

# Strategies for Aluminum in the Auto Body

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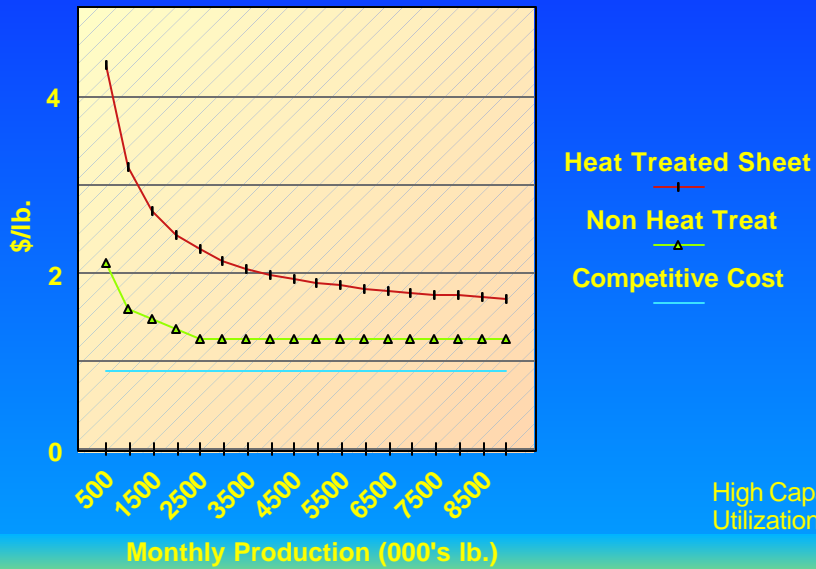
## Overview

- **Cost Analysis of Aluminum in the Autobody**
  - **Cost of Aluminum Rolling**
    - ▶ *Industry consolidation, scale economies, new technologies*
  - **Automotive Designs**
    - ▶ *Two case studies, comparing compact and midsize cars.*
    - ▶ *Economics of parts fabrication and assembly*

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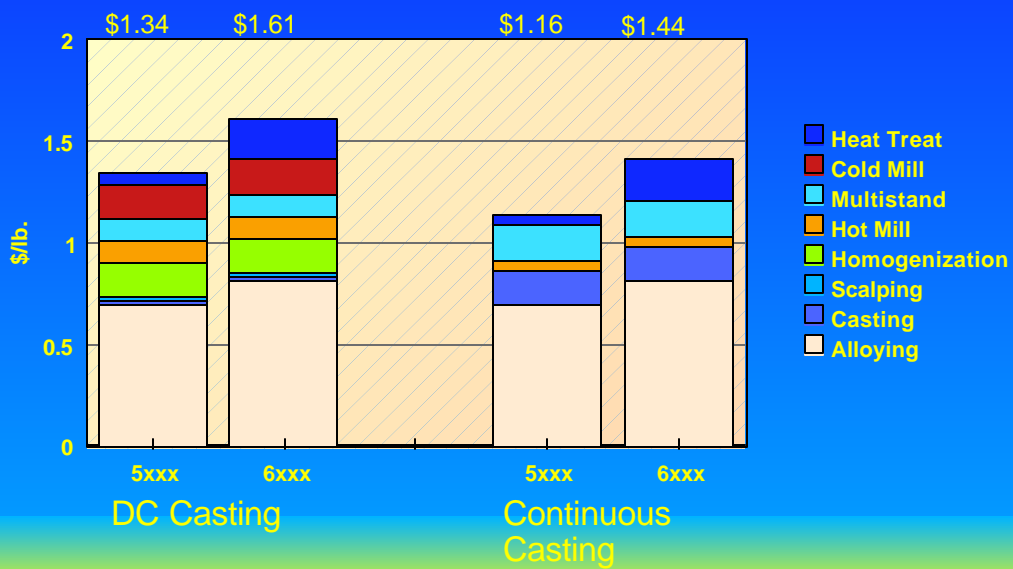
# Aluminum Rolling Costs-Scale



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# DC versus Continuous Casting



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## DC versus Continuous Casting

	5xxx	6xxx
Concasting with Hot Mill	1.16\$/lb.	1.44\$/lb.
Concasting -Direct Cold Rolling	1.04\$/lb.	1.32\$/lb.
DC Casting	1.34\$/lb.	1.62\$/lb.

