

SRIM in Large Structural Body Components

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Study Objectives

- Understand SRIM process
 - Key factors
 - Advantages of the technology
- SRIM Market Position
 - SRIM process cost analysis
 - Compare with competitive materials
- Forecast SRIM Opportunities

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SRIM Study Approach

- SRIM Technical Cost Modeling
 - Preforming
 - Molding
- Truck Bed Case Study
 - Debate between SRIM & SMC for truck bed applications
 - Part size limited in SMC, leading to consideration of SRIM
- Underbody Case Study
 - Potential for composites due to parts consolidation

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SRIM Cost Model Key Factors

P4 Preforming Technology

- Key Inputs
 - Part Geometry
 - Fiber content
 - Scrap rate
- Predictive Capabilities
 - Cycle Time
 - Number of robots
 - Equipment/Tooling Cost

Injection Molding

- Key Inputs
 - Part Geometry
 - Resin Properties
 - Total Yield
- Predictive Capabilities
 - Curing time
 - Part Weight
 - Press Tonnage needed
 - Press/Tooling cost

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Truck Bed Case Study: SRIM Assumptions

- **Technical Specs**
 - Weight: 60 lbs
 - Thickness: 3 mm
 - Projected surface area: 6.5*4.5 sq ft

- **Materials Properties**
 - **Glass chopped fibers**
 - Price: \$1.7/lb
 - Density: 2.54 g/cc
 - **Polyurethane Resin**
 - Price: \$1.5/lb
 - Density: 1.2 g/cc

- **Process Parameters**
 - **Preforming**
 - fiber content: 50%
 - cycle time: 4 min
 - 4 gun robots
 - **Molding**
 - cycle time: 4 min
 - press tonnage: 3000 t
 - total yield loss: 5%

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Truck Bed Case Study: SMC Assumptions

- **Technical Specs**
 - Weight: 60 lbs
 - Thickness: 3 mm
 - Projected surface area: 6.5*4.5 sq ft

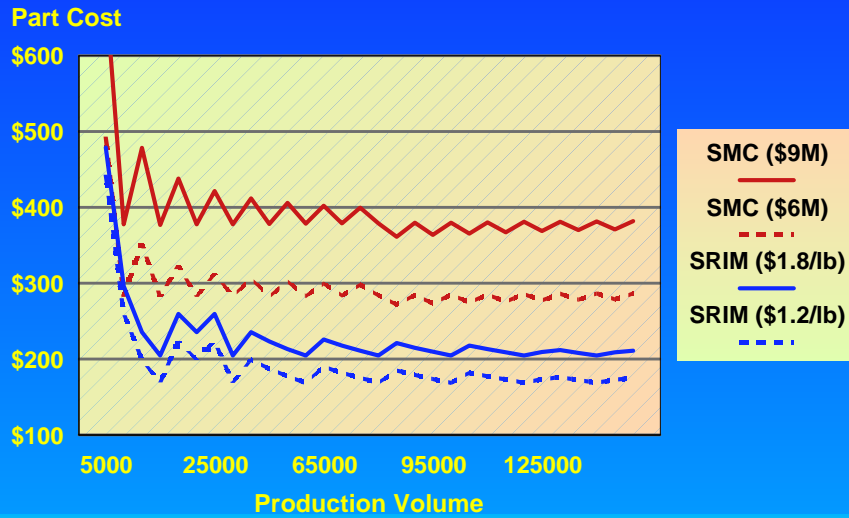
 - **Materials Properties**
 - **Vinyl Ester/ Glass Fiber SMC Sheet**
 - Fiber content: 40%
 - Price: \$0.87/lb
 - Density: 1.8 g/cc

 - **Process Parameters**
 - **Compression Molding**
 - cycle time: 8 min
 - press size: 6,700 t*
 - press cost: \$7,150,000
- * Press size does not currently exist

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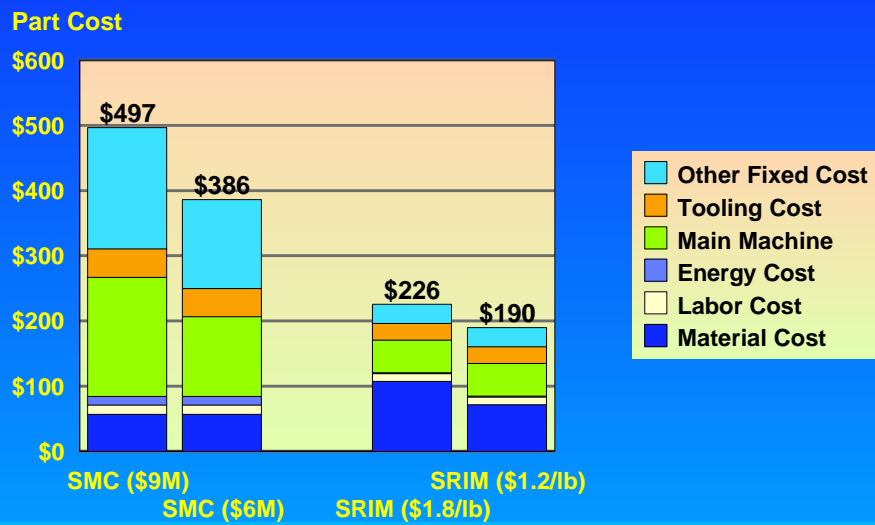
Truck Bed SRIM versus SMC



