LAST YEAR--*WHAT'S AN ATS??*
ATS AWARDS AND ACCOLADES

- Popular Mechanics Top Gadgets of 2012 - CUE
- Esquire Magazine Car of the Year
- Popular Mechanics Automotive Excellence Award - Luxury
- Urban Wheels Car of the Year
- Motor Press Guild Vehicle of the Year
- Men’s Journal Gear of the Year Award
- Wards Auto 2013 10 Best Engine Award - 2.0L Turbo
- NHTSA 5*, 5*, 5* Safety Ratings
- Detroit Free Press 2013 Car of the Year
- Hispanic Motor Press Award
- Autobytel 2013 Luxury Car of the Year
- PBS Motorweek Driver’s Choice Award “Best Sport Sedan”
- Connected World Magazine Connected Car of the Year
- Automotive Journalist Association of Canada 2013 Best New Luxury Car
- Auto123.com - 2013 Luxury Compact Car of the Year
- Autos.ca - 2013 Top Pick Luxury Car
- Sharp Magazine (Canada) - ”Best Reason to Buy American” Award
- 2013 ALG Residual Value Award (Canada) - Premium Midsize Car
- Motor Trend Head-to-Head Comparison Win - ATS 3.6L over the BMW 335i and MB C350
- Finalist for AOL Autos Technology of the Year - CUE
- Vanity Fair Top Five New Cars of 2012
- AutoTrader.com “Must Test Drive” List
- Detroit News Reader’s Choice Award – Best Luxury Car
- Golden Klaxton Award – Middle Class (Russia)
- Culture Map Houston – Car of the Year
Objectives of the Body in White Design

- **Performance goals of the BIW:**
  - Achieve high ratings on all global governmental and consumer safety metrics.
  - Class competitive overall and local stiffness's for handling and isolation.
  - Best in Class BIW mass.

- **Manufacturing Goals**
  - Integrate into GM’s Global Manufacturing Bill of Process.
  - Quality of Execution.
  - Investment and Overall Cost Reduction.
Design Optimization Methodology

1. Architectural optimization for the bandwidth of gross vehicle mass, powertrains and performance requirements

2. Integration of efficient load paths and geometry

3. Assessment of sub-system targets; CAE optimization

4. Additive part design; Design details
Focus on Efficient Fundamentals

Design Strategy--Topology

Body structure
Chassis structure

Front impact loads
Side impact loads
Rear impact loads

Straight primary structure
Package space for effective topology
Load-paths free from discontinuity
High stiffness joints
Cross members aligned
CAE Tools and Methods

- Coarse topology optimization
- Multi load case gauge optimization
- Expert interpretation of deformation modes
- Local topology optimization
- Casting shape optimization
- Bulkhead optimization

1,000'S of iterations (Design & CAE)
Design Strategy--Part Details

- Scalloped flanges
- Lightening holes
- Smallest parts possible
- Part designs modified to enable gage reduction of mating parts; i.e., folded bracket for welding ratio
Design Strategy--Material Selection

Material Breakdown by Mass

- Press Hardened / Hot Stamped: 2.90%
- Aluminum: 5.70%
- Dual or Multiphase: 29.60%
- Bake Hardened: 17.50%
- High Strength Low Alloy: 17.00%
- Maternsite: 4.80%
- Mild / Low Carbon: 22.60%

Aluminum
Design Strategy--Material Selection

- Mild Steel
- Bake Hardenable
- HSLA
- Dual-Phase/Multi-Phase
- Martensitic
- Press Hardened Steel
- Aluminum
Material Strategy

Cadillac steel strength trends

\[
\begin{align*}
Y_{S\text{avg}} &= 23\% \text{ increase} \\
T_{S\text{avg}} &= 16\% \text{ increase}
\end{align*}
\]
Material Strategy

Aluminum Specification

- Based on cost / kg saved
- Higher cost allowed near front of vehicle
- 50% - 50% mass distribution
Design Strategy--Crash Performance

Global Front Load-paths

- 75% load managed by lower body
- 25% load managed by upper body
Design Strategy--Crash Performance

Multi-stage Crush Box

- *Three cell aluminum extrusion*
- *Elongated for low and high speed*
- *Saw cut allows multi-stage crush*
Design Strategy—Crash Performance