## Design analysis

### Small Cars

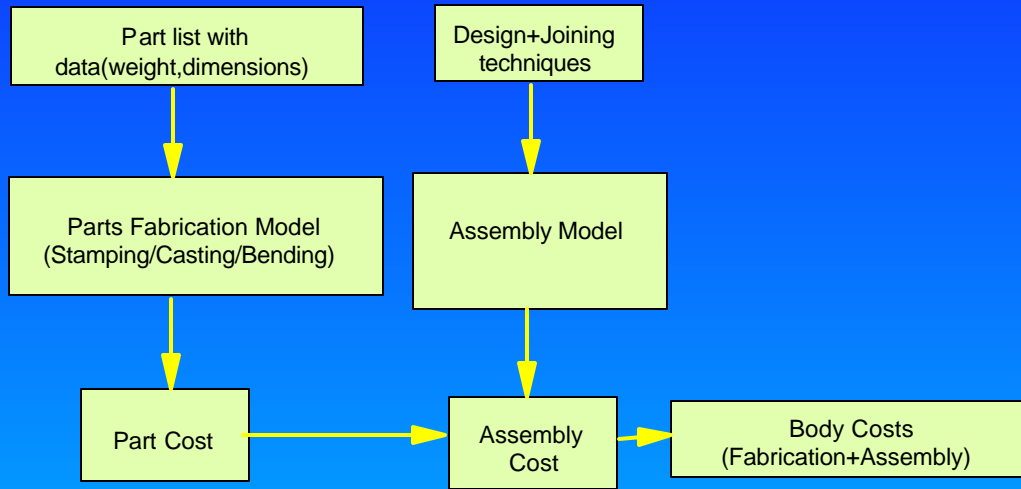
VW Lupo  
VW Lupo-Hybrid  
Audi A2

### Midsize Cars

Ford Contour  
Ford P2000  
Audi A8

- ▶ *Detailed analysis of cost of part fabrication*
- ▶ *Detailed analysis of assembly*
- ▶ *Cars chosen on basis of data availability*
- ▶ *Cars categorized into general groups and they are not exactly comparable to one another.*

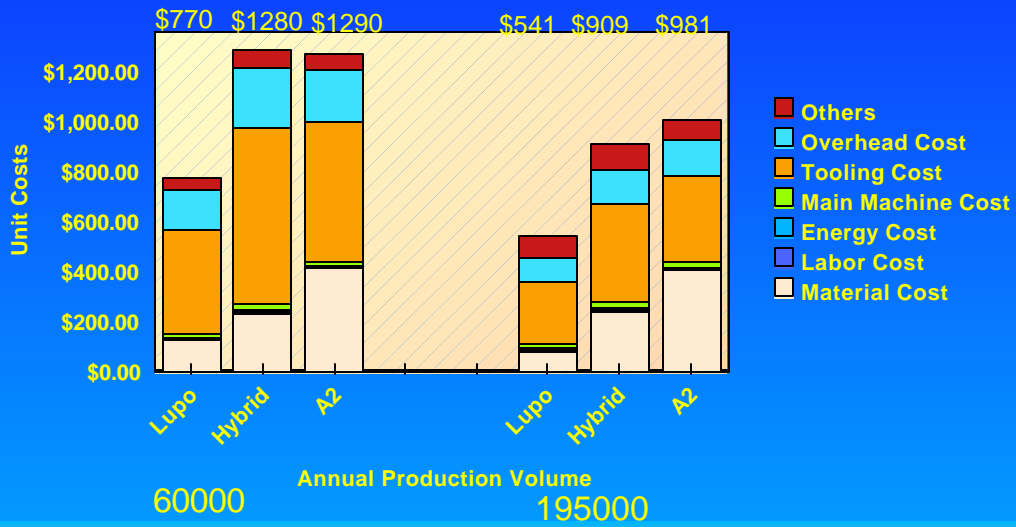
# Methodology for Design Analysis



## Small Cars

	Part Count	Total Parts Weight	Production	Remarks
VW Lupo	170 parts	195 kgs.	High Production (>100,000)	Steel Unibody 2 door car
VW Hybrid	170 parts	167 kgs.	Low Production (~15,000)	100 km/3 L. Closures made of Aluminum & Magnesium
Audi A2	~200 parts 60%stamped 70%no-bend extrusions	150 kgs.	Medium Production (60,000)	IInd generation Aluminum Spaceframe Significant Parts consolidation