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SRIM/SMC Cost Breakdown at 35,000 vpy



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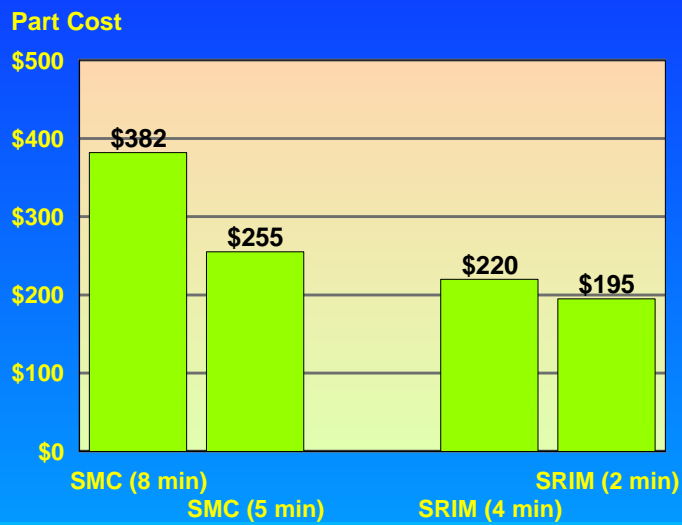
SRIM/SMC Sensitivity to cycle time at 35,000 vpy



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SRIM/SMC Sensitivity to cycle time at 100,000 vpy



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Underbody Case Study: SRIM versus Steel

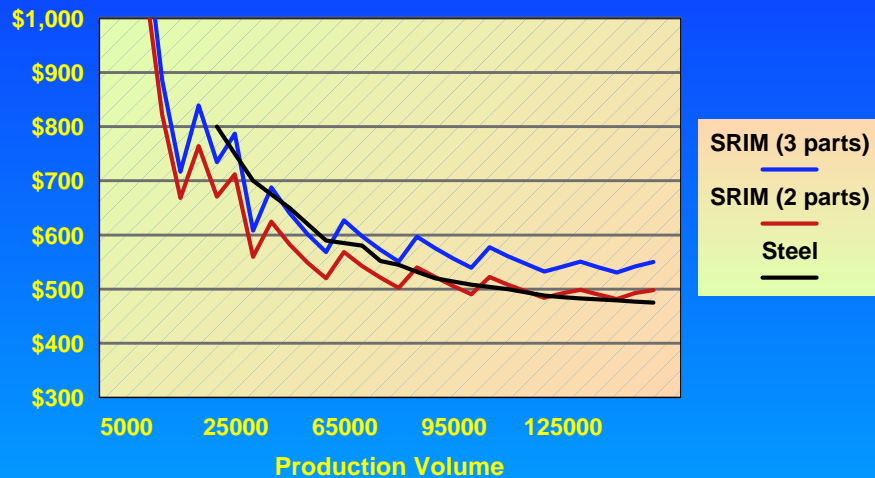
- SRIM Underbody: 3 parts design
 - Design
 - front cross member
 - front floor pan: 7 ft long
 - rear floor pan: 5 ft long
 - Weight: 99 lbs
 - Thickness: 3 mm
 - Cycle Time: 4 min 10 s
- SRIM Underbody: 2 parts design
 - Design
 - front cross member
 - floor pan: 12 ft long
 - Weight: 97.5 lbs
 - Thickness: 3 mm
 - Cycle Time: 4 min 10 s
- SRIM Parts Assembly
 - Adhesive Bonding System
- Steel Comparator Design
 - Honda Odyssey underbody from previous work at MSL
 - 57 steel parts
 - Total weight: 320 lbs

