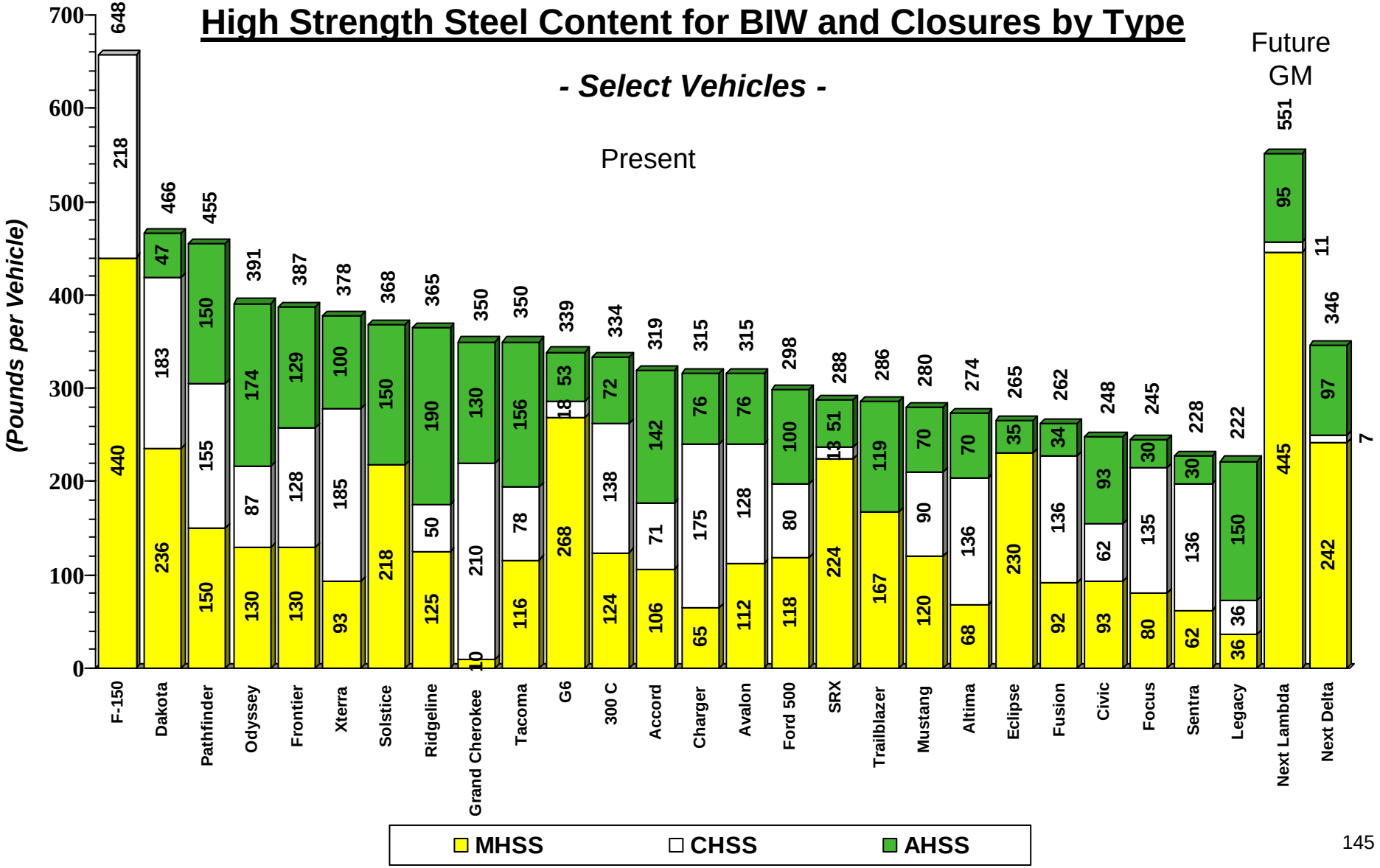
APPENDIX I



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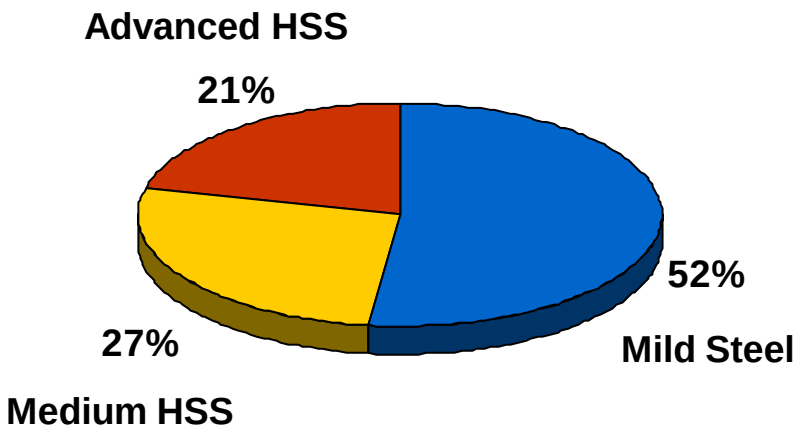
APPENDIX I

- No matter which way we look at the rankings, the foreign domestic manufacturers show a higher penetration of high strength steel than the “Big 3”, particularly GM. Chrysler is the high strength leader for the ‘Big 3”
- Conventional and advanced high strength steel will represent 20 percent of all steel content for bodies, frames and closures in 2006. Chrysler, Honda, Toyota and Nissan will all be at about 30 percent, Ford will be at 27 percent, Subaru will be at 25 percent; but at only 6 percent, GM brings the 2006 sample down to 20 percent
- We expect GM to increase their use of AHSS significantly over the next five years, but GM will lag the other OEMs for the remainder of the decade. The Trailblazer is a good example of where GM is headed with 21 percent of body using Duel Phase and Martensitic steels, but most new vehicles at GM will have AHSS and conventional HSS contents closer to 15 percent than to 30 percent