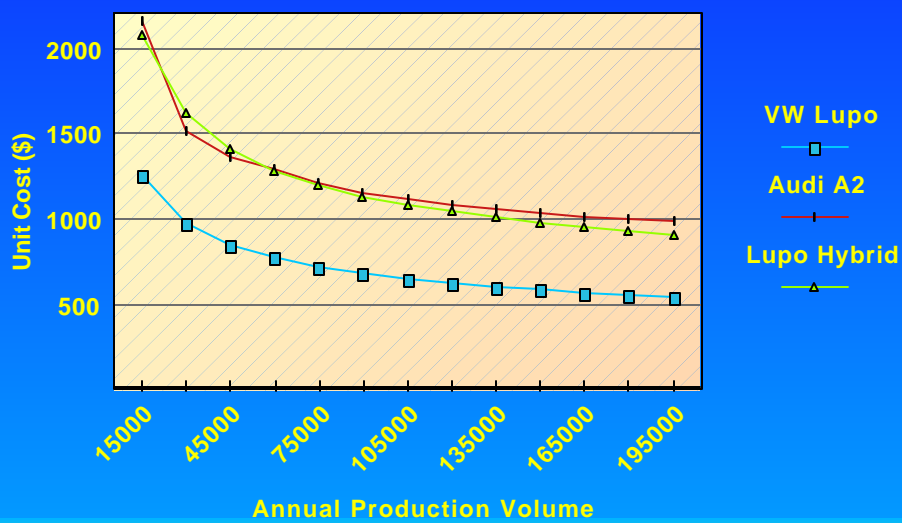
# Parts Fabrication Costs Breakdown



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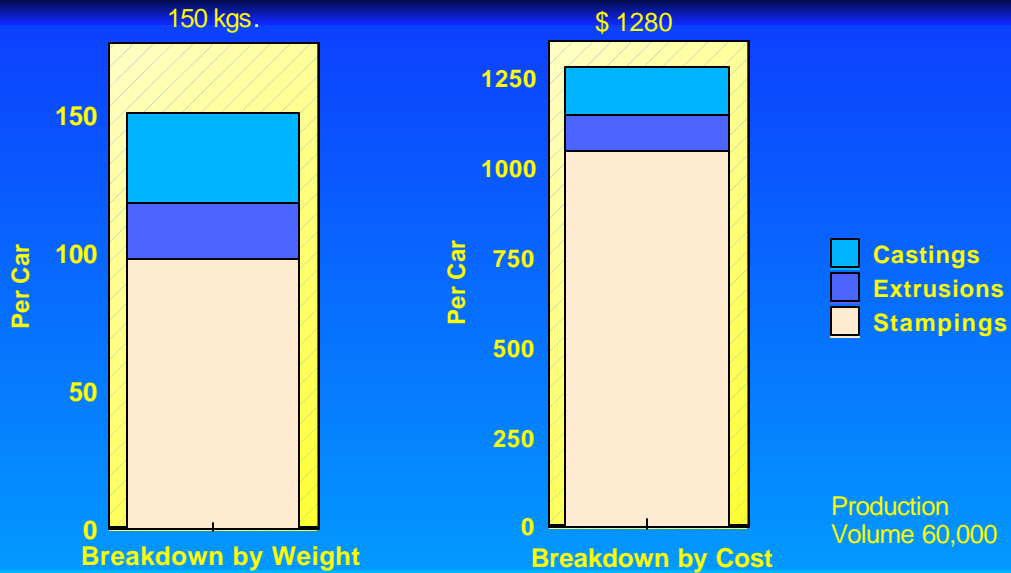
# Parts Fabrication Costs (small cars)



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## A2 Parts Breakdown(Weight & Cost)



