Exploring Advancements In The Use Of Aluminum Extrusion In Lightweighting

GALM 2015

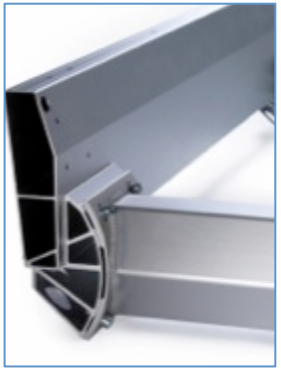
ALUMINUM EXTRUDERS COUNCIL

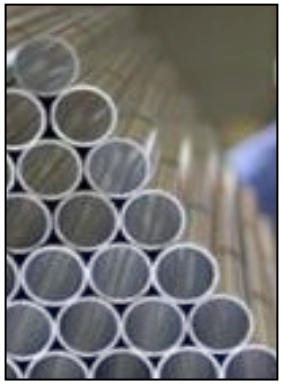
Agenda

- The North American Aluminum Extrusion Industry and the Aluminum Extruders Council
- Expanding Extrusion Applications
- Leveraging the 3 critical variables – Alloy, Geometry, Fabrication

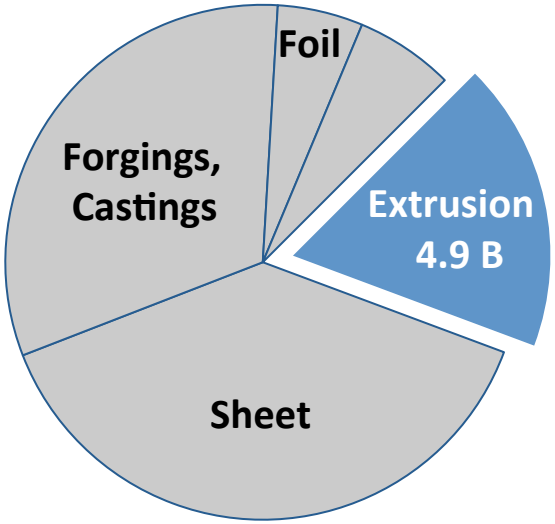
Introduction

Extrusion represents almost 20% of North American aluminum shipments

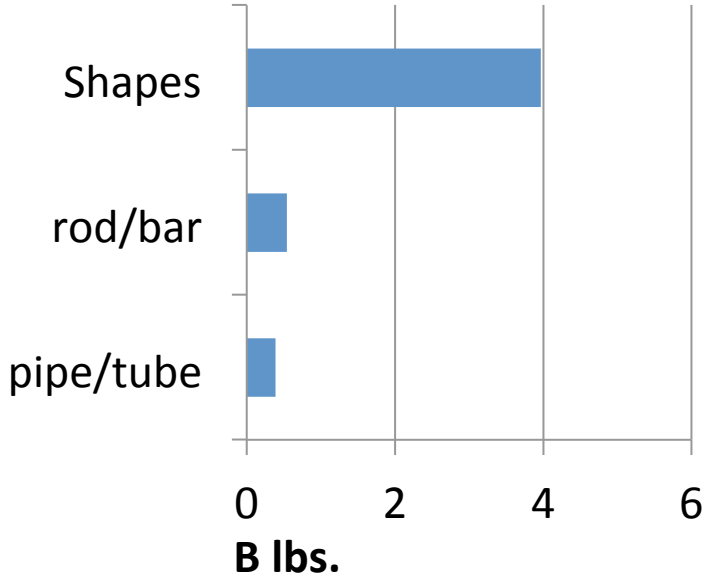




NA Aluminum Shipments
2014 25.5 B lbs.