Future BIW Steel Content by Type at GM

GMT 361 Trailblazer



BIW 552 Pounds
Essentially 100% Hot Dip or Electrogalvanized

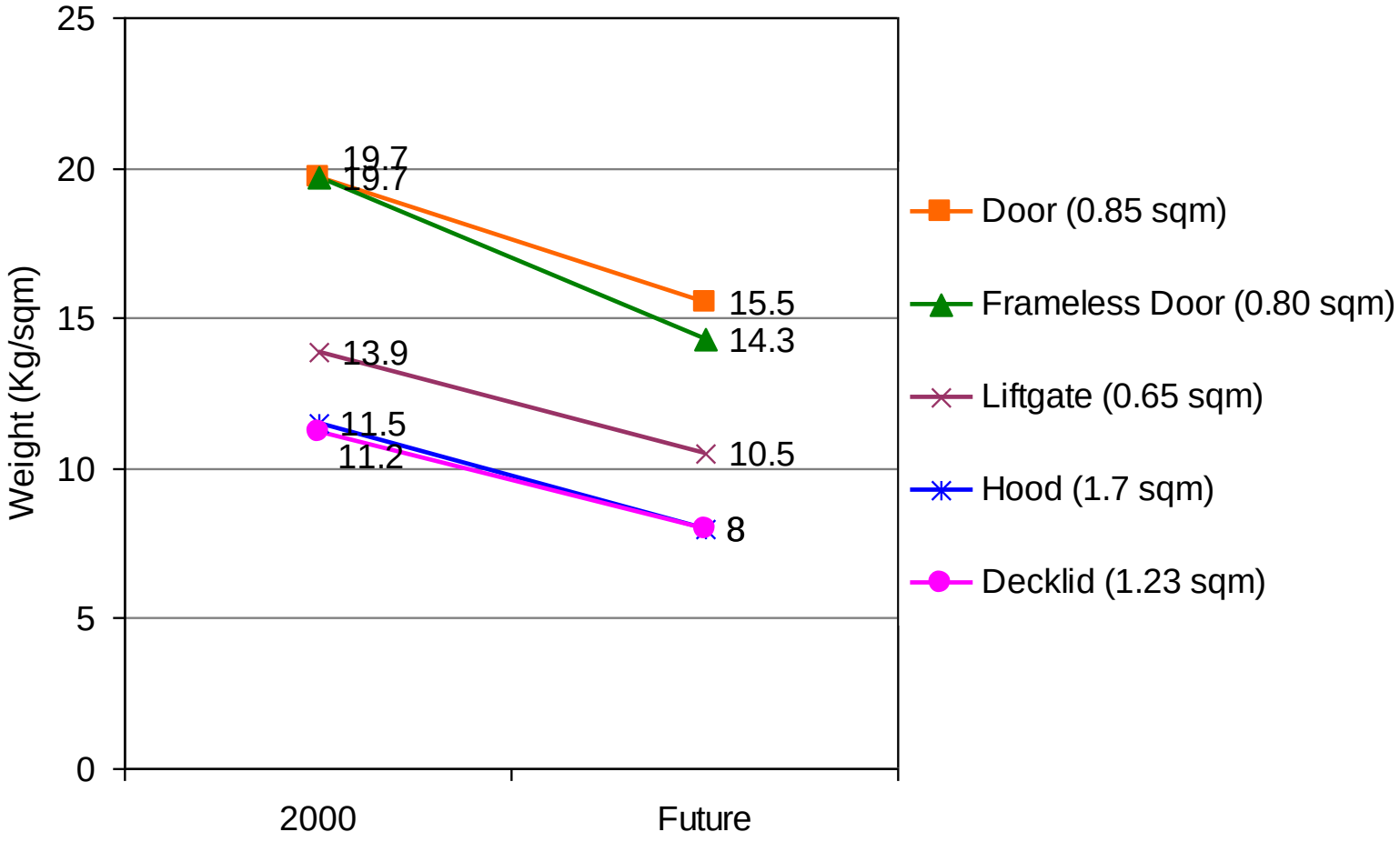
Steel Detail

AHSS	CR 980 UTS D Phase	5.9 lbs.
	CR 900 Martensitic	42.8 lbs.
	CR 780 UTS D Phase	23.4 lbs.
	CR 590 UTS D P	45.8 lbs.
Medium HSS	CR 340 TYS HSLA	22.7 lbs.
	CR 300 TYS HSLA	51.6 lbs.
	CR 270 TYS HSLA	7.2 lbs.
	CR 210 TYS BH	65.8 lbs.
	Mild Steel	287.0 lbs.
	Total	552.0 lbs.

Source: GM

Current and Future Steel Closure Weight (Based on ULSAC Report)

High Strength Steel is a formidable low cost competitor for aluminum



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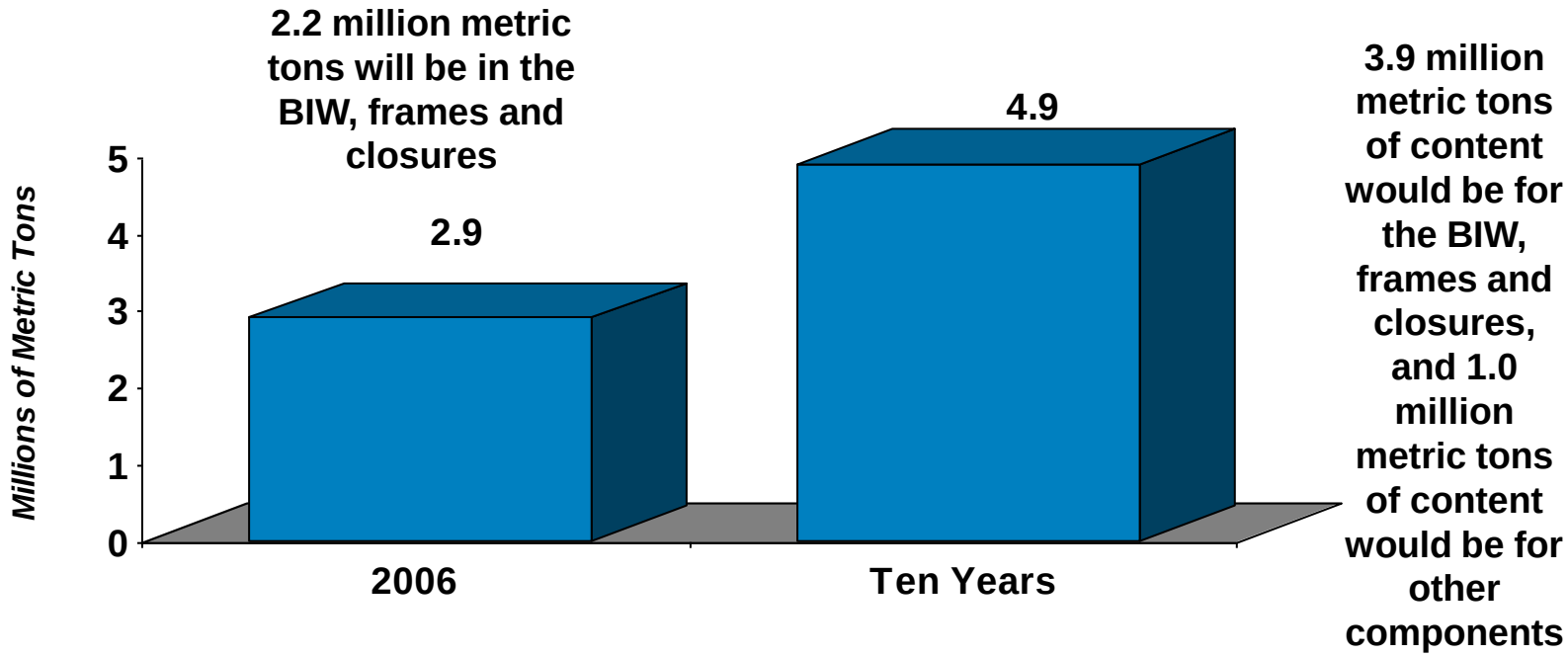
APPENDIX I

- Based on our sample and the expected production light of vehicles for 2006, high strength steel content for light vehicles will be 2.9 million metric tons for all components in 2006. BIW, frames and closures will be 2.2 million metric tons
- Over the next ten years we expect the 2.9 million tons of content to grow as much as 200,000 tons per year reaching 4.9 million metric tons or more in ten years
- On pages 150 we show HSS expected changes in 2008 for BIW, frames and closures by OEM. On page 151 we show expected changes over the next ten years for BIW, frames and closures by type of steel. These are Ducker Research forecasts based on our overall discussions with various OEMs and a review of published sources