Ultra High Strength Roll Forming

- Constant & bent sections
- High impact strength
- Cost effective
- Cold formed

Roll formed UHSS parts
Design Strategy--Crash Performance

High Performance Corner Doubler Exs:

- Lighter overall solution
- Tuning flexibility for variants
Design Strategy--Crash Performance

Stabilizing Bulkheads

- Lighter overall solution
- Tuning flexibility for variants
Design Strategy--NVH

*High Stiffness Seatback Ring*

- Box sections
- Lightening holes
- Large pass-through

*Pre-assembled for high stiffness*
Design Strategy--NVH
Weld Bonding

<table>
<thead>
<tr>
<th>Legacy</th>
<th>New to ATS</th>
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88 Meters Total

Diagram of car structure with lines indicating weld bonding areas.
**Design Strategy--NVH**

Patch Laminated Dash

- Concentrated mass, stiffness & damping in critical noise radiating area

- Patch laminated visco-elastic blank

- Co-formed in die
Summary

- Narrow the bandwidth
- Package the vehicle to control loads and avoid compromising load paths and part geometry
- Be realistic in setting and meeting targets; balance is critical to meet requirements without waste
- WORK THE DESIGN DETAILS
The Result--Stiffness & Efficiency

Body structure efficiency = \frac{\text{BIW mass (kg)}}{\text{Area (m}^2\text{)} \times \text{Torsion (kN-m/deg)}}

<table>
<thead>
<tr>
<th></th>
<th>Predecessor architecture</th>
<th>2013 ATS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global static torsion (kN-m/deg)</td>
<td>19.2</td>
<td>29.0</td>
</tr>
<tr>
<td>Body structure efficiency</td>
<td>4.01</td>
<td>2.34</td>
</tr>
</tbody>
</table>
The Result--Efficiency and Performance

Certification Mass vs Horsepower

Horsepower

Certification Mass (kg)

ATS
Competitor A
Competitor B
Competitor C
The Next Challenge: The 2014 CTS
The Next Challenge: The 2014 CTS
The Next Challenge: The 2014 CTS

The 2014 CTS is a larger car:

v. 2013 ATS
  • Wheelbase is + 135 mm
  • Overall Length is + 321 mm

v. 2013 CTS:
  • Wheelbase is + 30 mm
  • Overall Length is + 127 mm
2014 CTS Structural Enhancements

- Revised Seatback Structure and Bracing
- Stiffened Sun Roof Reinforcements
- 30 Meters of Added Adhesive
- Laser Welded Tie Bar
- Added Rocker Reinforcements
- Tailor Rolled Center Pillar
- Stiffened Cradle Attachments
Design Strategy - CTS Material Selection
Design Strategy - CTS Material Selection
Material Strategy

Increased Aluminum Specification from ATS

- 2014 CTS doors are aluminum
  Doors are larger than in 2013
  **Steel door beams**--bolted
  Mass reduction of 26 kg. v. 2013 CTS
  Mass reduction of 18 kg. v. best steel design
- ATS Al applications retained
- Material selection is based on cost / kg saved
- Total vehicle Al usage has increased:
  2013: 15%
  2014: 18%
Design Strategy--Tailor Rolled Center Pillar

2013 CTS
8 Parts
Mass 6.36Kg

2014 CTS
Press Hardened Steel
Gauges Tuned for Crash
2 Parts
Mass 4.62 Kg
THE RESULTS:

The New CTS Body is 8.5% LIGHTER and 40% STIFFER than the Previous Body

2013 CTS Body Mass: 352.1 Kg (sunroof) / 349.3 kg (base)
2014 CTS Body Mass: 322.0 Kg (sunroof) / 323.9 kg (base)

2013 CTS Stiffness: 17.4 (sunroof) / 19.2 (base) kN-m/deg
2014 CTS Stiffness: 24.7 (sunroof) / 26.8 (base) kN-m/deg

2013 CTS Body Structure Efficiency: 4.46 (sunroof) / 4.01(base)
2014 CTS Body Structure Efficiency: 2.87 (sunroof) / 2.66 (base)
THANK YOU