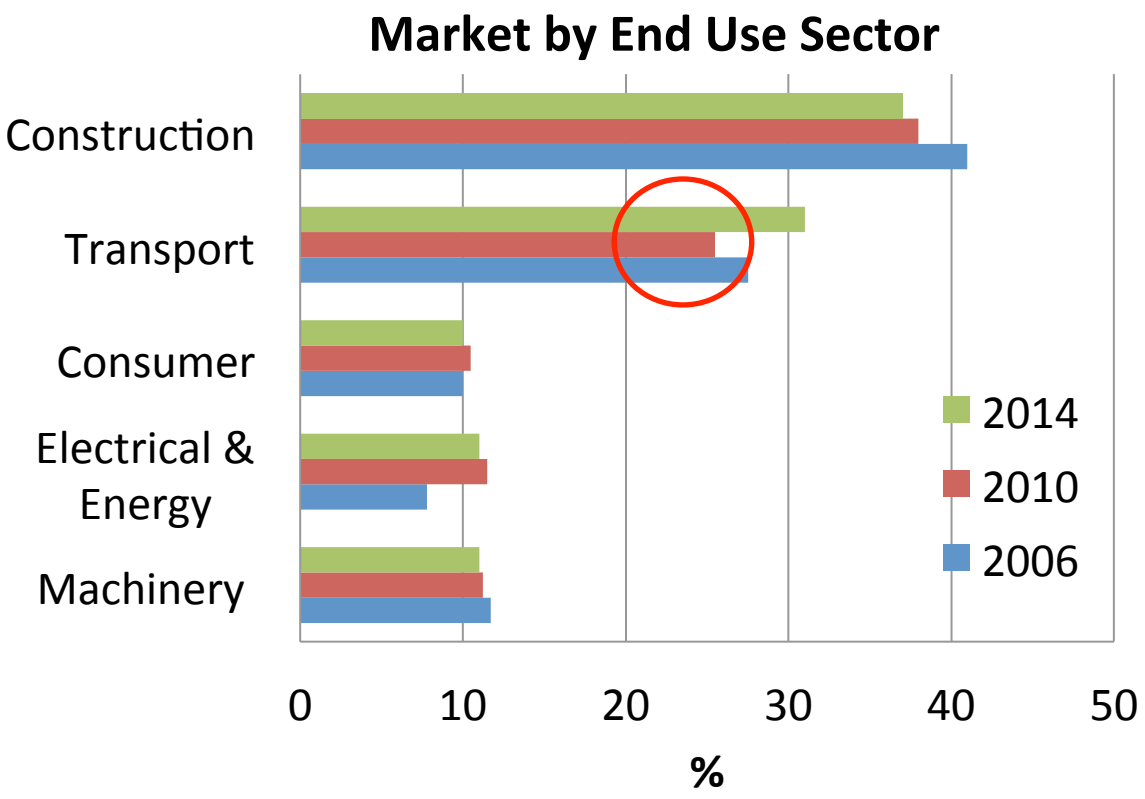


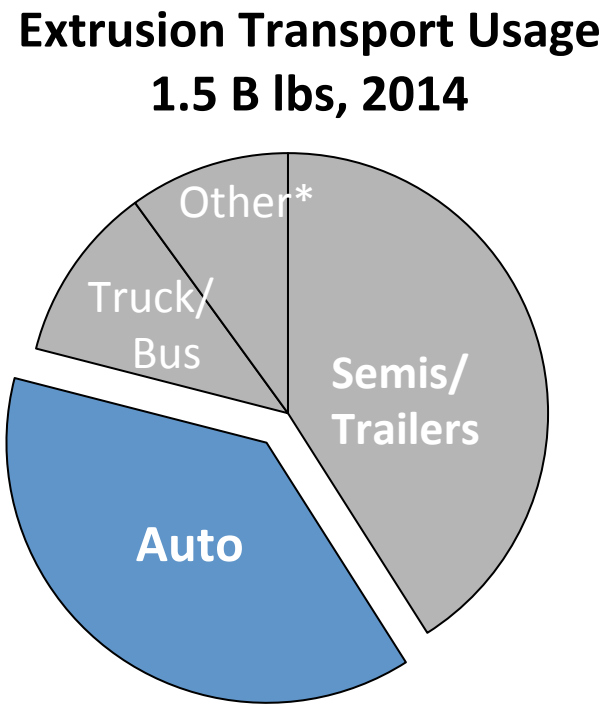
NA Extrusion Shipments



Introduction

Transportation is Extrusion's 2nd largest market, and increasing in importance, with autos a major element





* Other: rail, marine, aircraft, military, r.v.

Source: The Aluminum Association, AEC analysis

Introduction

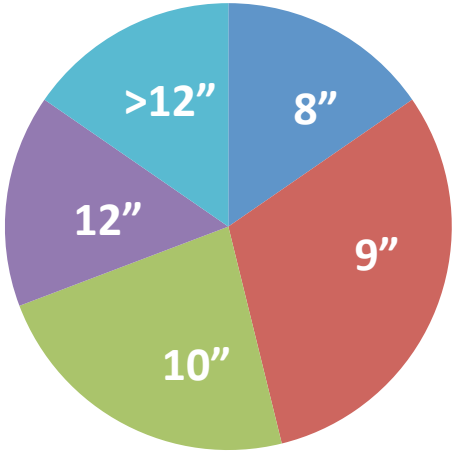
The Aluminum Extruders Council (AEC) represents the North American industry

- 50+ extruder members in the US and Canada, operating 220+ presses in 80 locations; 7 metal supplier members
- ~ 75% of NA extrusion production
- A 3-part mission
  - Assist users and potential users in the effective utilization of extruded components
  - Advance member professionalism through best practice development and sharing
  - Promote fair trade, and preserve a robust North American industry

Introduction

In the past 2 years, AEC members have put about 20 additional presses in place or on order …

New presses by size



At least 4– along with one major press upgrade - are ***dedicated to automotive.*** An investment of ~$100 million for over 75mm# of capacity

Source: Bonnell

Source: AEC analysis

Introduction

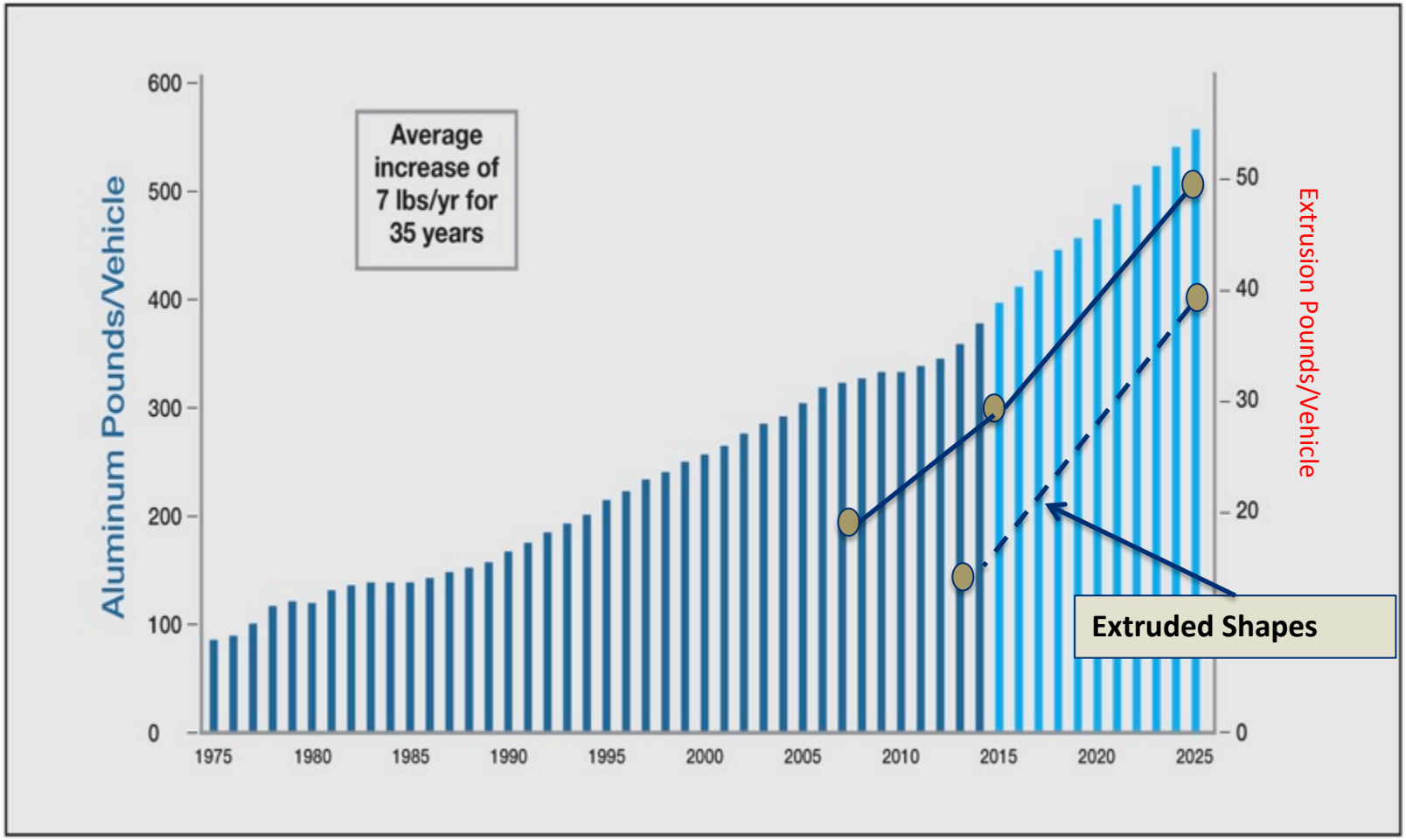
AEC's Automotive Industry Team : 8 Extruders/Component Suppliers and 2 Metal Suppliers