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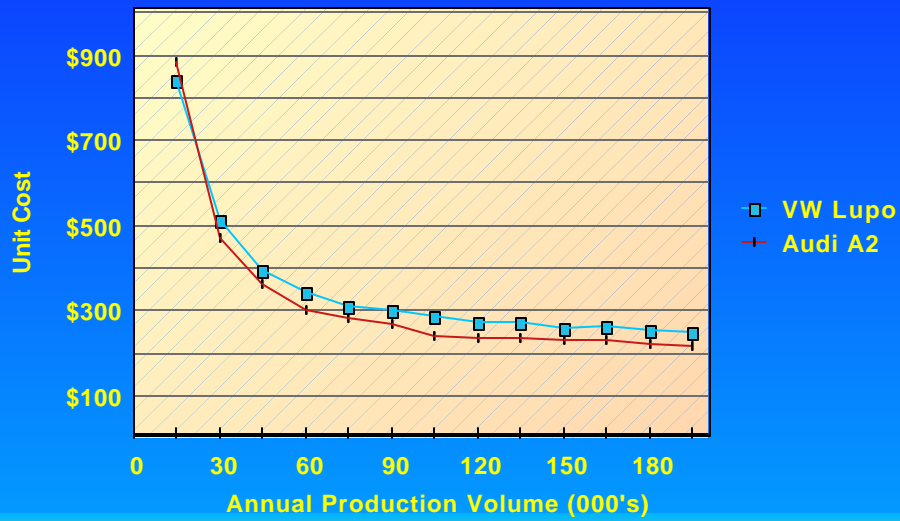
## Assembly (without closures)

- **VW Lupo**
  - ▶ *Resistance spot welding*
  - ▶ *Model predicts about 3250 spot welds*
- **Audi A2**
  - **Modeled based on available data**
    - ▶ *35 meters of laser seams*
    - ▶ *20 meters of MIG seams*
    - ▶ *1800 punch rivets*

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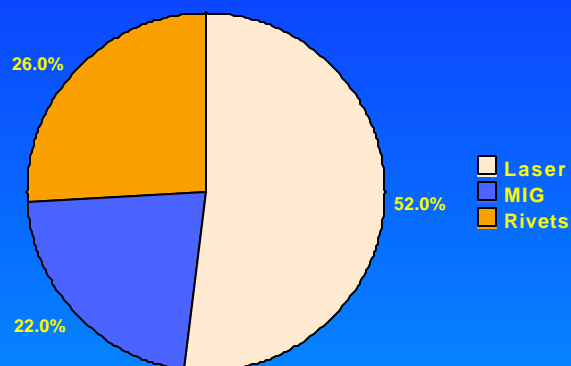
## Assembly Costs (small cars)



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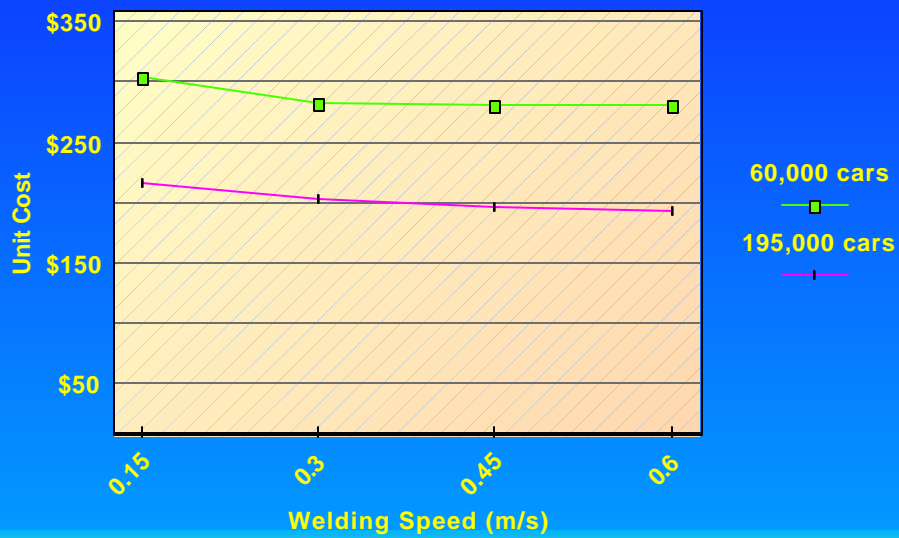
## Audi A2 - Joining Cost Breakdown