2006 High Strength Steel Content for Light Vehicles in North America

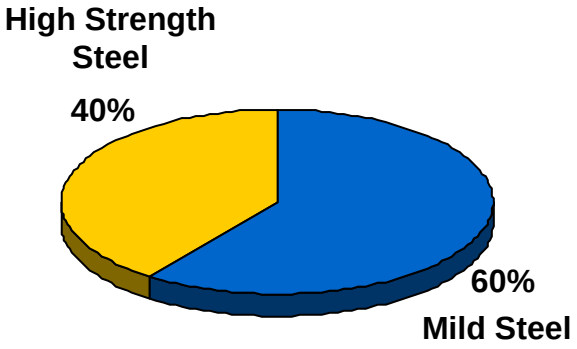
- All Components -



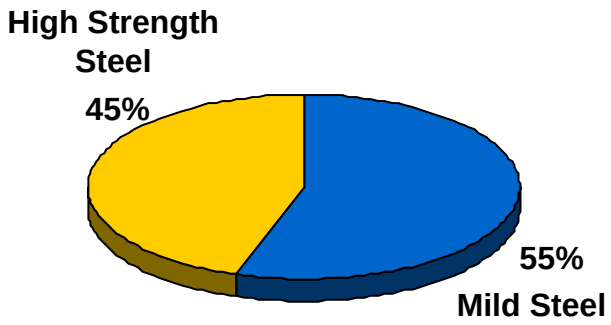
Actual shipments of HSS would be much higher due to engineered and other forms of scrap

BIW with Closures in 2008

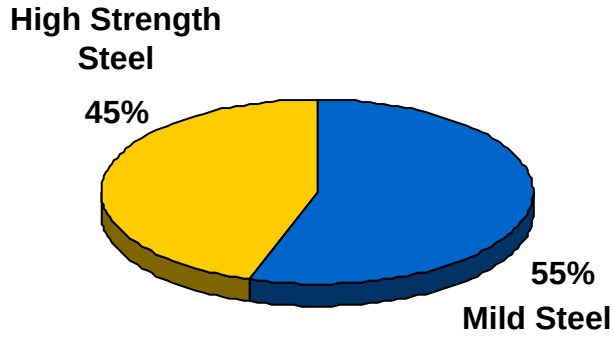
General Motors



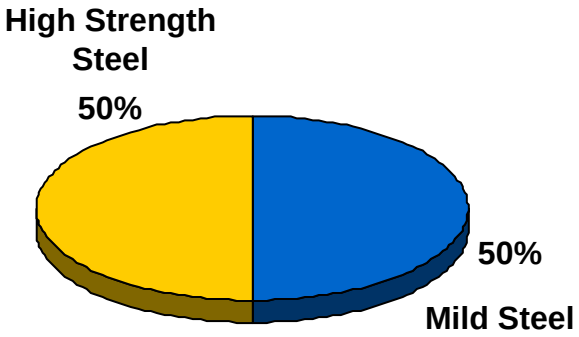
Ford



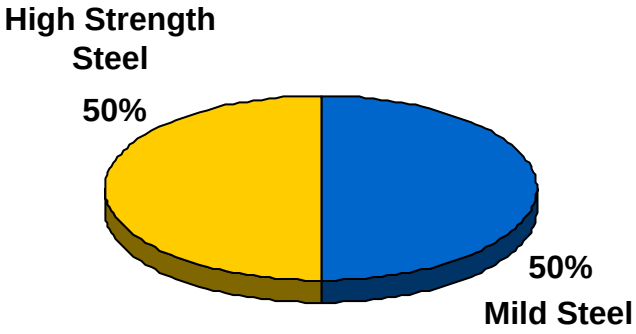
Chrysler



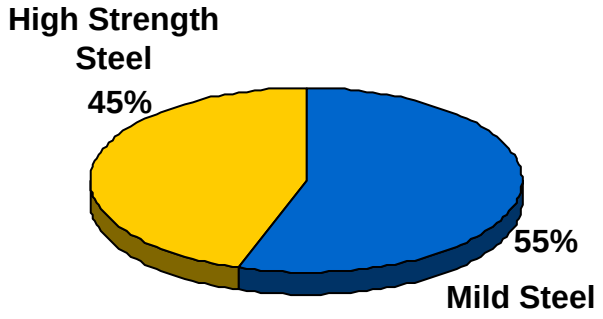
Toyota



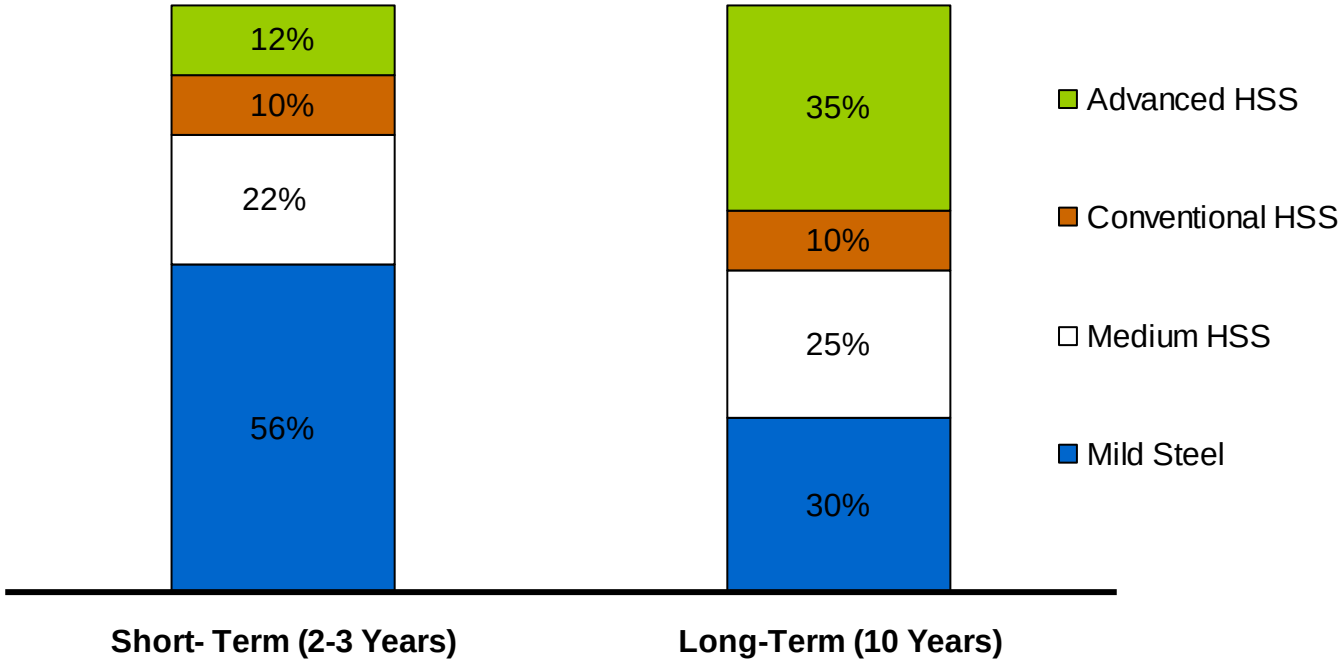
Honda



Nissan



Light Vehicle Steel Trends - BIW, Frame and Closures



Source: Ducker Research Forecast

APPENDIX II
ALUMINUM DATABASE EXAMPLE

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APPENDIX II
Aluminum Database Example