Their focus:

- Education – webinars, events like this
- Advancing the art – Joining Manual (with AA and EAA)

Extrusion in Autos

While Aluminum has a long increase in auto usage, extrusion – especially extruded shapes – only recently gained momentum



Source: The Aluminum Association, Ducker Worldwide, AEC analysis

Extrusion in Autos

Structural applications are expected to drive extrusion use

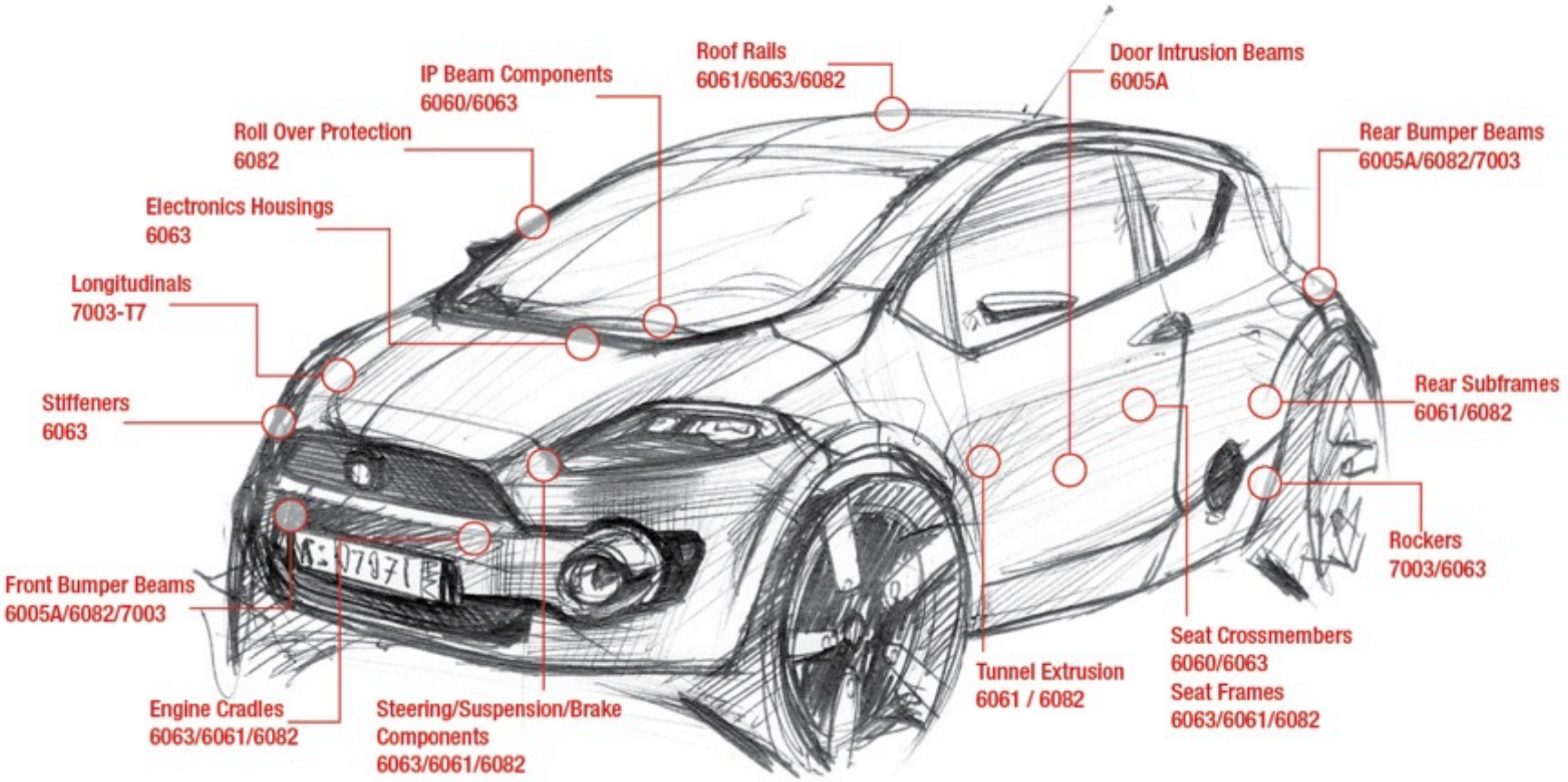
Extrusion pounds/vehicle

Type	Example	2012	2017	2025	Incr. in # usage*
Shapes	Interiors, Seats, Trim, Sunroof, Others	1	1.2	2	67%
Shapes	Exterior	3	3.2	4	25%
Shapes	Bumpers	4	5.5	6	9%
Shapes	Body Structures	1	4	17	**325%**
Shapes	Steering & Brakes	3	3	4	33%
Tube	Drive Shafts	1	1	1	
Rod & Bar	Transmission	4.5	4.5	4.5	
Shapes	Mounts	1.5	2	2.5	25%
Tube	Heat Exchangers	5.3	5.3	5.5	
Shapes	Suspension / Links / Chassis	1	2	3	50%
Total		25.3	31.7	49.5	84%