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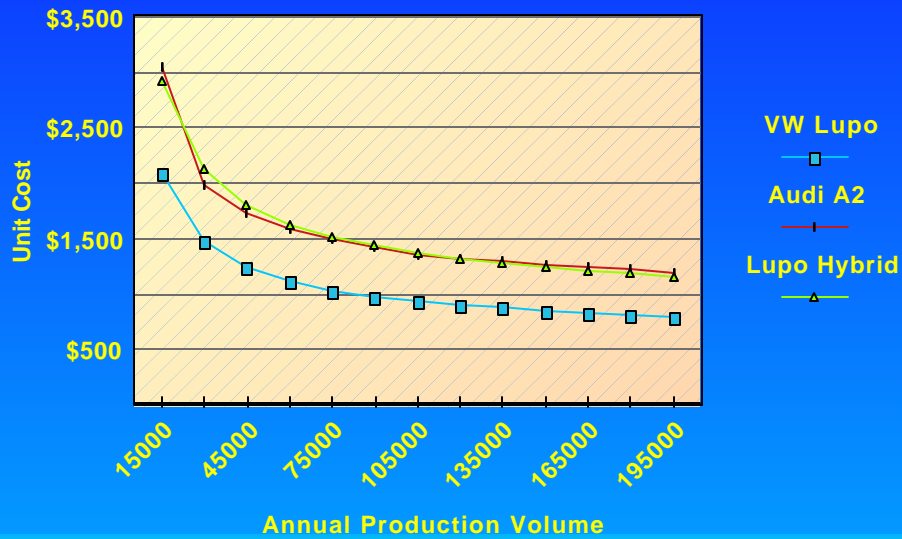
## Audi A2 - Sensitivity of Assembly Cost to Laser Welding Speed



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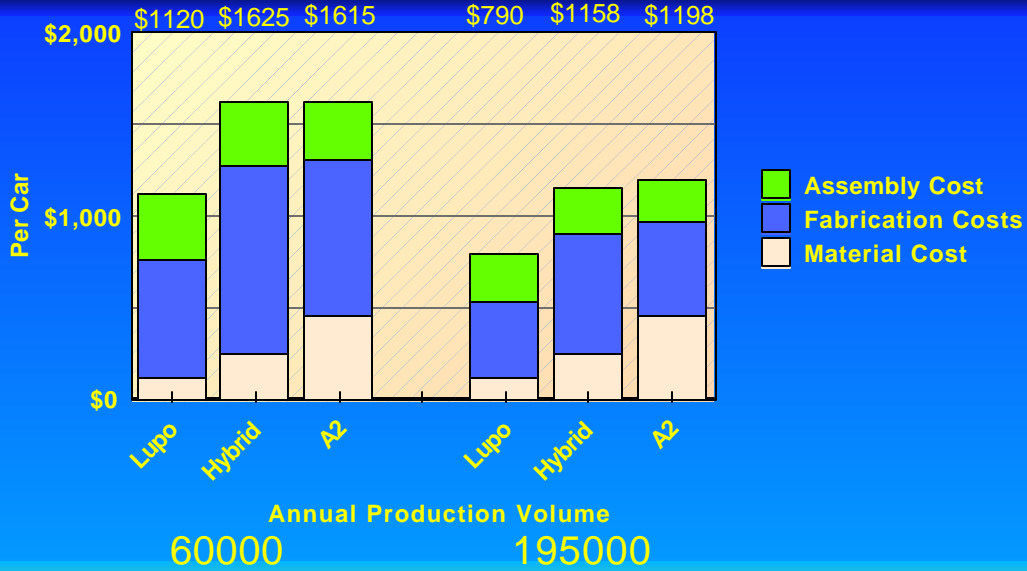
## Total Body Costs (small cars)