Engine: Manufacturer	Engine: Plant	Engine: Program	Engine: Model	CY2006	Block: 2006 Total Weight	Head:2006 Total Weight	Typical Vehicle
Cummins	Columbus, IN	ISB	6.7L 24v ohv L6	0	x	x	Dodge Ram Pickup [DS]
Cummins	Columbus, IN	PEGASUS	5.9L 24v ohv L6	120,420	x	x	Dodge Ram Pickup [DR/DE]
Cummins	Rocky Mount, NC	1SB	3.9L 8v ohv L4	1,860	x	x	Ford F-Series Super Duty [P131], Ford F-Series Super Duty [P356]
DaimlerChrysler	Connor Avenue, MI	EWC	8.3L 20v ohv V10	6,777	677700	474390	Dodge Durango [HB], Dodge Ram Pickup [DR/DE], Dodge Viper [ZB]
DaimlerChrysler	Connor Avenue, MI	EWC-MAJOR	8.4L 20v ohv V10	0	0	0	Dodge Durango [HB], Dodge Ram Pickup [DR/DE], Dodge Viper [ZB]
DaimlerChrysler	Kenosha, WI	EER	2.7L 24v dohc V6	116,009	7656594	5800450	Chrysler 300/300C [LX48], Chrysler Sebring Convertible [JR27], Chrysler Sebring Sedan [JS41], Dodge Stratus Sedan [JR41]
DaimlerChrysler	Kenosha, WI	EGG	3.5L 24v sohc V6	144,477	9535482	7223850	Chrysler 300/300C [LX48], Chrysler Pacifica [CS], Dodge Magnum [LX49]
DaimlerChrysler	Kenosha, WI	EPH	4.0L 12v ohv L6	35,223	x	x	Jeep Wrangler/Wrangler Unlimited [TJ]
DaimlerChrysler	Kenosha, WI	WORLD V6 3.2	3.2L 24v dohc V6	0	0	0	Chrysler 300/300C [LY48], Dodge Magnum [LY49]
DaimlerChrysler	Kenosha, WI	WORLD V6 4.1	4.1L 24v dohc V6	0	0	0	Chrysler 300/300C [LY48], Dodge Charger [LY48], Dodge Magnum [LY49]
DaimlerChrysler	Mack Avenue	EKG	3.7L 12v sohc V6	388,767	x	19438350	Dodge Dakota [ND], Dodge Nitro [KA], Dodge Ram Pickup [DS], Jeep Grand Cherokee [WK], Jeep Liberty [KJ]
DaimlerChrysler	Mack Avenue	EVA	4.7L 16v sohc V8	0	x	0	Jeep Grand Cherokee [WG]
DaimlerChrysler	Mack Avenue	EVA, EVC	4.7L 16v sohc V8	327,142	x	19628520	Dodge Dakota [ND], Dodge Durango [HB], Dodge Ram Pickup [DR/DE], Jeep Grand Cherokee [WK]
DaimlerChrysler	Mack Avenue	EVB - MDS	4.7L 16v sohc V8	0	x	x	Dodge Dakota [ND], Dodge Durango [HC], Dodge Ram Pickup [DS],Jeep Grand Cherokee [WK(2)]
DaimlerChrysler	Mack Avenue	MODULAR	3.7L 12v sohc V6	61	x	3050	Jeep Grand Cherokee [WG]
DaimlerChrysler	Mack Avenue	MODULAR	4.7L 16v sohc V8	22	x	1320	Jeep Grand Cherokee [WG]
DaimlerChrysler	Saltillo	ECB	2.4L 16v dohc L4	7,106	312664	213180	Chrysler Voyager [RG]
DaimlerChrysler	Saltillo	ECC	2.0L 16v dohc L4	0	0	0	Dodge Stratus Sedan [JR41]
DaimlerChrysler	Saltillo	EDV	2.4L 16v dohc L4	29,906	1315864	897180	Chrysler PT Cruiser [PT44], Chrysler Sebring Sedan [JR41], Dodge Neon [NPL], Dodge Stratus Sedan [JR41]
DaimlerChrysler	Saltillo	EDZ	2.4L 16v dohc L4	193,260	x	5797800	Chrysler PT Cruiser [PT44], Chrysler Sebring Sedan [JR41], Dodge Stratus Sedan [JR41]
DaimlerChrysler	Saltillo	EZA	5.7L 16v ohv V8	0	x	0	Dodge Durango [HB], Dodge Ram Pickup [DR/DE]
DaimlerChrysler	Saltillo	EZB - MDS	5.7L 16v ohv V8	473,537	x	28412220	Chrysler 300/300C [LX48], Dodge Charger [LX48], Dodge Ram Pickup [DR/DE], Jeep Grand Cherokee [WK]
DaimlerChrysler	Saltillo	HEMI V8	6.1L 16v ohv V8	21,854	x	1311240	Chrysler 300/300C [LX48], Dodge Charger [LX48]
DaimlerChrysler	Trenton, MI	ECB	2.0L 16v sohc L4	2,549	x	76470	Dodge Neon [NPL]
DaimlerChrysler	Trenton, MI	EGA-MAJOR	3.3L 12v ohv V6	239,364	x	11968200	Chrysler Town & Country [RS], Dodge Caravan [RS]
DaimlerChrysler	Trenton, MI	EGA-MAJORII	3.3L 12v ohv V6	0	x	0	Chrysler Town & Country [RT], Dodge Caravan [RT]
DaimlerChrysler	Trenton, MI	EGG	4.0L 24v sohc V6	0	0	0	Chrysler Pacifica [CT], Chrysler Town & Country [RT], Dodge Caravan [RT]
DaimlerChrysler	Trenton, MI	EGH-MAJOR	3.8L 12v ohv V6	230,305	x	11515250	Chrysler Pacifica [CS], Chrysler Town & Country [RS], Chrysler Voyager [RT], Dodge Caravan [RS]
DaimlerChrysler	Trenton, MI	EGH-MAJORII	3.8L 12v ohv V6	0	x	x	Chrysler Town & Country [RT], Dodge Caravan [RT]
DaimlerChrysler	Trenton, MI	EGH-MAJORII	3.9L 12v ohv V6	40,350	x	x	Jeep Wrangler/Wrangler Unlimited [JK]
Ford	Chihuahua #2	DURATEC HE	2.0L 16v dohc L4	122,909	5407996	3687270	Ford Ecosport [BV226], Ford Focus [C170]
Ford	Chihuahua #2	DURATEC HE	2.3L 16v dohc L4	181,248	7974912	5437440	Ford Escape [U204], Mazda 6 [J56J]
Ford	Chihuahua #2	DURATEC HE	2.5L 16v dohc L4	0	0	0	Ford Fusion [D338], Mazda 6 [J61]
Ford	Cleveland, OH #1	99S	3.0L 24v dohc V6	138,029	9109914	6901450	Ford Five Hundred [D258], Ford Freestyle [D219], Mercury Montego [D333]
Ford	Cleveland, OH #1	CYCLONE V6	3.5L 24v dohc V6	84,175	5555550	4208750	Ford Five Hundred [D258], Ford Fusion [D338], Mazda 6 [J61]
Ford	Cleveland, OH #2	99S	3.0L 24v dohc V6	400,125	26408250	20006250	Ford Escape [U204], Mazda Tribute [J14C], Mercury Mariner [U364]
Ford	Cleveland, OH #2	AJ-DE	3.0L 24v dohc V6	32,773	2163018	1638650	Mazda MPV [J16R], Mazda MPV [J44A]
Ford	Cleveland, OH #2	AJV6	2.1L 24v dohc V6	4,012	264792	200600	Jaguar X-Type [X400]
Ford	Cleveland, OH #2	AJV6	2.5L 24v dohc V6	4,117	271722	205850	Jaguar S-Type [X200], Jaguar X-Type [X400]
Ford	Cleveland, OH #2	AJV6	3.0L 24v dohc V6	30,857	2036562	1542850	Jaguar S-Type [X200], Jaguar X-Type [X400]
Ford	Cleveland, OH #2	DURATEC 2.5	2.5L 24v dohc V6	4,635	305910	231750	Ford Mondeo [CD132]
Ford	Cleveland, OH #2	DURATEC 3.0	3.0L 24v dohc V6	3,883	256278	194150	Ford Mondeo [CD132]
Ford	Cleveland, OH #2	DURATEC 6.0	5.9L 48v dohc	912	91200	63840	Lincoln Navigator [U326]
Ford	Dearborn, MI	DURATEC HE	1.8L 16v dohc L4	0	0	0	Ford Mini Car [B410]
Ford	Dearborn, MI	DURATEC HE	2.0L 16v dohc L4	76,249	3354956	2287470	Ford Focus [C170]
Ford	Dearborn, MI	DURATEC HE	2.3L 16v dohc L4	29,959	1318196	898770	Ford Ranger [PN105-150]
Ford	Essex, Ontario	992	4.2L 12v ohv V6	128,276	x	6413800	Ford F-Series [P221], Ford Freestar [V229]
Ford	Essex, Ontario	99L	5.4L 24v sohc V8	80,343	x	4820580	Ford Expedition [U222], Lincoln Navigator [U228]
Ford	Essex, Ontario	ESSEX	3.9L 12v ohv V6	44,696	2949936	2234800	Ford Freestar [V229]
Ford	Lima, OH	99U	3.0L 12v ohv V6	103,585	x	x	Ford Ranger [PN105-150], Ford Taurus [D186]

