Fiscal and Functional Electron-Beam Curing Requirements *for* Enhancing the Properties of Polymeric Materials *in* Automotive Applications

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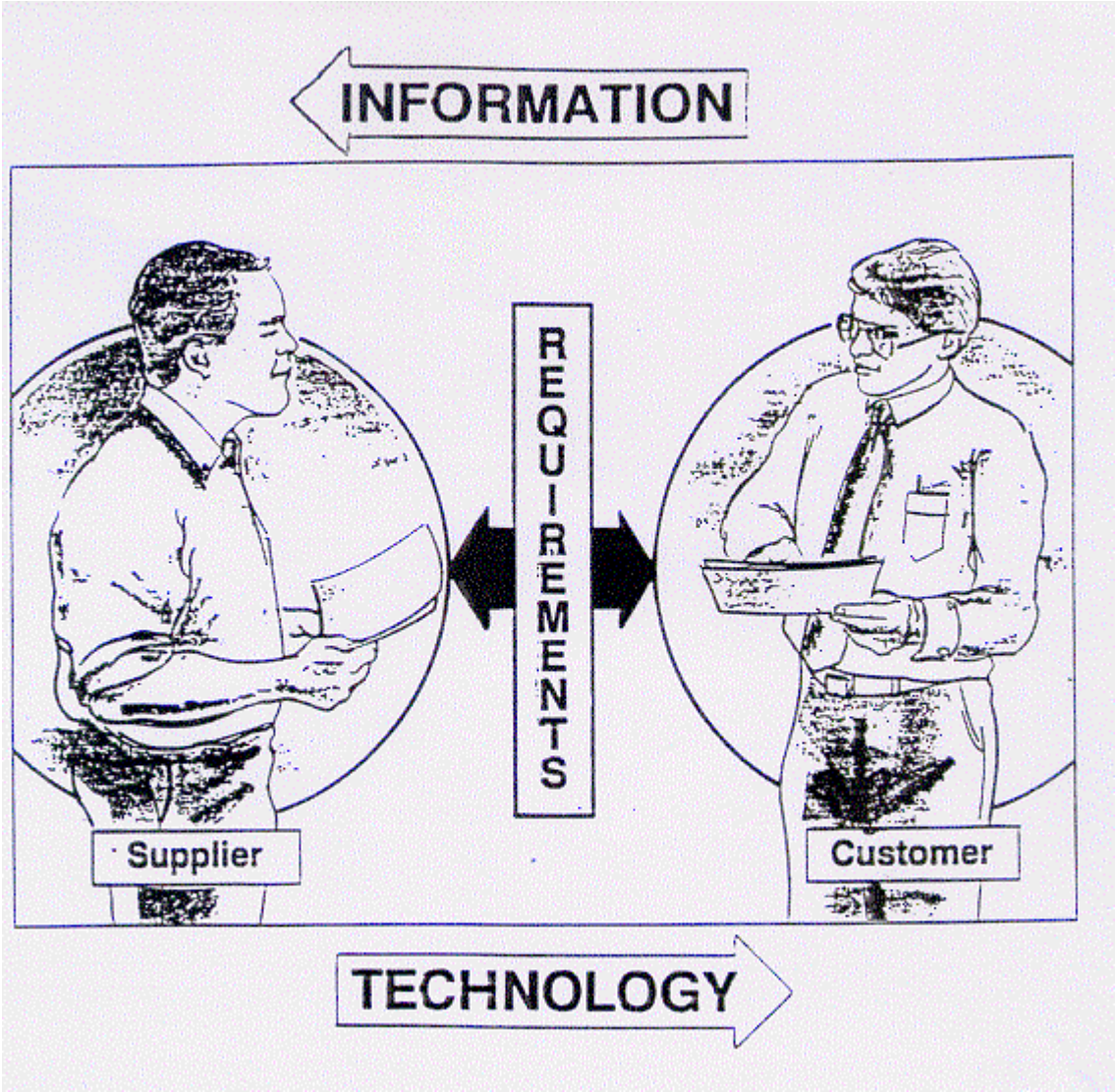
Moving Technology to the Marketplace