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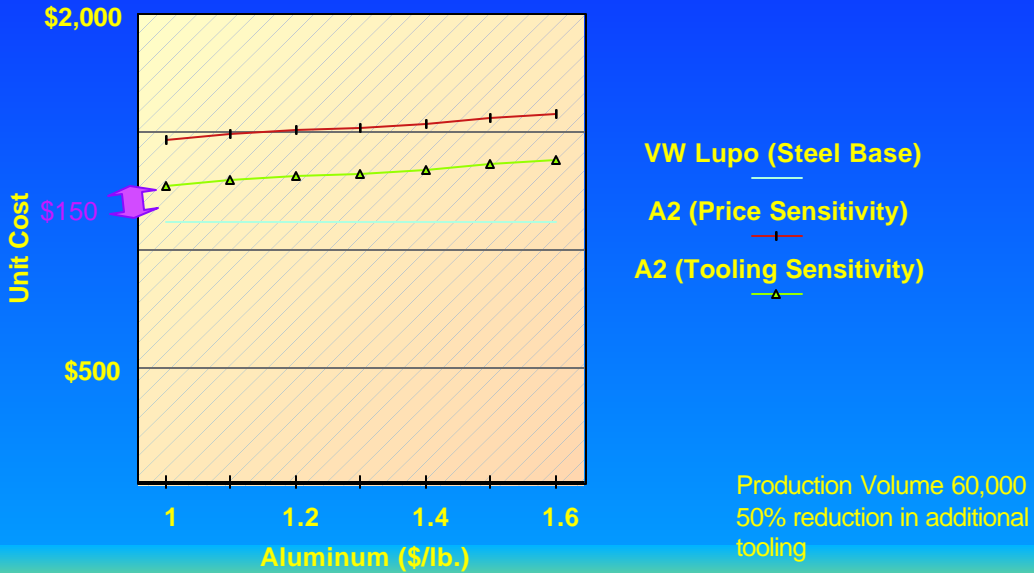
# Total Carbody Breakdown



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# Sensitivity of Body Cost to Aluminum Price & Tooling Costs



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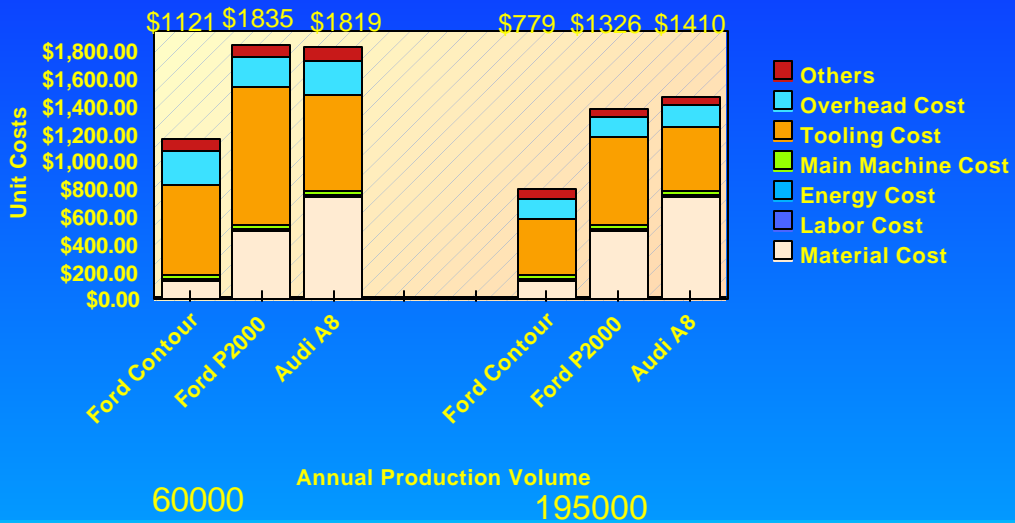
## Midsize Cars

	Part Count	Total Parts Weight	Production	Remarks
Contour	200 parts	215 kgs.	High Production (>100,000)	Steel Unibody Detailed part list available
Ford P2000	288 parts	152 kgs.	NA	Aluminum Unibody Detailed part list available
Audi A8	~300 parts 53% stamped 25% extrusions 22% castings	249 kgs.	Low Production	1st generation Aluminum Spaceframe

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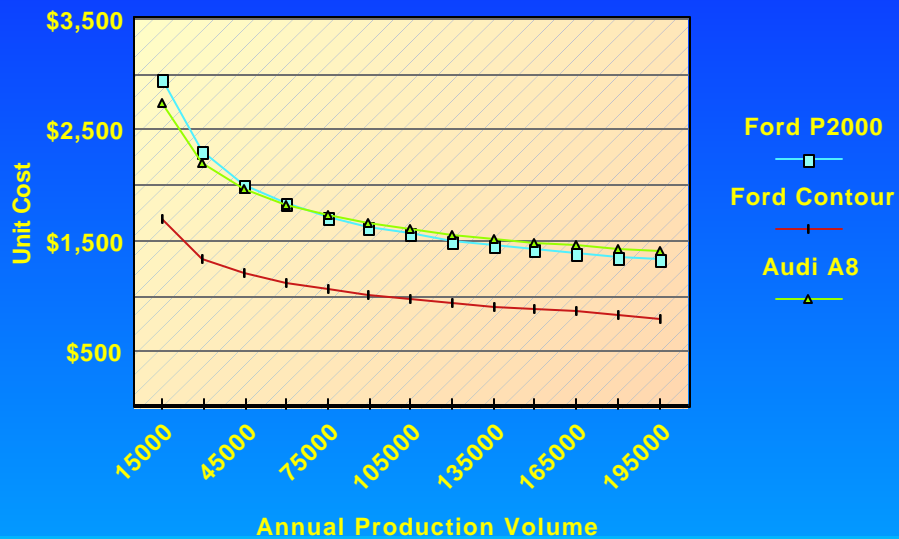
## Parts Fabrication Costs Breakdown