* Per vehicle 2017-2025; Source: Ducker International, AEC analysis

Extrusion in Autos

Currently, we see applications throughout the vehicle …



Extrusion in Autos

… and the lightweighting dividends of Aluminum are clear

Full Size Crew Cab Pick-up

Luxury Sedan

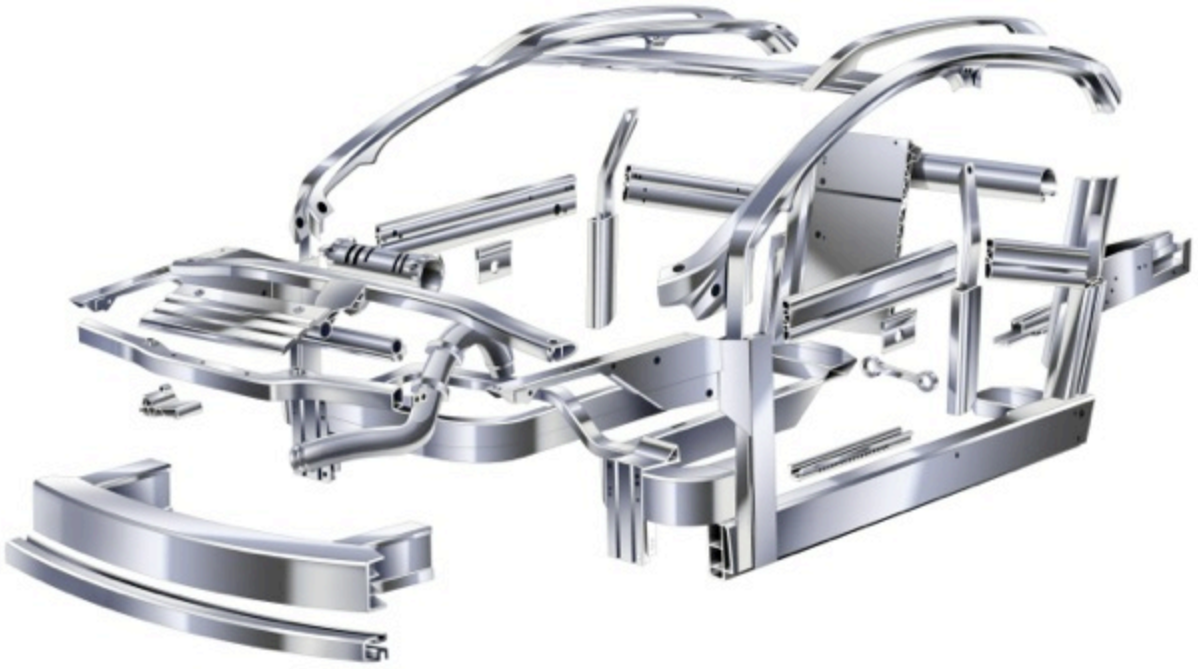
BIW weights in pounds

	Ford F-150	Segment Competitor
Cab	406	647
Bed	115	281
Tesla Model S	605	810
Audi A8	593	822

Designing with Extrusion

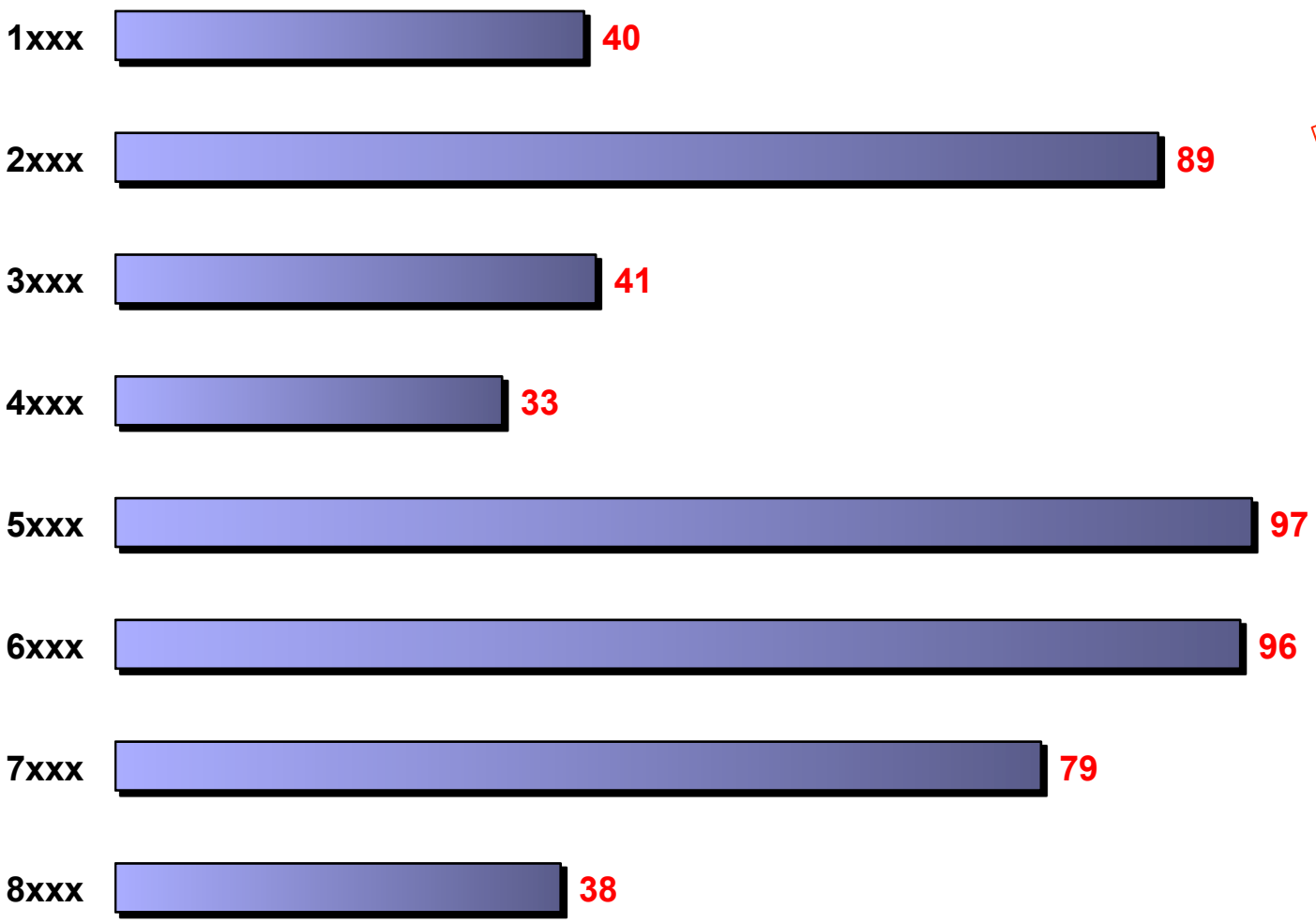
Key Parameters

- Alloy Selection
- Shape Development
- Fabrication & Assembly Technology



Alloys

As of March, 2014, there were 513 Alloys Registered with the Aluminum Association. This does NOT include proprietary alloy variants.



Now 531 alloys registered!