Those Who Develop Technology

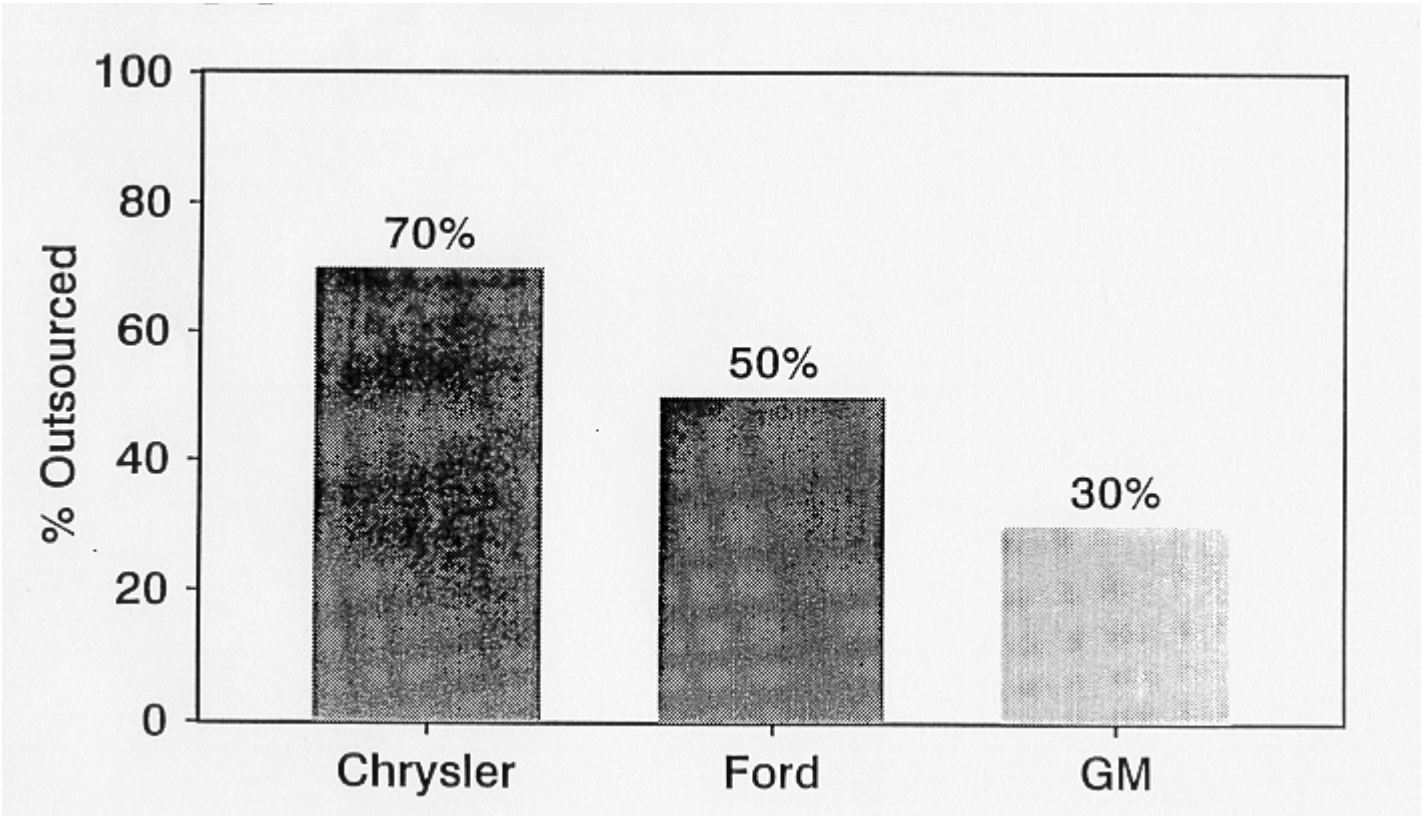
and

Those Who Implement Technology

“Need to Talk”


INFORMATION
REQUIREMENTS
Supplier
Customer
TECHNOLOGY

Supplier Manufactured Parts

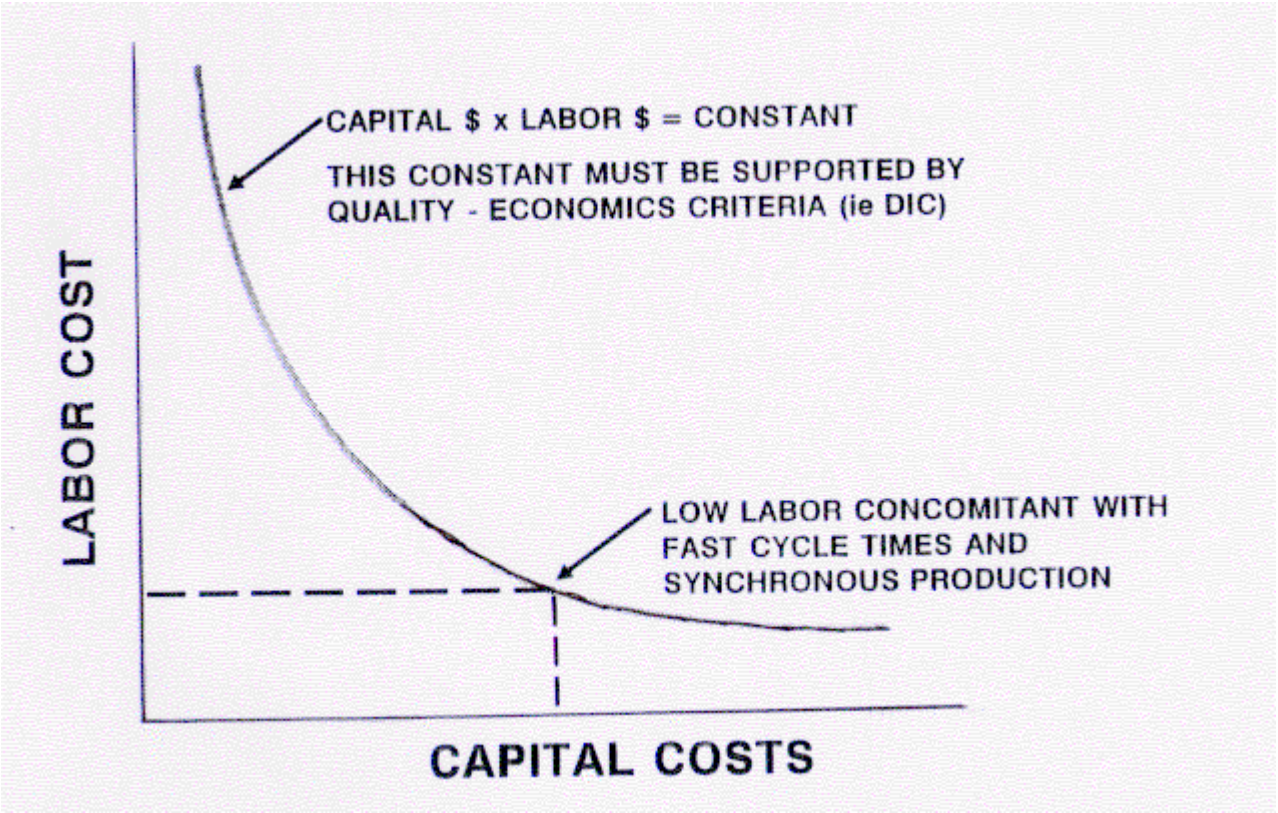


Automotive Industry Requirements

The Three "R's"

- Rapid
  - High Volume Manufacturing
  - Automated
- Robust
  - Operate in a "Non-Ideal" Plant Environment
- Reasonable Cost

