Cost Model Analysis with Advanced High Strength Steels

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Understanding Production Costs

- Cost is a critical element when deciding on a material or design
- But, cost is sometimes difficult to assess particularly for new materials & process technologies
  - Historical accounting data often unavailable
  - Inconsistent treatment of the data
- And, cost for new materials & technologies often rapidly changing
  - Improved processing conditions/learning
  - Technological development
Need for Process Based Cost Models

• Provide consistent basis for analysis
• Explicitly defined boundaries for the problem
• Based on technology assessment and therefore can be used to investigate the impact of:
  – Process improvements
  – Using different materials
  – Alternate designs
Cost Modeling Entire Product Lifecycle

- Materials Cost
- Recycle/Recovery
- Product Use
- Assembly

- Product Development
- Parts Fabrication
## Impact of High Strength Steels

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials Cost</strong></td>
<td>Parts Consolidation: Fewer tools, presses &amp; other resources</td>
<td>Higher Unit Cost</td>
</tr>
<tr>
<td><strong>Parts Fabrication</strong></td>
<td>Parts Consolidation: Less assembly required Reduced space &amp; logistics</td>
<td>Formability Issues: More expensive tools, slower cycle times, etc.</td>
</tr>
<tr>
<td><strong>Assembly</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Need to Balance These Competing Factors: **COST MODELS**
Case Study: Benefits of High Strength Steel

Lightweight Front End Structures

• Front end structures are prime candidates for redesign
  – Lightweight design allows a shift of vehicle weight from front to rear
  – Many opportunities for parts consolidation

• Approaches in steel include
  – High strength steels
  – Tailored blanks
  – Hydroformed tubes
Front End Study: Design Issues

<table>
<thead>
<tr>
<th>Material</th>
<th>Baseline</th>
<th></th>
<th></th>
<th>High Strength</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of</td>
<td>Weight</td>
<td></td>
<td># of</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td>Parts</td>
<td>(kg)</td>
<td></td>
<td>Parts</td>
<td>(kg)</td>
</tr>
<tr>
<td>Stampings</td>
<td>32</td>
<td>30.77</td>
<td></td>
<td>14</td>
<td>12.75</td>
</tr>
<tr>
<td>Tailored Blanks</td>
<td>2</td>
<td>5.36</td>
<td></td>
<td>6</td>
<td>18.90</td>
</tr>
<tr>
<td>Rollformings</td>
<td>1</td>
<td>6.39</td>
<td></td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Hydroformings</td>
<td>---</td>
<td>---</td>
<td></td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>35</strong></td>
<td><strong>42.52</strong></td>
<td></td>
<td><strong>20</strong></td>
<td><strong>31.65</strong></td>
</tr>
</tbody>
</table>
## Front End Study: Materials Distribution

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>High Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Steels</td>
<td>29.48 kg</td>
<td>2.63 kg</td>
</tr>
<tr>
<td>HSLA Steels</td>
<td>13.04 kg</td>
<td>---</td>
</tr>
<tr>
<td>Dual Phase Steels</td>
<td>---</td>
<td>29.02 kg</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>42.52 kg</td>
<td>31.65 kg</td>
</tr>
</tbody>
</table>
# Front End Study: Overall Results

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>High Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>$49</td>
<td>$53</td>
</tr>
<tr>
<td>Blank Production</td>
<td>$7</td>
<td>$22</td>
</tr>
<tr>
<td>Forming</td>
<td>$64</td>
<td>$52</td>
</tr>
<tr>
<td>Assembly</td>
<td>$77</td>
<td>$57</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$197</strong></td>
<td><strong>$184</strong></td>
</tr>
</tbody>
</table>
Considering Other Parts of the Lifecycle

- Materials Production
- Recycle/Recovery
- Product Use
- Assembly
- Parts Fabrication
- Product Development
- Cost of Product Development Activities
- Influence of Platform Strategy/Shared Parts
Product Development Issues: 
Instrument Panel Beam Designs

• Two Functionally Equivalent IP Beams
  – Steel:
    Tubular structure + 24 brackets
  – Magnesium:
    Die Cast structure + 4 brackets

• Base Case:
  – 75,000 units/year per variant
  – 5 year product life
  – Mg Price: $3.10/kg

• Variants: Original design + variant 10% longer
Direct Manufacturing Costs: IP Beams

Parts Fabrication

- Steel Fabrication
- Mg Fabrication

Assembly

- Steel Assembly
- Mg Assembly

TOTAL

- Steel Total
- Mg Total

Other Fixed
Tooling
Other Variable
Material
Major magnesium beam had over 3x development cost versus steel tube

Overall steel design over 4x number of parts, thus higher total development costs
Production Volume & Mg Price Sensitivity

Production Volume ('000s) vs. Mg Price/kg

- Steel Preferred
- Mg Preferred

- Mg Price/kg:
  - $2.40
  - $2.50
  - $2.60
  - $2.70
  - $2.80
  - $2.90
  - $3.00
  - $3.10
  - $3.20
  - $3.30
  - $3.40
Influence of Shared Components

Production Volume ('000s)

Mg Price/kg

Steel Preferred

Mg Preferred

Sharing
IP Beam Case Summary

• Manufacturing cost does not always provide complete answer
  – Product development costs
  – Platforming issues

• Parts consolidation key to competitive position of Mg
  – But additional parts consolidation also possible in steel
  – Using higher strength steels and tailored tubes could reduce the need for reinforcements
    • Lower costs in manufacturing
    • Lower development costs
Other Important Considerations

- Materials
  - Production
  - Recycle/Recovery
- Product Development
  - Parts Fabrication
  - Product Use
  - Assembly
- Energy Issues
  - Recycling
- Cost