Now 100

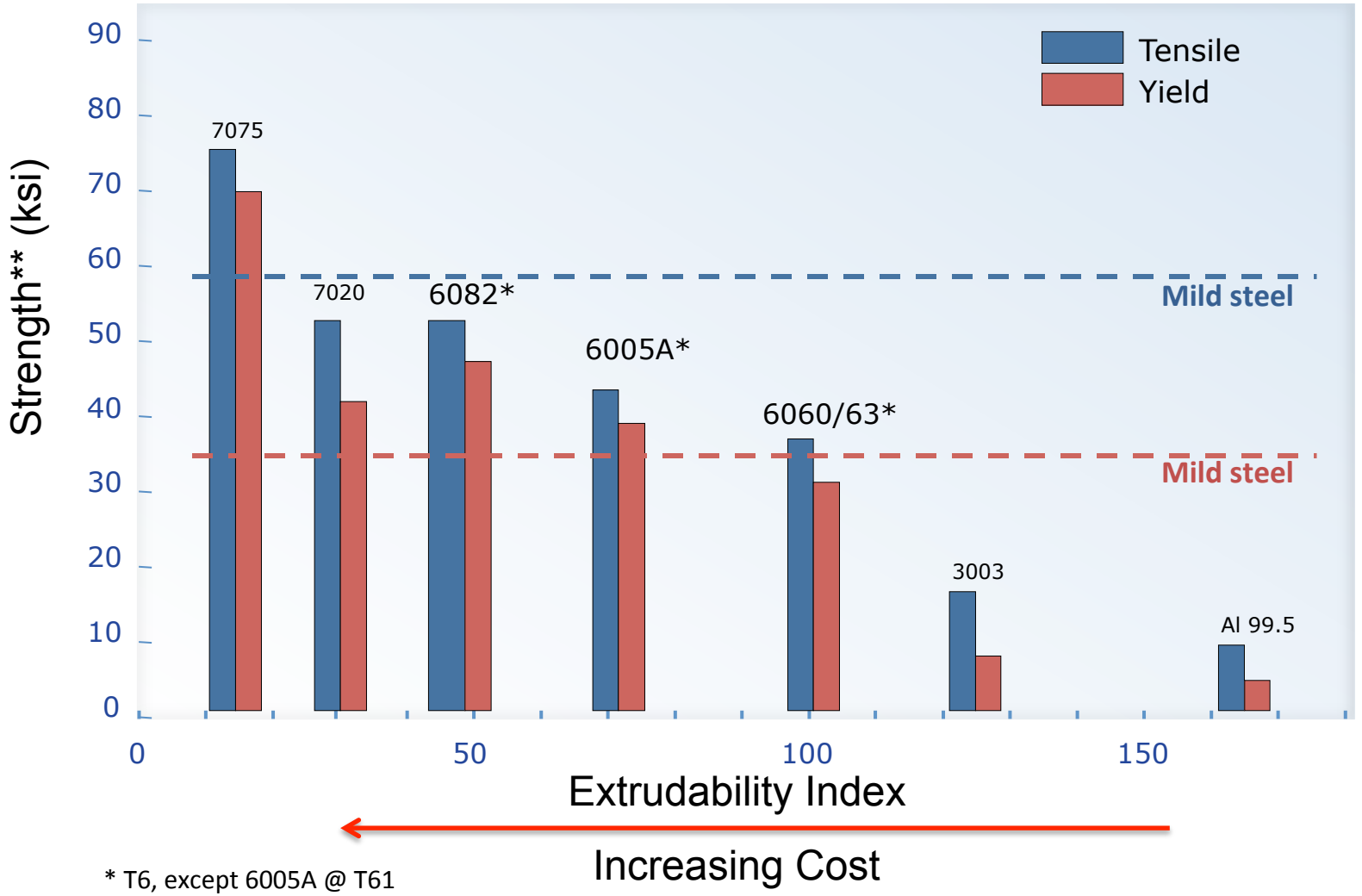
Alloys

Trace amounts matter …

Alloy Composition	6063	6061	7004
Silicon (Si)	0.40%	0.60%	0.13%
Magnesium (Mg)	0.70%	1.00%	1.50%
Iron (Fe)	0.18%	0.35%	0.18%
Copper (Cu)	0.05%	0.28%	0.05%
Manganese (Mn)	0.05%	0.05%	0.45%
Chromium (Cr)	0.05%	0.10%	0.05%
Zinc (Zn)			4.20%
Total Alloying Elements	1.43%	2.38%	6.56%
% Aluminum	98.57	97.62	93.44

Alloys

… in determining physical properties as well as extrudability (or cost)



* T6, except 6005A @ T61
**typical properties

Alloys

A new alloy application: Extruded 5083 in lieu of 5083 sheet or plate

Example

Why 5083?

- Outstanding corrosion resistance (primarily used today for marine applications)
- Excellent for high speed laser welding

Why extrusion?

- Near-net shape minimizes downstream machining and other manufacturing operations
- Low tooling cost, with short lead times

Note that an variant of the standard 5083 alloy was developed to provide higher tensile and yield performance

5XXX alloy/ Temper Mechanical Properties

	UTS, MPa		YTS, MPa		%Elongation Min
Alloy	Min	Max	Min	Max	
5083-O	269	352	110	-	14
5083-H111	276	-	165	-	12
5083-H112	269	-	110	-	12
5083 Cl I	310	-	241	-	9

Alloys/Geometry

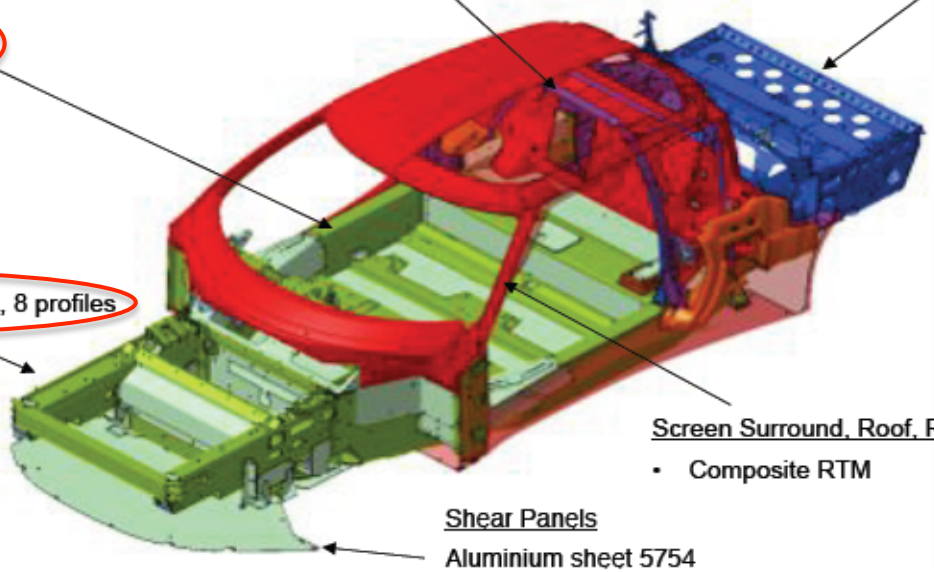
There is often more than one "right" answer