Capital vs Labor Costs Constraints



Key Challenges

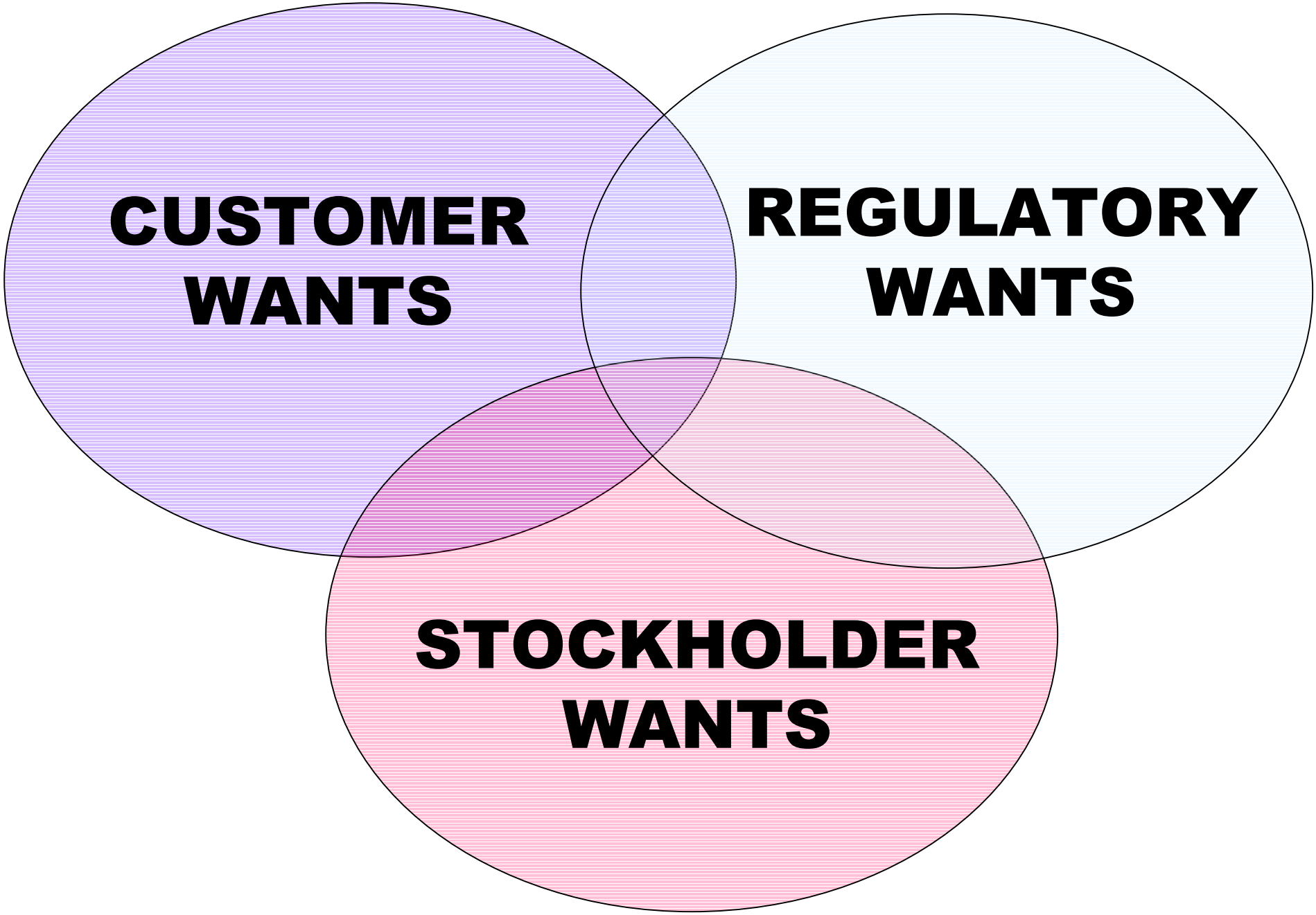
- Improve Quality
- Simplify Manufacturing
- Improve Profitability

KEY CHALLENGES

- Government Regulations

KEY CHALLENGES

- New, Practical Customer Features
- Beating Competition


CUSTOMER WANTS
REGULATORY WANTS
STOCKHOLDER WANTS

PNGV™

PARTNERSHIP FOR A NEW GENERATION OF VEHICLES

GOAL THREE

- Triple current fuel economy (80 mpg)
- Intrepid/Lumina/Taurus size, performance and cost
- Meet current and anticipated safety standards
- Improved recyclability and reduced vehicle emissions
- Concept vehicle by 2000 and production prototype by 2004

PNGV Vehicle Mass Reduction Goals for 3X Fuel Economy Gain

System	Current Vehicle (lbs)	Target (lbs)	% Decrease
Body	1,134	566	50
Chassis	1,101	550	50
Powertrain	868	781	10
Fuel / Other	137	63	55
Curb Weight	3,240	1,960	40

Supercar Supporting Technologies

- Materials
- Propulsion
- Energy Storage
- Electrical Components and Control System
- Design
- Manufacturing

Supporting Automotive Technologies

Materials

- Advanced Metals (Ti, etc.)
- Lightweight Metals (Al, Mg, etc.)
- Engineering Plastics
- Polymer Composites
- Metal-Matrix Composites
- Ceramics
- Iron
- Steel