DUCKER worldwide

APPENDIX II
Aluminum Database Example

Engine: Manufacturer	Engine: Plant	Engine: Program	Engine: Model	CY2006	Block: 2006 Total Weight	Head:2006 Total Weight	Typical Vehicle
Ford	Lima, OH	AJ41	3.9L 32v dohc V8	17,023	1498024	1021380	Ford Thunderbird [M205], Lincoln LS [DEW98]
Ford	Lima, OH	B8444S	4.4L 32v dohc V8	0	0	0	Ford Five Hundred [D258], Lincoln Fullsize Sedan [E386], Lincoln Midsize Sedan [D385]
Ford	Lima, OH	CYCLONE V6	3.5L 24v dohc V6	19,072	1258752	953600	Ford Midsize CUV [U387], Ford Midsize MAV [D471]
Ford	Lima, OH	CYCLONE V6	4.1L 24v dohc V6	0	0	0	Ford Explorer [U251], Ford Mustang [S197], Ford Ranger [P375]
Ford	Romeo, MI	99S, 99W	4.6L 16v sohc V8	332,660	x	19959600	Ford Crown Victoria [EN53-114], Ford F-Series [P221], Mercury Grand Marquis [EN53-114]
Ford	Romeo, MI	99S, 99W	4.6L 24v sohc V8	181,174	x	10870440	Ford Explorer [U251], Ford Mustang [S197]
Ford	Romeo, MI	99L	5.4L 16v sohc V8	0	0	0	Ford Econoline [VN127]
Ford	Romeo, MI	99L	5.4L 24v sohc V8	9,255	814440	555300	Ford F-Series [P415], Ford Mustang [S197]
Ford	Romeo, MI	99L	5.4L 32v dohc V8	893	78584	53580	Ford GT [S361]
Ford	Romeo, MI	99V	4.6L 32v dohc V8	0	x	0	Lincoln Aviator [U231]
Ford	Romeo, MI	DURATEC HE	2.3L 16v dohc L4	1,400	61600	42000	Ford Ranger [PN105SA]
Ford	Windsor, Ontario #2	99L	5.4L 16v sohc V8	79,407	x	4764420	Ford Econoline [VN127]
Ford	Windsor, Ontario #2	99L	5.4L 24v sohc V8	634,647	x	38078820	Ford Expedition [U222], Ford F-Series [P221], Ford SuperCrew [P221]
Ford	Windsor, Ontario #2	99S	6.8L 20v sohc	431	x	28015	Ford Econoline [VN127]
Ford	Windsor, Ontario #2	99S	6.8L 30v sohc	55,100	x	3581500	Ford Econoline [VN127], Ford F-Series Super Duty [P131]
Ford	Windsor, Ontario #2	DRAGON	5.7L 24v sohc V8	0	x	0	Ford Expedition [U324]
Fuji Heavy	Lafayette, IN	EJ25	2.5L 16v dohc H4	85,508	3762352	2565240	Subaru B9 Tribeca [00X], Subaru Legacy [21Z]
Fuji Heavy	Lafayette, IN	EZ30	3.0L 24v dohc H6	58,203	3841398	2910150	Subaru B9 Tribeca [00X], Subaru Legacy [21Z]
General Motors	Flint, MI #1	L26	3.8L 12v ohv V6	111,496	x	x	Buick Lucerne [GMX222]
General Motors	Flint, MI #1	L36	3.8L 12v ohv V6	172,422	x	x	Buick LaCrosse [GMX365], Pontiac Grand Prix [GMX367]
General Motors	Flint, MI #1	L67	3.8L 12v ohv V6	0	x	x	Chevrolet Impala [GMX210]
General Motors	Flint, MI #2	LL8	4.2L 24v dohc L6	301,323	19887318	15066150	Chevrolet Trailblazer [GMT360], GMC Envoy [GMT360]
General Motors	Flint, MI #2	LL8-MAJOR	4.4L 24v dohc L6	0	0	0	Chevrolet Trailblazer [GMT361]
General Motors	Flint, MI #2	LY7	3.6L 24v dohc V6	34,266	x	1713300	Buick Rendezvous [GMT967], GMC Acadia [GMT968]
General Motors	Flint, MI #3	V DIESEL	3.4L 32v dohc V6	0	x	0	Cadillac STS [GMX295(2)]
General Motors	Flint, MI #3	V DIESEL	4.5L 32v dohc V8	0	x	0	Chevrolet Silverado [GMT901]
General Motors	Livonia, MI	L37	4.6L 32v dohc V8	94,110	9222780	6587700	Cadillac DTS [GMX272]
General Motors	Livonia, MI	LD8, L37	4.6L 32v dohc V8	2,511	246078	175770	Cadillac DeVille [GMX270]
General Motors	Livonia, MI	LH2	4.6L 32v dohc V8	13,268	1300264	928760	Cadillac SRX [GMT265]
General Motors	Livonia, MI	LT8	4.6L 32v dohc V8	0	0	0	Chevrolet Impala [GMX211]
General Motors	Moraine, OH #2	LB7	6.6L 32v ohv V8	162,187	x	x	Chevrolet Silverado [GMT800], Chevrolet Silverado [GMT880]
General Motors	Ramos Arizpe	LA1	3.4L 12v ohv V6	0	x	0	Buick Rendezvous [GMT257]
General Motors	Ramos Arizpe	LX9	3.5L 12v ohv V6	261,883	x	13094150	Chevrolet Malibu/Malibu Maxx [GMX380], Chevrolet Uplander [GMT201]
General Motors	Ramos Arizpe	LZ3	3.5L 12v ohv V6	130,310	x	6515500	Chevrolet Monte Carlo [GMX231], Chevrolet Impala [GMX211]
General Motors	Ramos Arizpe	LZ4	3.5L 12v ohv V6	26,818	x	1340900	Chevrolet Uplander [GMT201]
General Motors	Ramos Arizpe	LZ8	3.9L 12v ohv V6	49,108	x	2455400	Chevrolet Malibu/Malibu Maxx [GMX380]
General Motors	Romulus, MI	L59 - GEN III CI	5.3L 16v ohv V8	117,568	x	7054080	Chevrolet Silverado [GMT800], Chevrolet Tahoe [GMT820]
General Motors	Romulus, MI	L76 - GEN IV AI DoD	6.0L 16v ohv V8	32,010	2816880	1920600	Chevrolet Silverado [GMT901], Holden Commodore [VE]
General Motors	Romulus, MI	L92 - GEN IV AI DoD	6.2L 16v ohv V8	37,996	3343648	2279760	Cadillac Escalade [GMT926]
General Motors	Romulus, MI	LC9 - GEN IV AI DoD	5.3L 16v ohv V8	21,081	1855128	1264860	Chevrolet Silverado [GMT901]
General Motors	Romulus, MI	LF6, L35, LU3	4.3L 12v ohv V6	66,927	x	x	Chevrolet Astro [M-VAN], Chevrolet Silverado [GMT800]
General Motors	Romulus, MI	LH6 - GEN IV AI DoD	5.3L 16v ohv V8	1,868	164384	112080	Chevrolet Trailblazer EXT [GMT370]
General Motors	Romulus, MI	LH6 - GEN IV AI DoD	5.3L 16v ohv V8	62,396	5490848	3743760	Saab 9-7X [GMT360]
General Motors	Romulus, MI	LM4 - GEN III AI	5.3L 16v ohv V8	19,041	1675608	1142460	GMC Envoy XL [GMT370]
General Motors	Romulus, MI	LM7 - GEN III CI	5.3L 16v ohv V8	196,619	x	11797140	Chevrolet Silverado [GMT800], Chevrolet Van/Express [GMT610]
General Motors	Romulus, MI	LM7, L59	5.3L 16v ohv V8	612	x	36720	Chevrolet Tahoe [GMT820]
General Motors	Romulus, MI	LMF - GEN IV CI	5.3L 16v ohv V8	0	x	0	Chevrolet Van/Express [GMT610]
General Motors	Romulus, MI	LMG - GEN IV CI DoD	5.3L 16v ohv V8	24,616	x	1476960	Chevrolet Avalanche [GMT941]
General Motors	Romulus, MI	LQ4 - GEN III CI	6.0L 16v ohv V8	175,220	x	10513200	Chevrolet Silverado [GMT800], GMC Sierra [GMT800]
General Motors	Romulus, MI	LQ9 - GEN III CI	6.0L 16v ohv V8	6,977	x	418620	Cadillac Escalade ESV [GMT830]