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## Parts Fabrication Costs (midsize cars)



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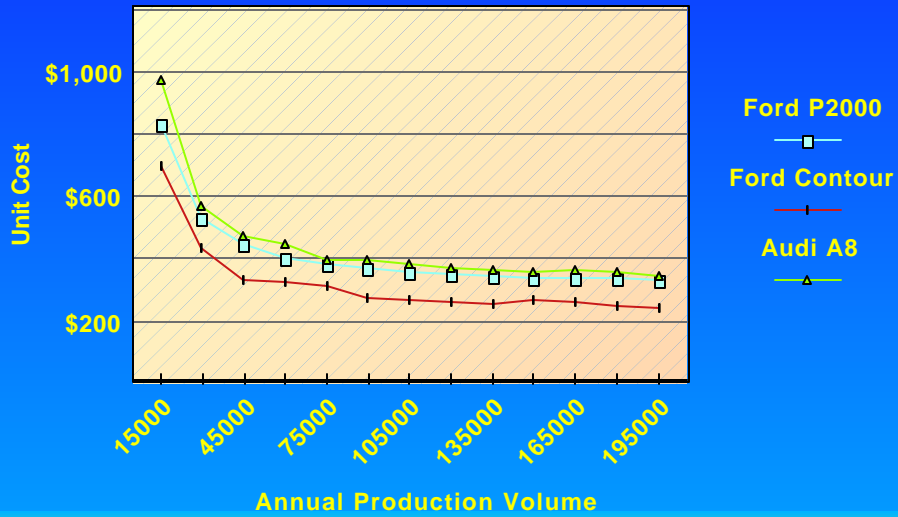
## Assembly (without closures)

- **Ford P2000 and Contour**
  - ▶ Resistance spot welding
  - ▶ Model predicts for Contour 3630 spot welds and P2000 4060 spot welds.
- **Audi A8**
  - Modeled based on available data
    - ▶ 500 spot welded points
    - ▶ 70 meters of MIG seams
    - ▶ 1100 punch rivets
    - ▶ 178 clinches

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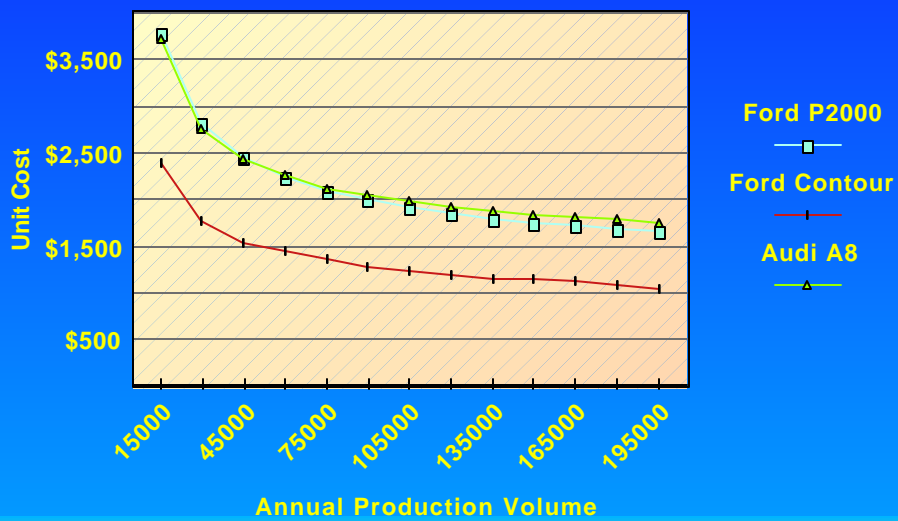
## Assembly Costs (midsize cars)