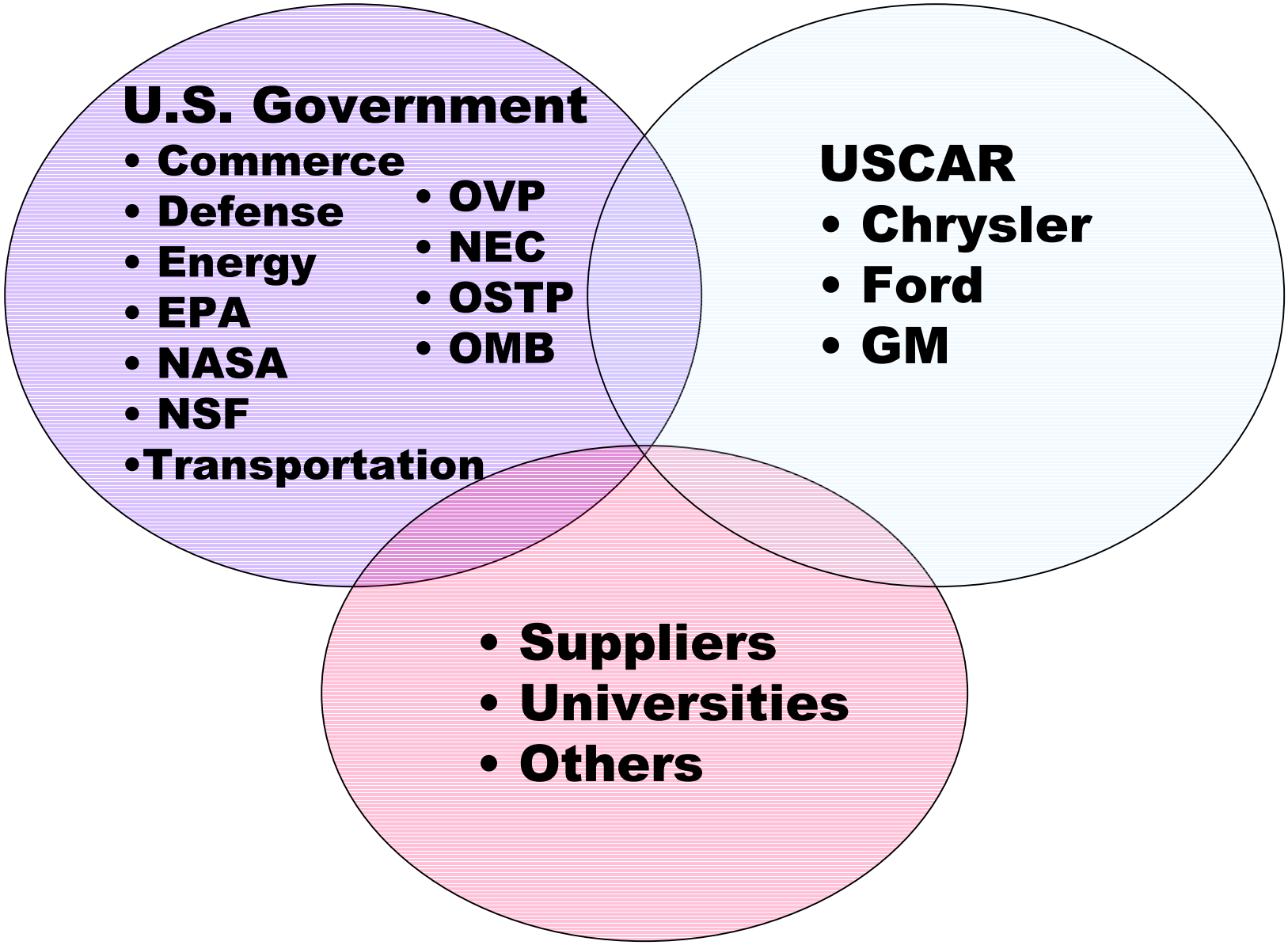
Dominant Constraints for Advanced Materials

- Customer Acceptance (Internal)
- Market Acceptance (External Customers)
- Economic Issues
- Environmental Issues (At Low and High Production Volumes)

Supercar Dominant Constraints

- Market Acceptance
- Economic Affordability
- Environmental Impact

PARTNERSHIP FOR A NEW GENERATION OF VEHICLES



USCAR Consortia

- Auto / Oil Air Quality Improvement Research Program
- ✔ CAD / CAM Partnership
- Electrical Wiring Component Application Partnership
- ✔ Environment Research Consortium
- High Speed Serial Data Communications R&D Partnership
- ✔ Low Emissions Paint Consortium
- ✔ Low Emissions Technologies R&D Partnership
- Natural Gas Vehicle Technology Partnership
- Occupant Safety Research Partnership
- ✔ Supercomputer Automotive Applications Partnership
- ✔ United States Advanced Battery Consortium
- ✔ United States Automotive Materials Partnership (USAMP)
- Vehicle Recycling Partnership

✔ Supports PNGV Goals

Why We Need Polymer Composites in Automotive Applications

- Reduce Vehicle Weight
  - Reduce Energy Consumption
  - Reduce Impact on the Environment
  - Reduce Dependence on Imported Fuel
    - Reduce Trade Deficit
- Reduce Tooling Investment Cost
  - Reduce Manufacturing Complexity
  - Reduce Break-Even Volume

WHY PLASTIC?

- Integration of Components
- Provide 6 Piece Body vs. 100 Pieces in Steel
- Molded in Color
- Reduce Weight by 50%
- Reduce Cost by 20%
- Reduces Tooling by 70%
- Reduced Labor
- Reduced Plant Size