DUCKER worldwide

APPENDIX II
Aluminum Database Example

Engine: Manufacturer	Engine: Plant	Engine: Program	Engine: Model	CY2006	Block: 2006 Total Weight	Head:2006 Total Weight	Typical Vehicle
General Motors	Romulus, MI	LR4 - GEN III CI	4.8L 16v ohv V8	139,342	x	8360520	Chevrolet Silverado [GMT800]
General Motors	Romulus, MI	LR4-GEN IV	4.8L 16v ohv V8	68	x	4080	Chevrolet Tahoe [GMT820]
General Motors	Romulus, MI	LS2 - GEN IV AI	6.0L 16v ohv V8	7,749	681912	464940	Cadillac CTS [GMX320]
General Motors	Romulus, MI	LY2 - GEN IV CI	4.8L 16v ohv V8	4,179	x	250740	Chevrolet Silverado [GMT901]
General Motors	Romulus, MI	LY5 - GEN IV CI DoD	5.3L 16v ohv V8	20,829	x	1249740	Chevrolet Avalanche [GMT941]
General Motors	Romulus, MI	LY6 - GEN IV CI	6.0L 16v ohv V8	27,748	x	1664880	Chevrolet Suburban [GMT931]
General Motors	Silao	L59 - GEN III CI	5.3L 16v ohv V8	29,861	x	1791660	Chevrolet Avalanche [GMT805], Chevrolet Suburban [GMT830]
General Motors	Silao	LC9 - GEN IV AI DoD	5.3L 16v ohv V8	32,189	2832632	1931340	Chevrolet Suburban [GMT931]
General Motors	Silao	LH6 - GEN IV AI DoD	5.3L 16v ohv V8	26,467	2329096	1588020	Chevrolet Suburban [GMT931]
General Motors	Silao	LM7 - GEN III CI	5.3L 16v ohv V8	24,293	x	1457580	Chevrolet Avalanche [GMT805], Chevrolet Suburban [GMT830]
General Motors	Silao	LMG - GEN IV CI DoD	5.3L 16v ohv V8	93,580	x	5614800	Chevrolet Tahoe [GMT921], GMC Yukon [GMT922]
General Motors	Silao	LY5 - GEN IV CI DoD	5.3L 16v ohv V8	39,955	x	2397300	Chevrolet Tahoe [GMT921], GMC Yukon [GMT922]
General Motors	Spring Hill, TN	L61	2.2L 16v dohc L4	66,427	2922788	1992810	Saturn Ion [GMX357]
General Motors	Spring Hill, TN	L850	2.0L 16v dohc L4	0	0	0	Cadillac BLS [EPSILON(2)]
General Motors	Spring Hill, TN	LE5	2.4L 16v dohc L4	233,465	10272460	7003950	Chevrolet HHR [GMT001], Pontiac G6 [GMX381]
General Motors	Spring Hill, TN	LNF	2.0L 16v dohc L4	3,220	141680	96600	Saturn Ion [GMX002]
General Motors	St. Catherines,	ELECTRON6	2.8L 24v dohc V6	0	0	0	Cadillac BLS [EPSILON(2)]
General Motors	St. Catherines,	L59 - GEN III CI	5.3L 16v ohv V8	3,517	x	211020	Chevrolet Suburban [GMT830]
General Motors	St. Catherines,	LC9 - GEN IV AI DoD	5.3L 16v ohv V8	27,784	2444992	1667040	Chevrolet Suburban [GMT931]
General Motors	St. Catherines,	LH6 - GEN IV AI DoD	5.3L 16v ohv V8	22,845	2010360	1370700	Chevrolet Suburban [GMT931]
General Motors	St. Catherines,	LM7 - GEN III CI	5.3L 16v ohv V8	64,762	x	3885720	GMC Sierra [GMT800]
General Motors	St. Catherines,	LMG - GEN IV CI DoD	5.3L 16v ohv V8	89,960	x	5397600	Chevrolet Tahoe [GMT921]
General Motors	St. Catherines,	LP1	2.8L 24v dohc V6	13,837	913242	691850	Cadillac CTS [GMX320]
General Motors	St. Catherines,	LQ4	6.0L 16v ohv V8	297	x	17820	Hummer H2 [H2]
General Motors	St. Catherines,	LQ4 - GEN III CI	6.0L 16v ohv V8	37,488	x	2249280	Chevrolet Silverado [GMT880]
General Motors	St. Catherines,	LQ9 - GEN III CI	6.0L 16v ohv V8	0	x	0	Cadillac Escalade [GMT825C]
General Motors	St. Catherines,	LR4 - GEN III CI	4.8L 16v ohv V8	67,951	x	4077060	Chevrolet Silverado [GMT800]
General Motors	St. Catherines,	LS1 - GEN III AI	5.7L 16v ohv V8	12,081	1063128	724860	Holden Commodore [VY]
General Motors	St. Catherines,	LS2 - GEN IV AI	6.0L 16v ohv V8	67,441	5934808	4046460	Chevrolet Corvette [GMX245]
General Motors	St. Catherines,	LS4 - GEN IV AI DoD	5.3L 16v ohv V8	121,214	10666832	7272840	Chevrolet Impala [GMX211], Chevrolet Monte Carlo [GMX231], Pontiac Grand Prix [GMX367]
General Motors	St. Catherines,	LS6 - GEN III AI	5.7L 16v ohv V8	0	0	0	Cadillac CTS [GMX320]
General Motors	St. Catherines,	LY2 - GEN IV CI	4.8L 16v ohv V8	761	x	45660	Chevrolet Silverado [GMT901]
General Motors	St. Catherines,	LY5 - GEN IV CI DoD	5.3L 16v ohv V8	34,585	x	2075100	Chevrolet Tahoe [GMT921]
General Motors	St. Catherines,	LY7	3.6L 24v dohc V6	134,113	x	6705650	Buick LaCrosse [GMX365], Cadillac CTS [GMX320], Cadillac SRX [GMT265], Cadillac STS [GMX295]
General Motors	Toluca	FAMILY I DOHC	1.6L 16v dohc L4	25,824	x	774720	Chevrolet Monza [GM4200], Chevrolet Swing/Joy [GM4200]
General Motors	Tonawanda, NY	L52	3.5L 20v dohc L5	86,145	5168700	3876525	Chevrolet Colorado [GMT355], Hummer H3 [GMT345]
General Motors	Tonawanda, NY	L52-MAJOR	3.8L 20v dohc L5	58,751	3525060	2643795	Chevrolet Colorado [GMT355(2)]
General Motors	Tonawanda, NY	L61	2.2L 16v dohc L4	315,073	13863212	9452190	Chevrolet Cobalt [GMX001]
General Motors	Tonawanda, NY	L850	2.0L 16v dohc L4	75,531	3323364	2265930	Saab 9-3 [SB440]
General Motors	Tonawanda, NY	L850	2.2L 16v dohc L4	43,863	1929972	1315890	Opel Vectra [GM3200], Opel Zafira [GME A3370]
General Motors	Tonawanda, NY	LA1	3.4L 12v ohv V6	0	x	0	Chevrolet Impala [GMX210]
General Motors	Tonawanda, NY	LF6, L35, LU3	4.3L 12v ohv V6	25,691	x	x	Chevrolet Silverado [GMT800]
General Motors	Tonawanda, NY	LK5	2.8L 16v dohc L4	34,688	1526272	1040640	Chevrolet Colorado [GMT355]
General Motors	Tonawanda, NY	LK5-MAJOR	3.0L 16v dohc L4	31,425	1382700	942750	Chevrolet Colorado [GMT355]
General Motors	Tonawanda, NY	LX9	3.5L 12v ohv V6	0	x	0	Pontiac G6 [GMX381]
General Motors	Tonawanda, NY	LZ5	3.5L 12v ohv V6	110,894	6653640	4990230	Pontiac G6 [GMX381]
General Motors	Tonawanda, NY	LZ8	3.9L 12v ohv V6	271,788	23917344	16307280	Chevrolet Impala [GMX211], Pontiac G6 [GMX381]
General Motors	Tonawanda, NY	MARK VII	8.1L 16v ohv V8	69,838	x	x	Chevrolet Silverado [GMT800], Chevrolet Silverado [GMT880]
General Motors	Tonawanda, NY	MARK VIII	8.2L 16v ohv V8	3,260	x	x	Chevrolet Silverado [GMT901], Chevrolet Silverado [GMT911]
General Motors	Wixom, MI	LC3	4.4L 32v dohc V8	4,020	393960	281400	Cadillac STS [GMX295]