Production Multi-Material Body Structure: Lotus Evora
(Launched 2009)

Seat Belt Anchorage Frame
E355 steel
MIG welded
Powder coat

Chassis Tub
Aluminium sheet 5754
Aluminium extrusions
6060-35, 20 profiles
Bonded and riveted

Rear Subframe
Tenform 300 HSLA steel
Spot /MIG welded
Galvanised



Front Subframe
Aluminium sheet 5754
Aluminium extrusions 6060-35, 8 profiles
Bonded and riveted

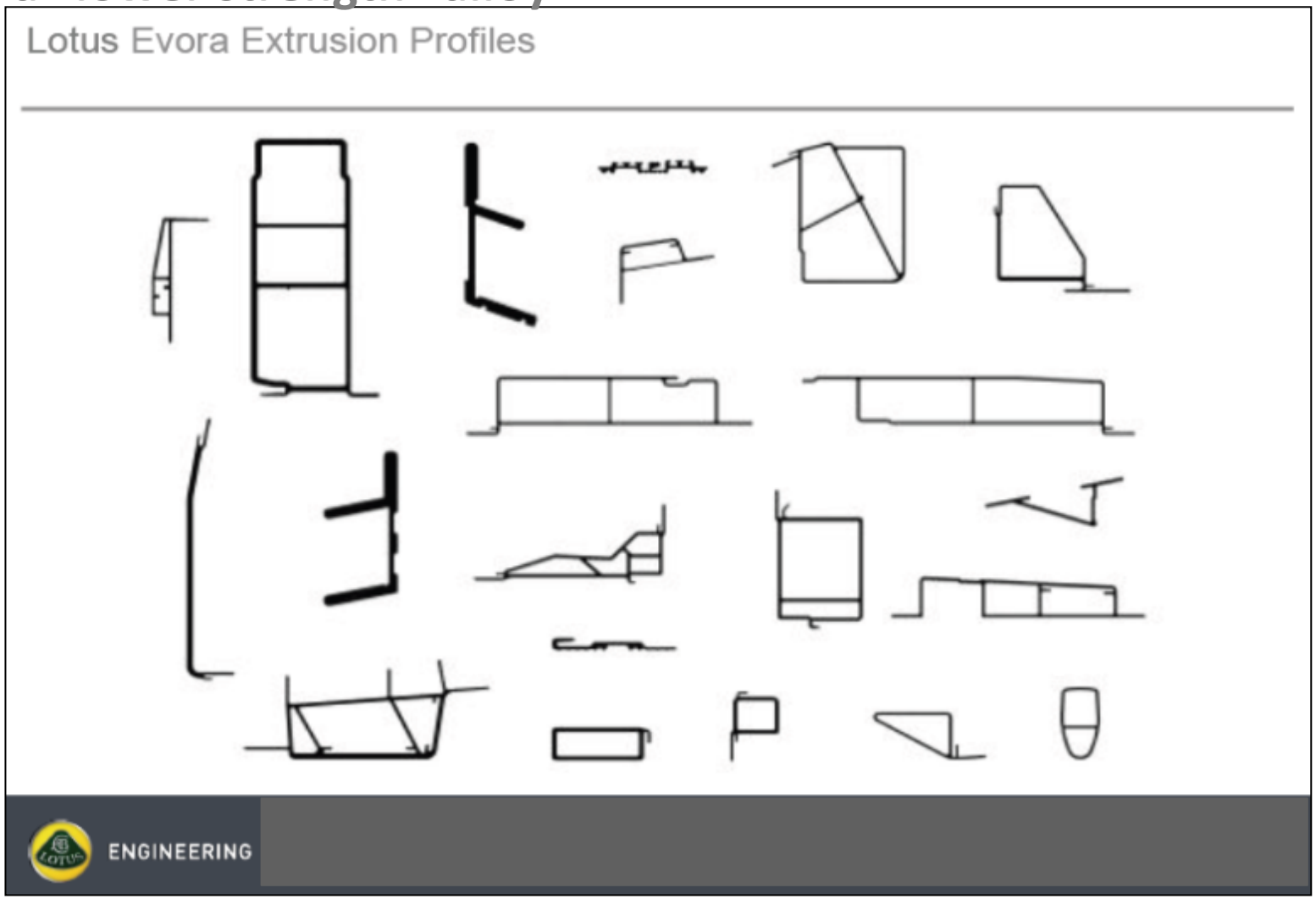
Screen Surround, Roof, Rear Bulkhead and Body-Side
- Composite RTM