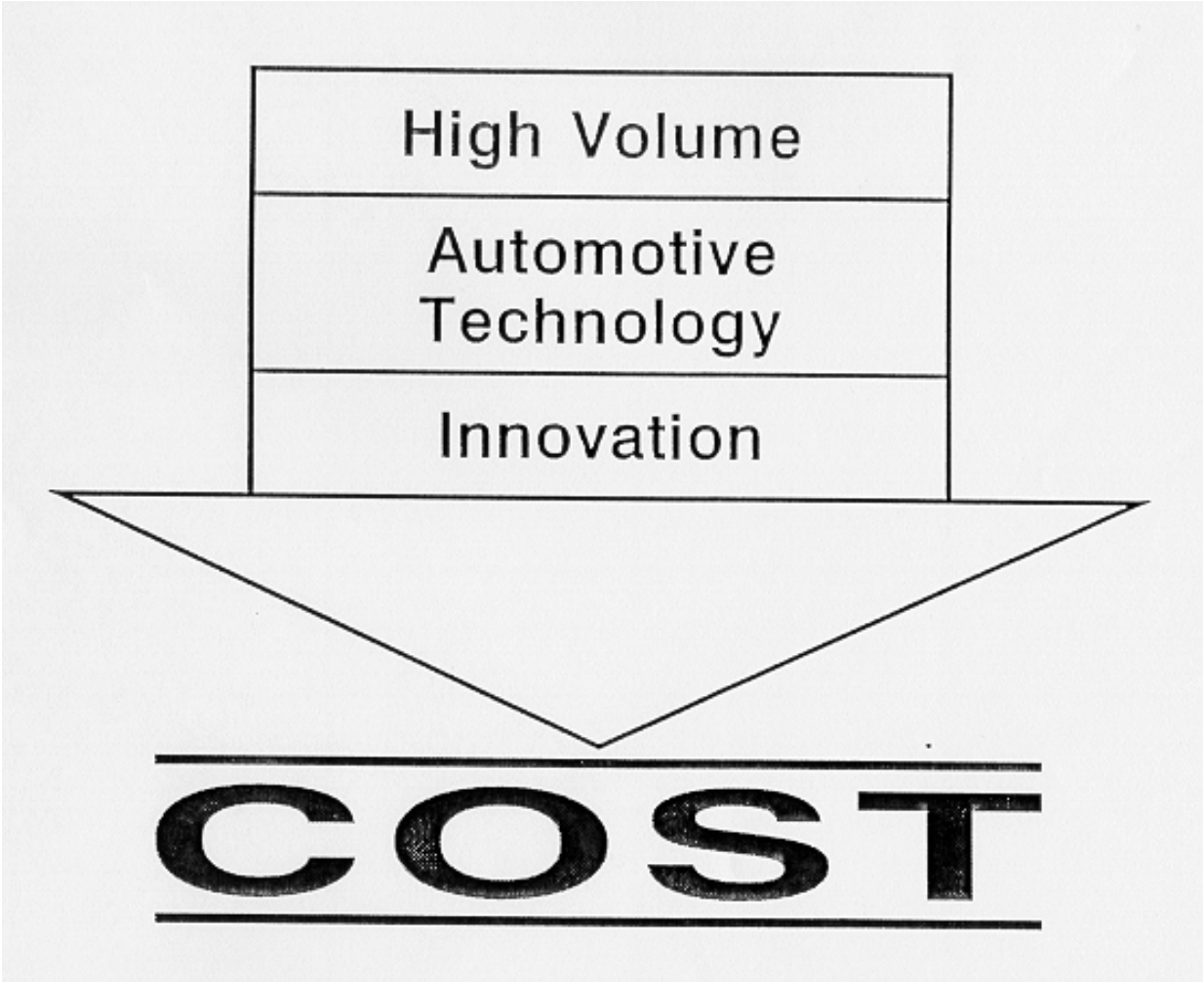
Composites for Automotive Structural Applications

OUTLINE

- Why We Need Composites
- What are the Requirements and Constraints Imposed on Composites
- What is Being Done to Develop and Implement Composites
- What We Can Do to Support These Efforts and the Larger Objective

Automotive Composites Requirements

- Low Materials Cost
- Short Cycle Time
- Robust Processing Window
- Fast, Reliable Assembly/Joining Technology
- Long Durability in Automotive Environments
- Reliable and Acceptable Crash Energy Management
- Minimal Environmental Impact
- Energy-Efficient Manufacturing
- Customer Acceptance
- High Performance-to-Weight Ratio


High Volume
Automotive Technology
Innovation
COST

Fuel Costs for Traveling 100,000 Miles in a Five-Passenger Car at 27 Miles / Gallon were 3,704 Gallons x $1.23 / Gallon = $4,555

Fuel Costs for Traveling 100,000 Miles in a Five-Passenger Car at 27 Miles / Gallon were 3,704 Gallons x $1.23 / Gallon = $4,555

And in a Five-Passenger Car at 82 Miles / Gallon were 1,220 Gallons x $1.23 / Gallon = $1,500

The Difference in Fuel Costs would be $3,055

(Plus Environmental Costs)

If Fuel Costs for Traveling 100,000 Miles in a Five-Passenger Car at 27 Miles / Gallon were 3,704 Gallons x $3.45 / Gallon = $12,778

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And in a Five-Passenger Car at 82 Miles / Gallon were 1,220 Gallons x $3.45 / Gallon = $4,207

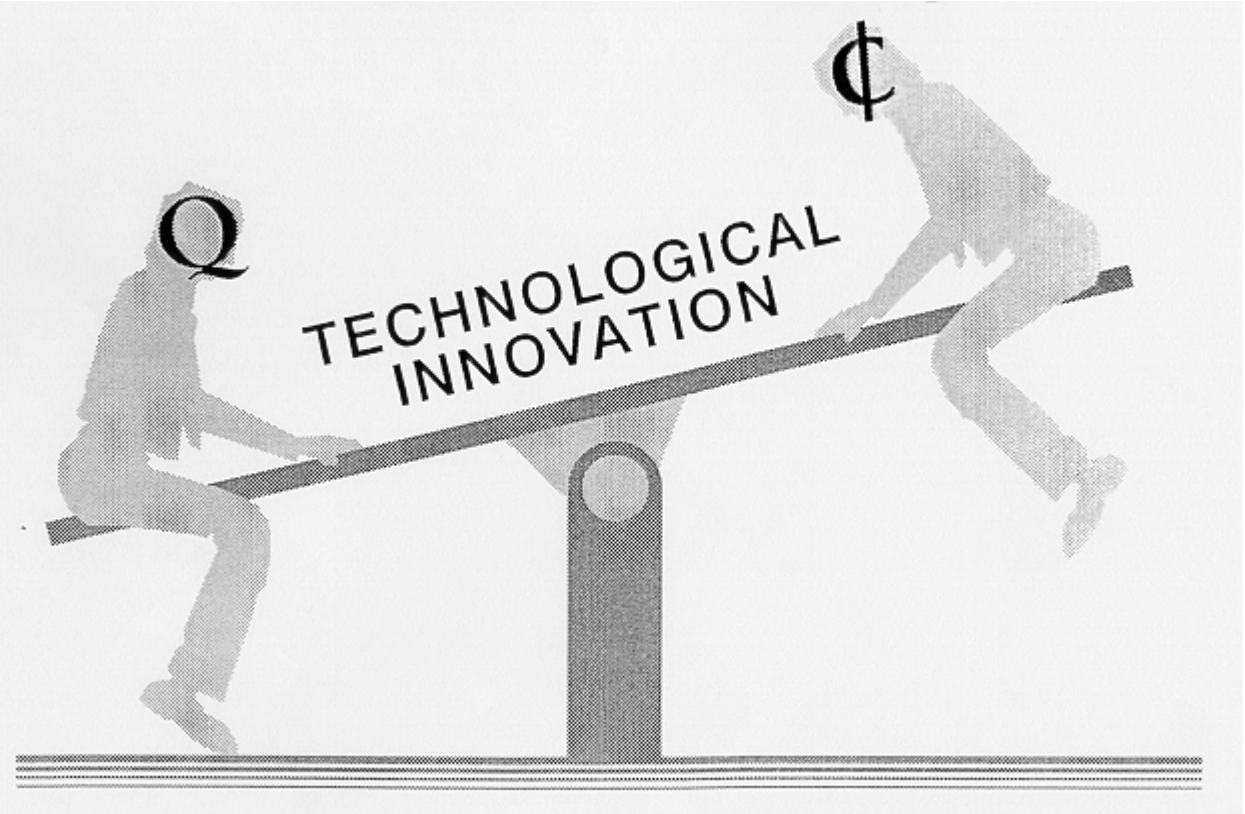
If Fuel Costs for Traveling 100,000 Miles in a Five-Passenger Car at 27 Miles / Gallon were 3,704 Gallons x $3.45 / Gallon = $12,778