APPENDIX II
Aluminum Database Example

Engine: Manufacturer	Engine: Plant	Engine: Program	Engine: Model	CY2006	Block: 2006 Total Weight	Head:2006 Total Weight	Typical Vehicle
General Motors	Wixom, MI	LS7 - GEN IV AI	7.0L 16v ohv V8	3,814	335632	228840	Chevrolet Corvette [GMX245]
General Motors	Wixom, MI	LTR	7.5L 48v dohc	253	22264	15180	Cadillac ULS [GMX276]
Global Engine	Dundee, MI	W4	2.0L 16v dohc L4	133,004	5320160	3325100	Dodge Caliber [PM49]
Global Engine	Dundee, MI	W4	2.4L 16v dohc L4	69,245	2769800	1731125	Dodge Dakota [ND], Mitsubishi Eclipse [PS24]
Hino	Marion, AK	HINO DIESEL	7.0L 32v dohc V8	0	x	0	Toyota Tundra [180L]
Honda	Anna, OH	D17A	1.7L 16v sohc L4	0	0	0	Honda Civic [CS]
Honda	Anna, OH	J30	3.0L 24v sohc V6	111,307	7346262	5565350	Honda Accord [UA]
Honda	Anna, OH	J30 - ICT	3.0L 24v sohc V6	23,518	1552188	1058310	Honda Accord [UA]
Honda	Anna, OH	J32	3.2L 24v sohc V6	109,294	7213404	5464700	Acura TL [GQ]
Honda	Anna, OH	J35	3.5L 24v sohc V6	173,356	11441496	8667800	Acura MDX [MD], Honda Ridgeline [VU], Saturn VUE [GMT315]
Honda	Anna, OH	J37	3.7L 24v sohc V6	19,341	1276506	967050	Acura MDX [DJ]
Honda	Anna, OH	J37 - ICT	3.7L 24v sohc V6	0	0	0	Honda Pilot [HP(2)], Honda Ridgeline [VU]
Honda	Anna, OH	K18	1.8L 16v sohc L4	307,038	12281520	7675950	Honda Civic [UH]
Honda	Anna, OH	K20A	2.0L 16v dohc L4	20,970	922680	629100	Acura EL [UH], Honda Civic [UH]
Honda	Anna, OH	K24	2.4L 16v dohc L4	284,421	12514524	8532630	Honda Accord [UA]
Honda	El Salto	K24	2.4L 16v dohc L4	43,620	1919280	1308600	Honda Accord [UA]
Honda	Lincoln, AL	J35	3.5L 24v sohc V6	280,262	18497292	14013100	Honda Odyssey [UM], Honda Pilot [HP]
Honda	Lincoln, AL	J35 - ICT	3.5L 24v sohc V6	116,256	7672896	5812800	Honda Odyssey [UM]
Honda	Lincoln, AL	J37 - ICT	3.7L 24v sohc V6	0	0	0	Honda Pilot [HP(2)]
Hyundai	Hope Hull, AL	G6-LAMBDA	3.3L 24v dohc V6	248,160	16378560	12408000	Hyundai Sonata [NF]
Hyundai	Hope Hull, AL	G6-LAMBDA	3.8L 24v dohc V6	0	0	0	Hyundai Azera [TG]
Hyundai	North Mexico	G6-LAMBDA	3.5L 24v dohc V6	0	0	0	Kia Midsize Pickup [HMP]
Hyundai	North Mexico	G8	4.5L 32v dohc V8	0	0	0	Hyundai Midsize Pickup [HMP], Kia Midsize Pickup [HMP]
International	Indianapolis, IN	VT	6.4L 32v ohv V8	79,212	x	x	Ford F-Series Super Duty [P356]
International	Indianapolis, IN	VT365	6.0L 32v ohv V8	229,931	x	x	Ford F-Series Super Duty [P131]
International	Melrose Park, IL	DT 466	7.6L 24v dohc L6	0	x	x	Ford F-Series Super Duty [P356]
Linamar	Gomez Palacio,	F4R	2.0L 16v dohc L4	13,094	576136	392820	Nissan Primastar [X83], Opel Vivaro [X83], Renault Trafic [X83]
Linamar	Gomez Palacio,	F9Q	1.9L 8v sohc L4	54,773	2410012	1643190	Nissan Primastar [X83], Opel Vivaro [X83], Renault Trafic [X83]
Renault/Nissan	Aguascalientes	GA16DNE	1.6L 16v dohc L4	49,459	2176196	1483770	Nissan Tsuru [GS]
Renault/Nissan	Aguascalientes	KA24	2.4L 12v sohc L4	30,384	1215360	850752	Nissan Hardbody [D21], Nissan TX-A Chassis [D21]
Renault/Nissan	Aguascalientes	KH18	1.8L 16v dohc L4	19,669	865436	590070	Nissan Platina [X11C]
Renault/Nissan	Aguascalientes	KH20	2.0L 16v dohc L4	48,158	2118952	1444740	Nissan Sentra [L32H]
Renault/Nissan	Aguascalientes	QG18DE	1.8L 16v dohc L4	79,407	x	2382210	Nissan Sentra [HS]