Shear Panels
Aluminium sheet 5754
Front, rear

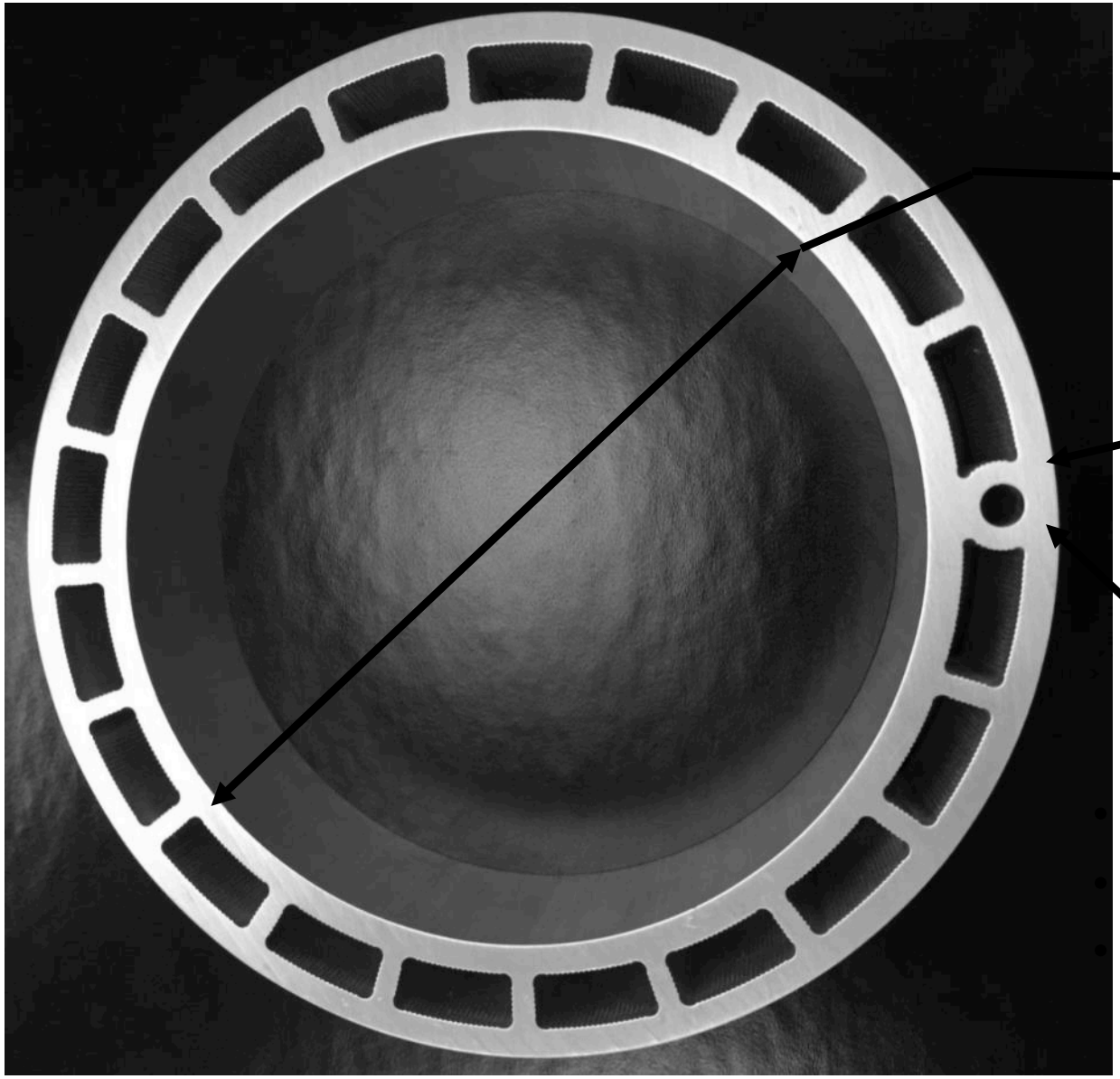
ENGINEERING

Geometry

Lotus used profile geometry – and multiple hollows - to offset a “lower strength” alloy