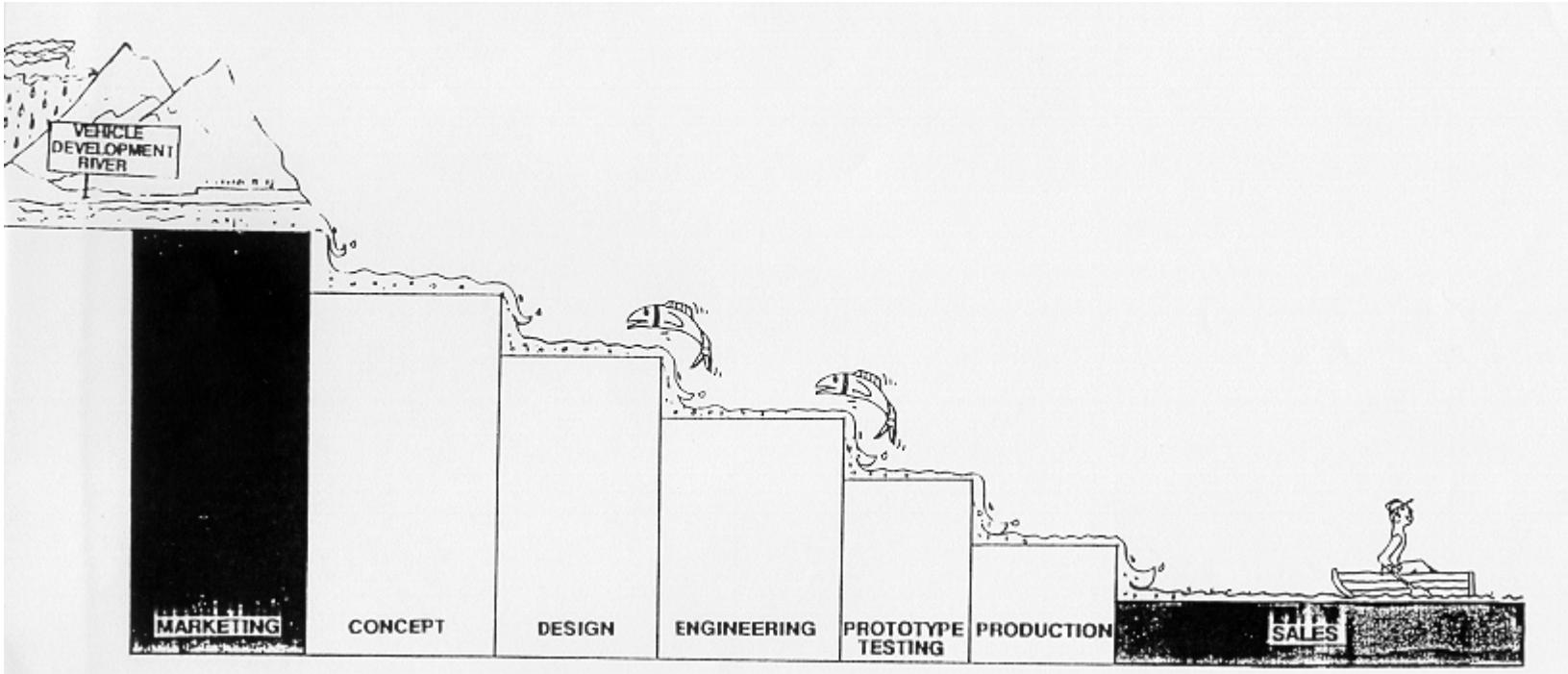
And in a Five-Passenger Car at 82 Miles / Gallon were 1,220 Gallons x $3.45 / Gallon = $4,207

The Difference in Fuel Costs would be $8,571

(Plus Environmental, Economic and Political Costs)

