Conversion:
Aluminum Radiator Support into Steel Design
for General Motors’
New Full Size Pick-Up Trucks

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Presentation Outline

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- Design Requirements
- Design Challenges
- Design Alternatives
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- Summary
The all aluminum Radiator Support Assembly was used on the previous generation of full-size trucks (SUV and Pickup).

The assembly was bolted to the Fender structures in the circled areas.

Extruded and stamped aluminum components were mig-welded together with gauges ranging from 2.0 mm to 5.0 mm.

The removable Upper Tie Bar is bolted to the assembly by three bolts at each end.
The major changes in the new generation full size truck radiator support assembly were:

- Moving the location of the fender attachments from the side to the front face of the assembly
- Increasing the height of the vertical members at either end by 35 mm
Design Requirements

In addition, the new design needed to:

1. Meet the same packaging & attachment constraints as the aluminum design.
2. Be mass neutral to the all aluminum design.
3. Meet or exceed strength & stiffness performance targets.
4. Be a lower cost solution than the aluminum version.
Due to tight packaging constraints, it was not possible to modify either geometry or section size.

Needed to meet (or exceed) the aluminum extruded dual cell section upper tie bar bending stiffness with a more cost effective steel design.

Ability to significantly down-gauge the steel design to reduce mass was limited by welding requirements.

Design, prototyping, and durability validation had to be completed in 12 months.
Design Alternatives

Feasibility studies were conducted with suppliers to explore possible design solutions:

- All stamped steel components
- Combination of Hydro-formed and stamped steel parts
- Combination of Hydro-formed steel and composite parts
- Stamped steel parts with plastic inserts
- Combination of steel bent tubes and stamped steel parts
- Die cast magnesium parts
- Combination of roll-formed and stamped steel parts
Example:
Hydro-formed tube design
None of the preliminary design proposals met all the requirements, especially mass and packaging.

Some proposals were abandoned due to technology risks and cost reasons.

The rolled form design proposal was the closest to meeting all criteria (including cost). This design was therefore selected and further optimization was pursued with Van-Rob.
For the given stiffness and strength requirements, the design was optimized for mass by:

- Conducting appropriate sensitivity analysis to identify the critical joints
- Creating a steel Upper Tie Bar with a section similar to that of the aluminum extruded design
- Using High Strength Steel (HSS) to meet load requirements with minimum gauge
- Appropriately adding lightening holes (maintaining the balance between strength and stiffness)
- Using Tailored Roll Blank (TRB) technology to design a Lower Tie Bar with variable panel thickness
Use of High Strength Steel (HSS) on the radiator support assembly

Red: HSS  
Green: Mild Steel
• Lightening holes (circled)
TRB Lower Tie Bar helped meet the mass target (neutral to aluminum)

- Homogenous material properties as opposed to welded blanks to improve fatigue performance
- 33% lighter than a constant gauge steel solution

Section A-A

Color Code
- 1.9 mm
- Transition 1.9 to 1.0
- 1.0 mm

Lightening holes with flanging for stiffness

Section B-B
Manufacturability:

- Make flanged lightening holes without secondary operations and the Lower Tie Bar with low cost Automated Bending Process.
This highly engineered steel radiator support assembly requires advance manufacturing processes to meet the high volume requirements

- Van-Rob developed an Automated Bending Process to accommodate the different profiles of the radiator support assembly
- Laser welding and cutting are used to complete the profile tubes
- These completed profile tubes are now ready for processing into complete structural assembly
Automatic Bending Process – Lower Tie Bar

Step-1
Punch out all the fastener and lightening holes

Step-2
Add a flange to the lightening holes

Step-3
Bend a tailor rolled blank into a finished profile

(Short video clip of the process)
Results

- The steel design was completed and validated on time. It passed the major durability test schedule in the first run.

- The stiffness (frequency response) of the steel version is about 1% less than that of the aluminum version however, still meets vehicle performance targets.

- The steel version was mass neutral to the all aluminum design. Additional mass was added to the final design due to new requirements unique to the new full size pickup trucks.

- 22% piece cost reduction resulting a significant annual savings by using the steel design.
Right Balance of Cost and Mass for a Highly Engineered Steel Radiator Support Assembly
Summary

• We have demonstrated that we can achieve a low-cost light weight design by using HSS and other advanced manufacturing technologies.

• Understanding the load paths in the design is critical.

• CAE is a useful tool in design optimization and validation, however, the analysis results need to be reviewed and interpreted carefully to avoid over design.

• Manufacturability should be well considered at design phase.

• Team work is important to the success of joint project.