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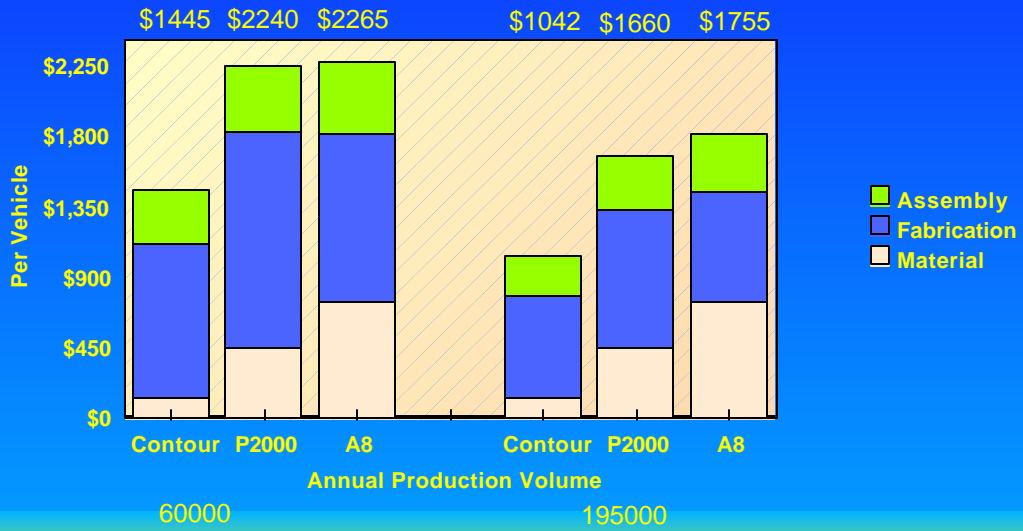
## Total Autobody Costs (midsize cars)



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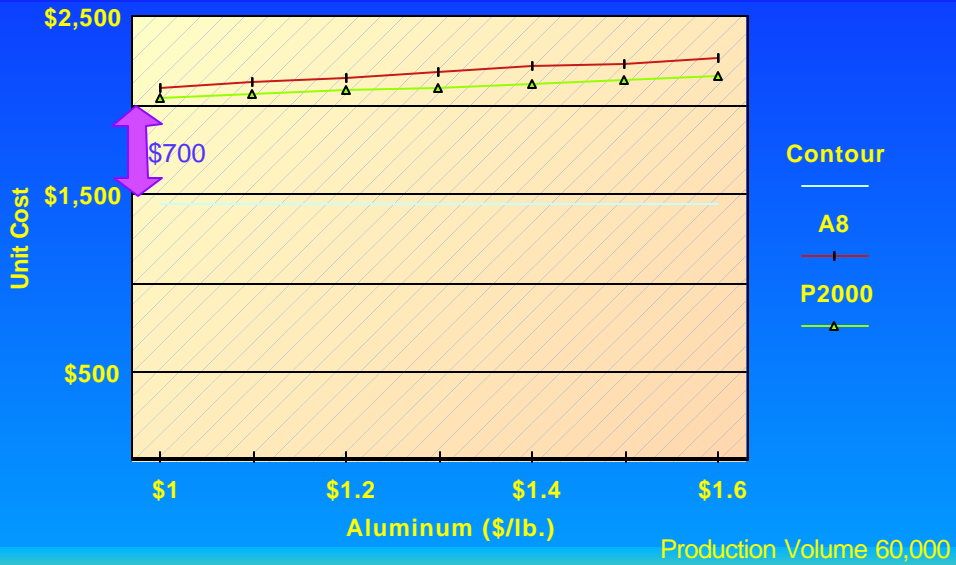
# Total Carbody Breakdown



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# Sensitivity of Body Cost to Aluminum Price



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## Conclusions

- **Continuous casting can result in significant reduction in Aluminum rolling costs (especially if hot milling can be eliminated)**
- **Aluminum Spaceframe and Unibody are competitive.**
- **At small volumes Spaceframe appears economical, due to high tooling costs of aluminum stampings, as this technology improves Unibody may be competitive.**
- **Aluminum Assembly - laser costs constitute 50% of costs.**