Technology Leveraging of Cost and Quality



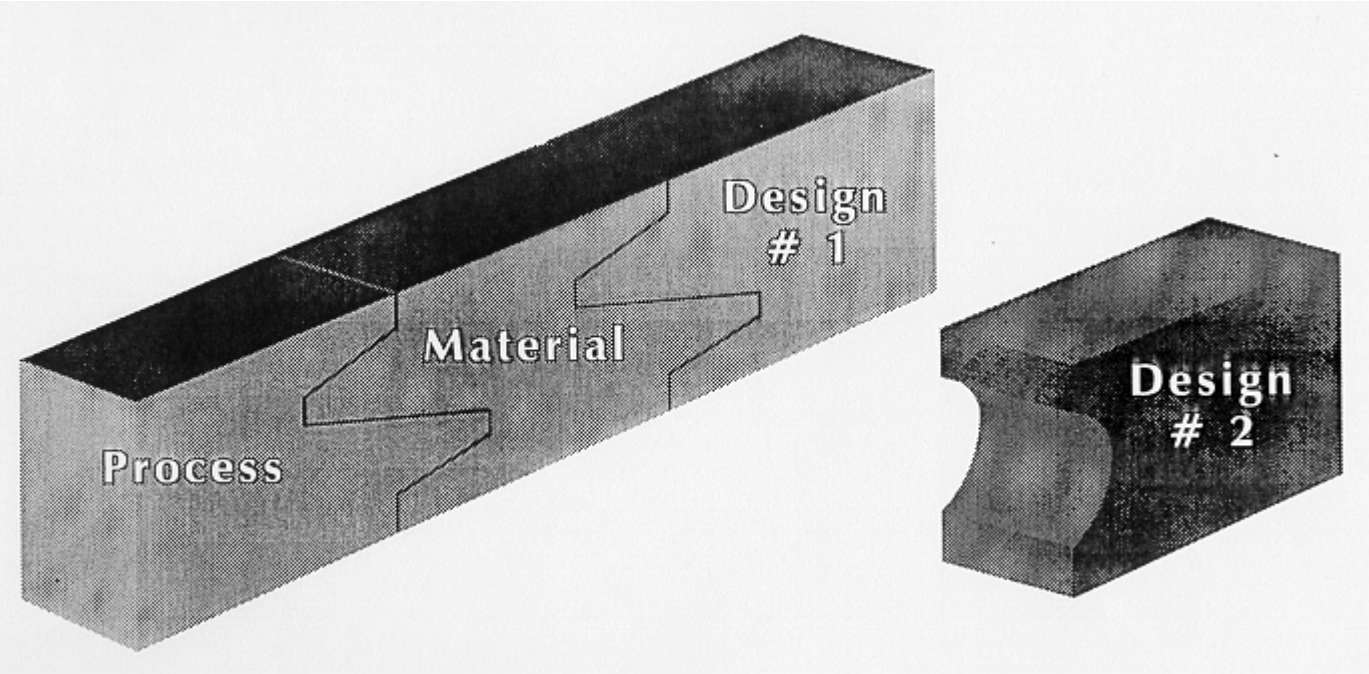


Product Development River

New Materials, Processes and Designs

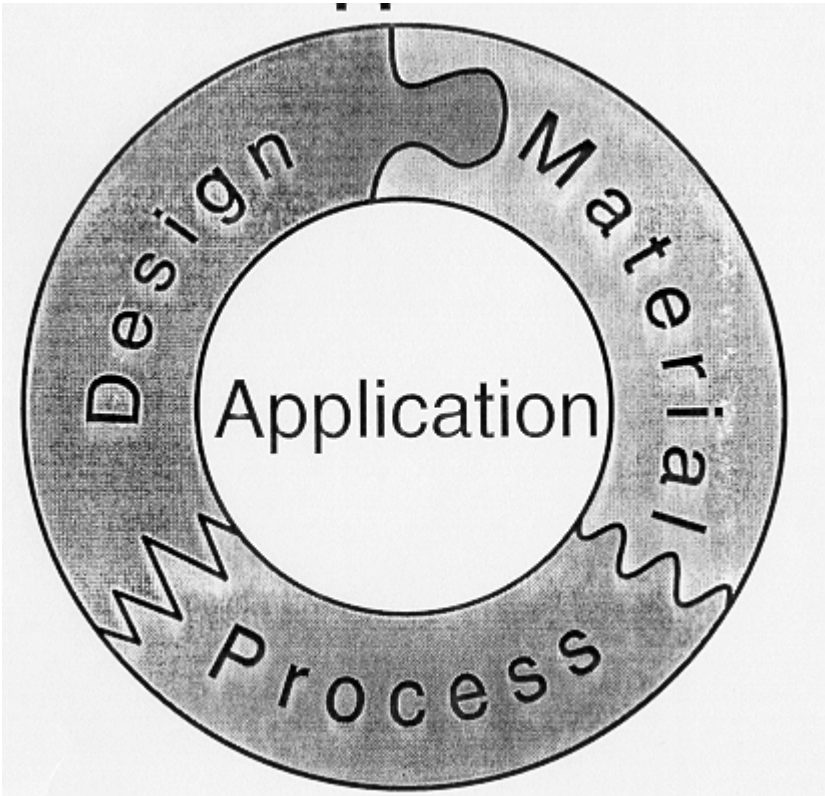
Are Being Developed to Reduce Weight, Improve Performance and Increase Energy Efficiency