Geometry



Ø131.00mm

◎	0.4	
○	0.2	A

Ø168.00 mm

○	0.4	▲

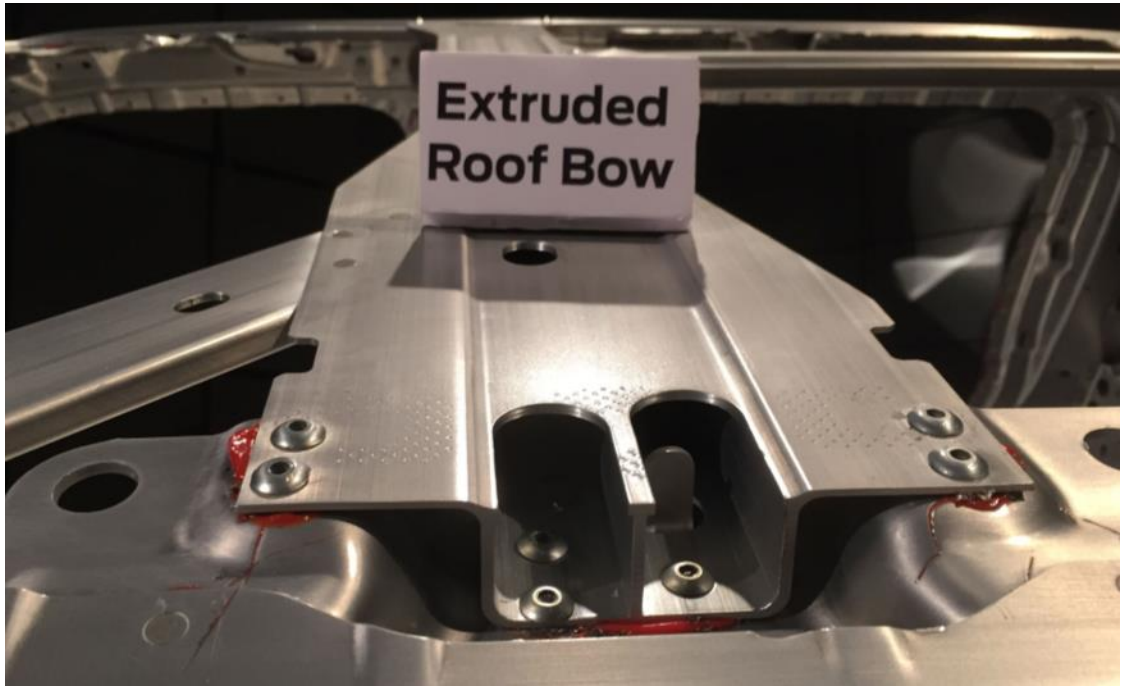
Ø6.5 mm +/- 0.20

⌖	0.6	A

- Circularity
- Concentricity
- Hole Dimensions

Geometry

Extruded Roof Bows



Ford F-150

Tesla Model S

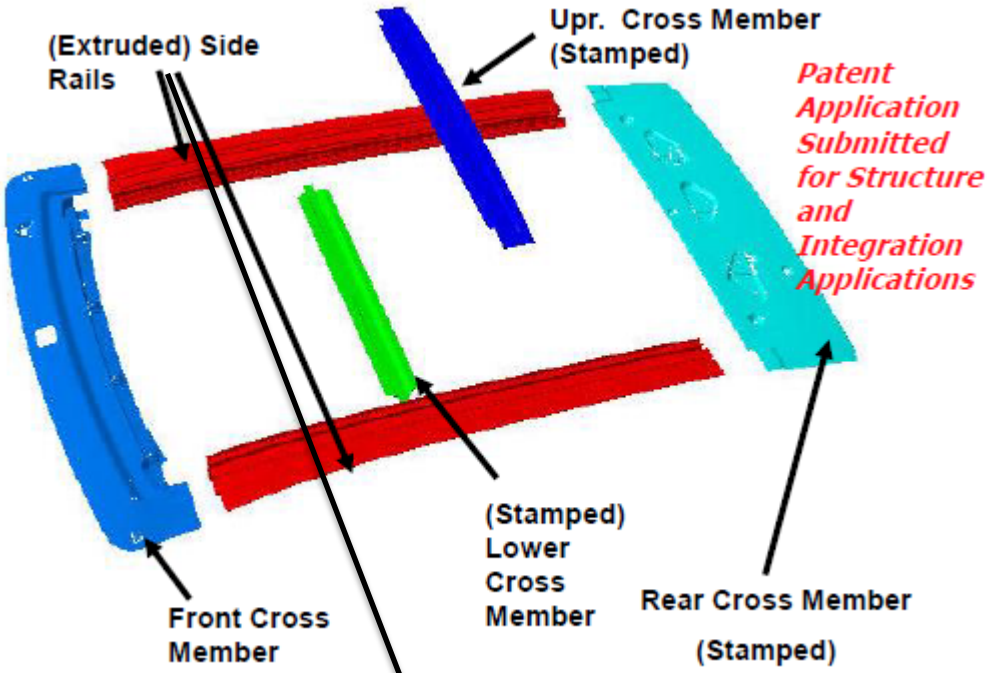
Source: Truck Trends

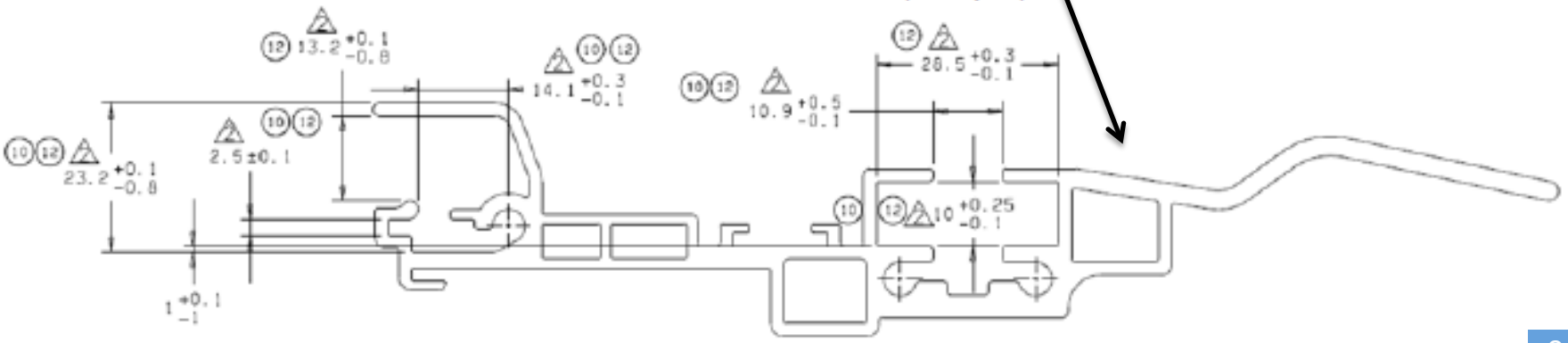
Geometry

Challenge: simplify steel-based 28 part mechanism for panoramic sunroof

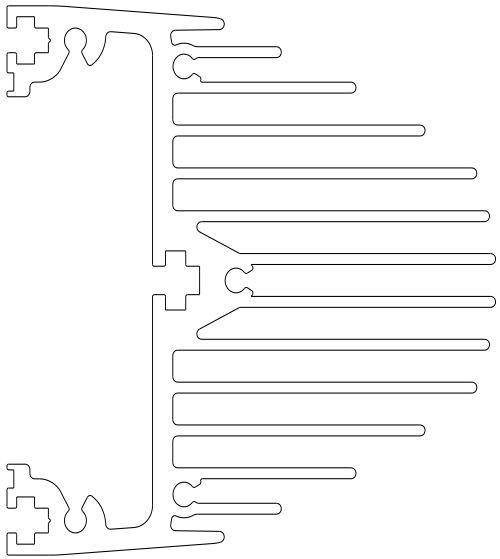
Extrusion-based result

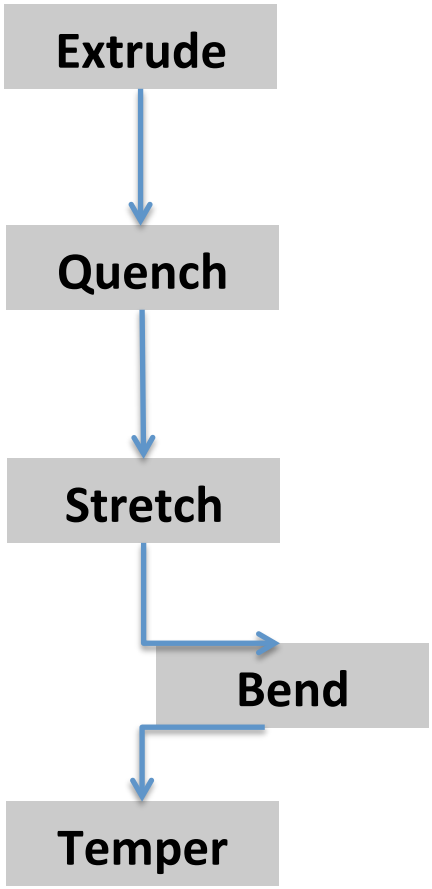
- 6 pieces only – 2 extrusions + 4 small aluminum stampings
- ***20% weight savings***
- Cost neutral with investment reduction for volume
- ***22 piece part reduction***; reduced labor cost





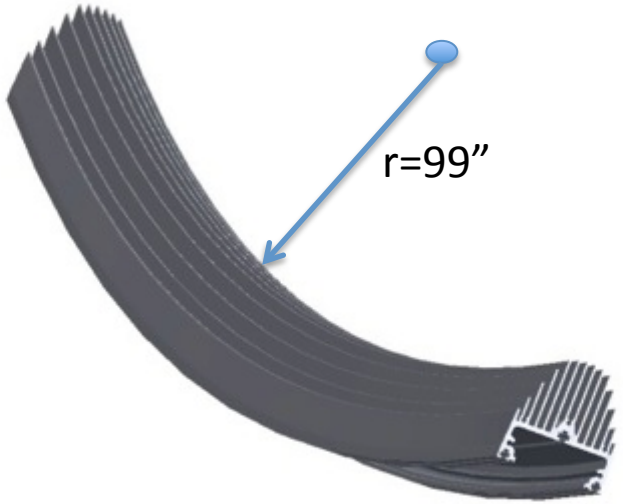
Fabrication





Aftermarket Light Bar

- 6360
- Stretch bent in T4 over a form



Engage an experienced extruder early on!

- Simply converting a steel component to aluminum is rarely cost effective
- Ensure that you have realistic cost expectations
- Understand the inevitable tolerance trade-offs

Thank You!

Exploring Advancements In The Use Of Aluminum Extrusion In Lightweighting
GALM 2015

Martin J. Bidwell
Chairman, Aluminum Extruders Council
President/CEO, Magnode Corporation
mbidwell@magnode.com

ALUMINUM EXTRUDERS COUNCIL

www.aec.org