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Underbody SRIM versus Steel

Underbody Cost

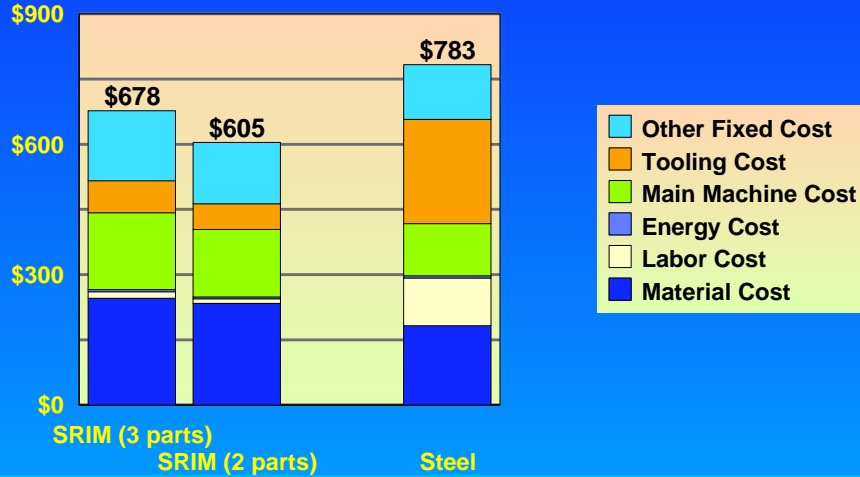


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Underbody Cost breakdown at 35,000 vpy

Underbody Cost

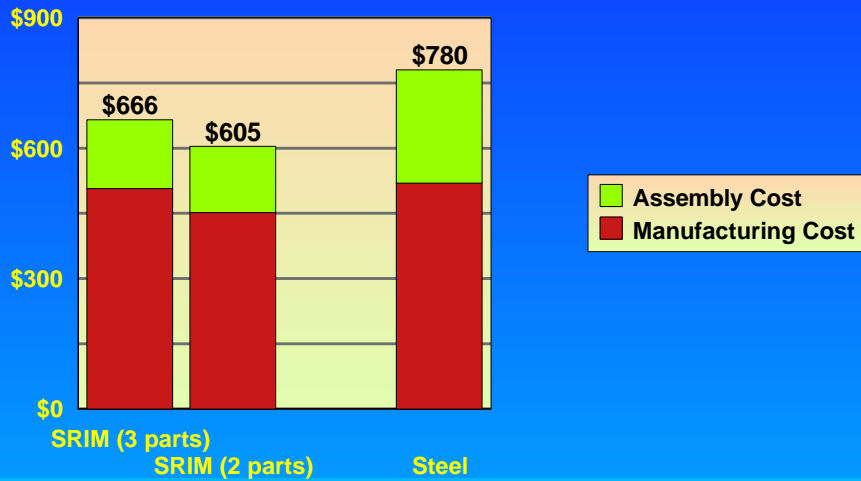


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Underbody Manufacturing versus Assembly at 35,000 vpy

Underbody Cost

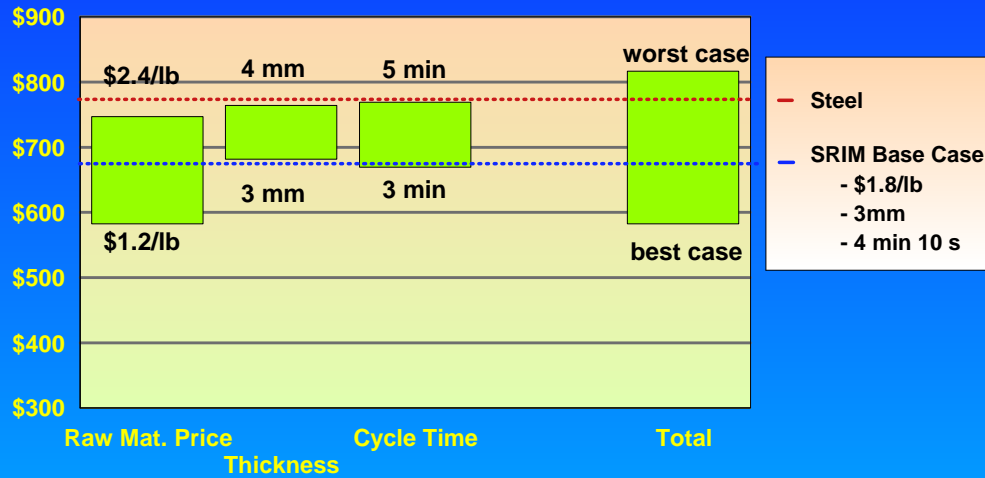


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SRIM Underbody (3 parts) Sensitivity Analysis at 35,000 vpy

Underbody Cost



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Conclusions

- SRIM potential substitute for large steel parts
 - Assemblies with large number of steel components
 - Particularly at low to medium production volumes
- SRIM uncertainties:
 - Process assumptions
 - cycle time, material price, geometry
 - Mechanical properties compared to steel
 - Integration in the assembly line
 - Time to develop the underbody concept

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