Renault/Nissan	Decherd, TN	QR20DE	2.0L 16v dohc L4	5,025	221100	150750	Nissan Primera [ED]
Renault/Nissan	Decherd, TN	QR25	2.5L 16v dohc L4	125,183	5508052	3755490	Nissan Altima [TK]
Renault/Nissan	Decherd, TN	QR25DE	2.5L 16v dohc L4	0	0	0	Nissan Primera [W39]
Renault/Nissan	Decherd, TN	QR25K	2.5L 16v dohc L4	101,014	4444616	3030420	Nissan Altima [L42A]
Renault/Nissan	Decherd, TN	VK56DE	5.6L 32v dohc V8	167,271	14719848	10036260	Nissan Armada [WZW], Nissan Titan [ZW]
Renault/Nissan	Decherd, TN	VK56K	5.6L 32v dohc V8	0	0	0	Nissan Titan [ZW]
Renault/Nissan	Decherd, TN	VQ35DE	3.5L 24v dohc V6	172,343	11374638	8617150	Nissan Altima [TK], Nissan Maxima [L41C], Nissan Quest [UL]
Renault/Nissan	Decherd, TN	VQ35K	3.5L 24v dohc V6	33,612	2218392	1680600	Nissan Altima [L42A], Nissan Maxima [L41C(2)]
Renault/Nissan	Decherd, TN	VQ40DE	4.0L 24v dohc V6	247,862	16358892	12393100	Nissan Frontier [H61B], Nissan Pathfinder [P61B], Nissan Xterra [N61B]
Toyota	Buffalo, WV	1TZ-FE	2.4L 16v dohc L4	0	0	0	Pontiac Vibe [152L], Toyota Corolla [150L]
Toyota	Buffalo, WV	2GR-FE	3.5L 24v dohc V6	0	0	0	Lexus RX350 [483X], Toyota Sienna [500X]
Toyota	Buffalo, WV	3MZ-FE	3.3L 24v dohc V6	242,016	15973056	12100800	Lexus RX330 [483N], Toyota Sienna [500N]
Toyota	Buffalo, WV	ZZ-FE	1.8L 16v dohc L4	219,712	9667328	6591360	Pontiac Vibe [329N], Toyota Corolla [330N]
Toyota	Buffalo, WV	ZZ-FE	2.0L 16v dohc L4	0	0	0	Pontiac Vibe [152L], Toyota Corolla [150L]
Toyota	Cambridge, Ontario	1TZ-FE	2.4L 16v dohc L4	0	0	0	Toyota Corolla [150L], Toyota Matrix [151L]
Toyota	Cambridge, Ontario	ZZ-FE	1.8L 16v dohc L4	212,848	9365312	6385440	Toyota Corolla [330N], Toyota Matrix [328N]
Toyota	Cambridge, Ontario	ZZ-FE	2.0L 16v dohc L4	0	0	0	Toyota Corolla [150L], Toyota Matrix [151L]

APPENDIX II
Aluminum Database Example

Engine: Manufacturer	Engine: Plant	Engine: Program	Engine: Model	CY2006	Block: 2006 Total Weight	Head:2006 Total Weight	Typical Vehicle
Toyota	Georgetown, KY	1FZ-FE	2.6L 16v dohc L4	0	0	0	Toyota Camry [044L], Toyota Highlander [400L]
Toyota	Georgetown, KY	1MZ-FE	3.0L 24v dohc V6	875	57750	43750	Toyota Camry [300N]
Toyota	Georgetown, KY	2AZ-FE	2.4L 16v dohc L4	325,035	21452310	16251750	Toyota Camry [300N]
Toyota	Georgetown, KY	2GR-FE	3.5L 24v dohc V6	171,544	11321904	8577200	Toyota Avalon [770N], Toyota Camry [044L]
Toyota	Georgetown, KY	3MZ-FE	3.3L 24v dohc V6	13,581	896346	679050	Toyota Camry [300N], Toyota Camry Solara [592N]
Toyota	Huntsville, AL	1GR-FE	4.0L 24v dohc V6	132,335	8734110	6616750	Toyota Tacoma [635N], Toyota Tundra [800T]
Toyota	Huntsville, AL	2UZ-FE	4.7L 32v dohc V8	123,926	x	7435560	Toyota Sequoia [120N], Toyota Tundra [800T]
Toyota	Huntsville, AL	6UZ-FE	5.7L 32v dohc V8	0	x	0	Toyota Tundra [180L]
Toyota	Long Beach, CA	2TR-FE	2.7L 16v dohc L4	93,674	4121656	2810220	Toyota Tacoma [635N]
Volkswagen	Puebla	EA086	1.9L 8v sohc L4	7,728	x	231840	Volkswagen Beetle [VW349]
Volkswagen	Puebla	EA113	2.0L 16v dohc L4	21,136	x	634080	Volkswagen Jetta [VW351]
Volkswagen	Puebla	EA113	2.5L 20v dohc L5	215,349	x	8613960	Volkswagen Jetta [VW351]
Volkswagen	Puebla	EA188 PD	1.9L 8v sohc L4	45,724	x	1371720	Volkswagen Jetta [VW351]
Volkswagen	Puebla	EA827	2.0L 8v sohc L4	34,533	x	1035990	Volkswagen Jetta [VW341]