Implementation Match

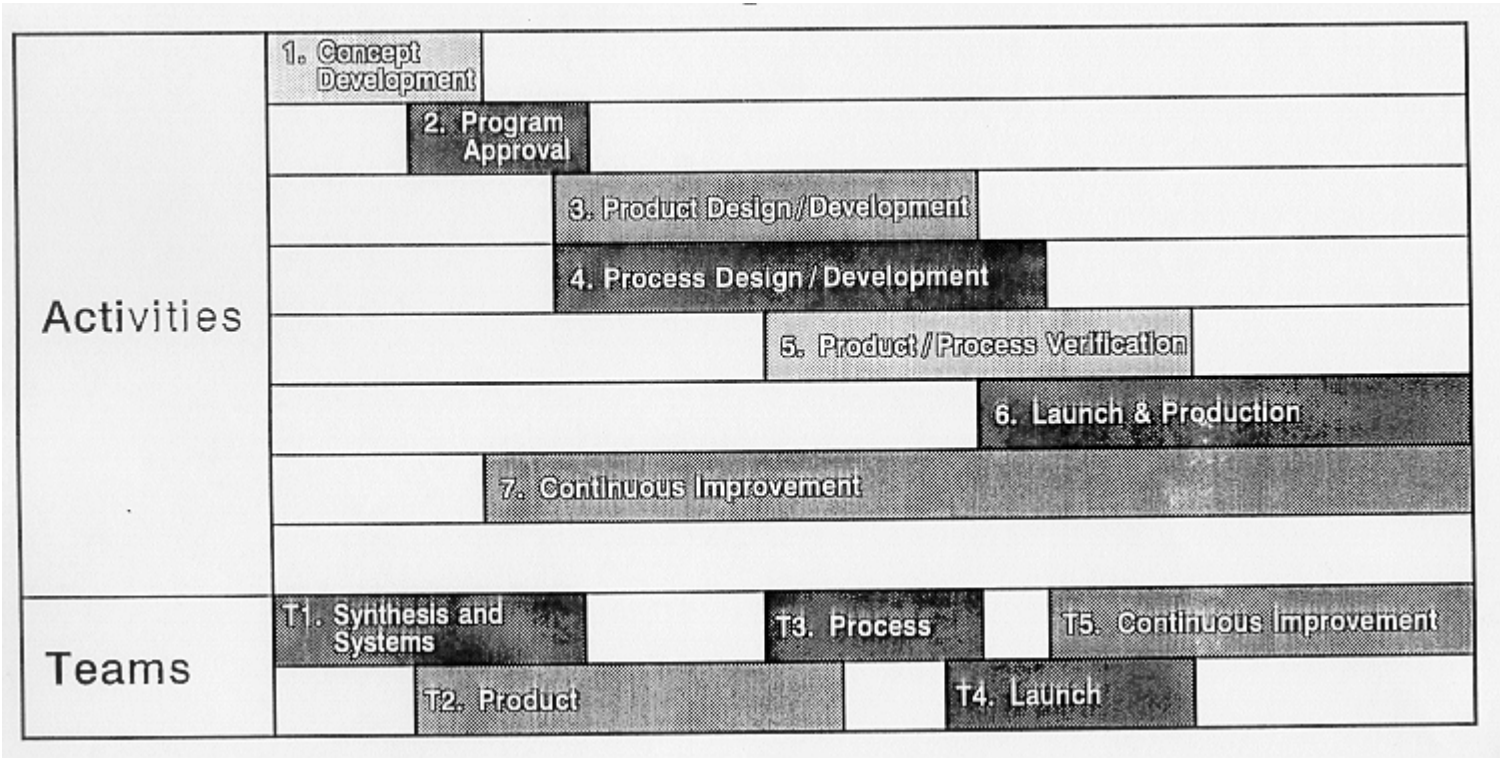


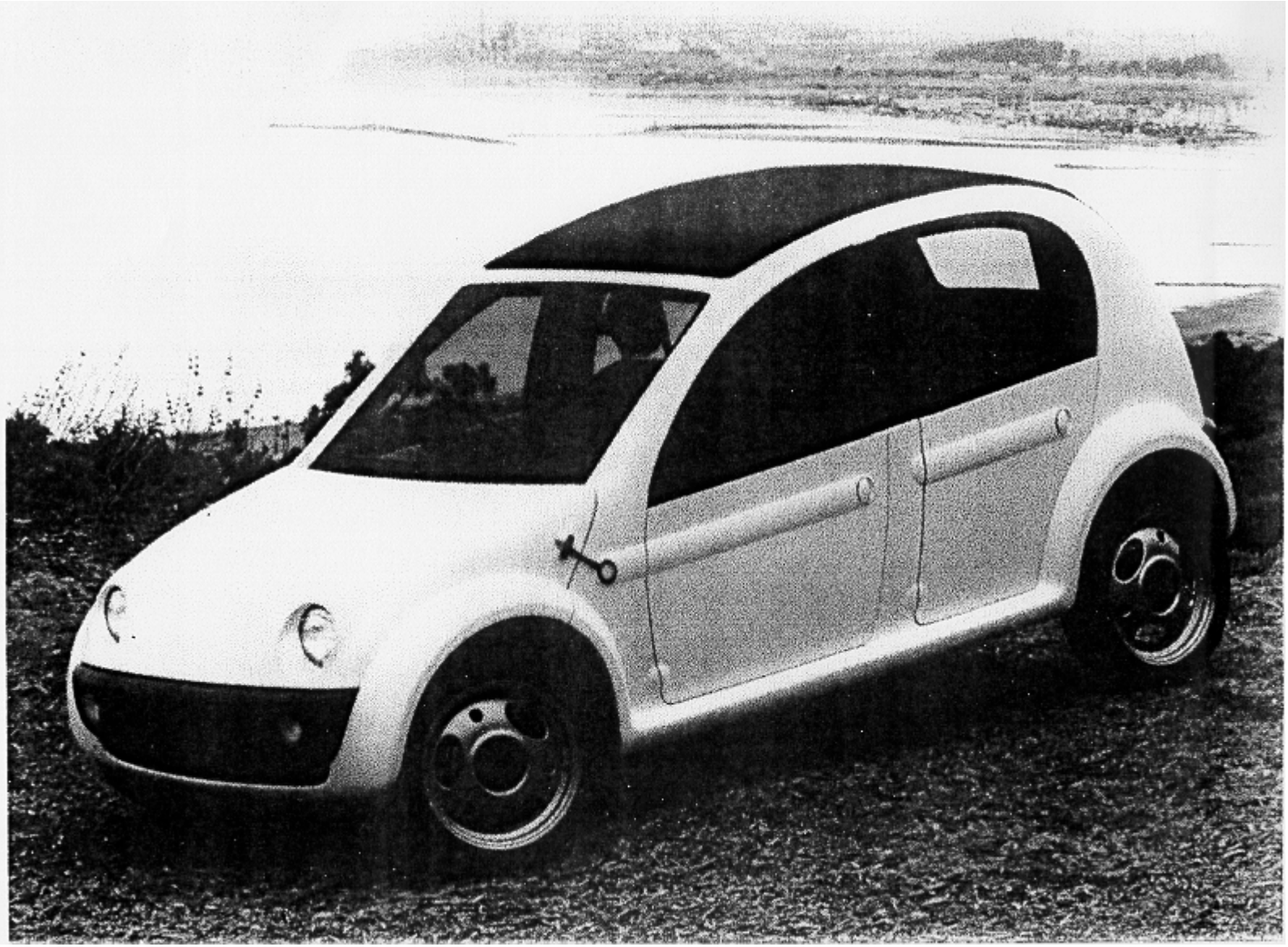
The Design Must Match the Process & the Material

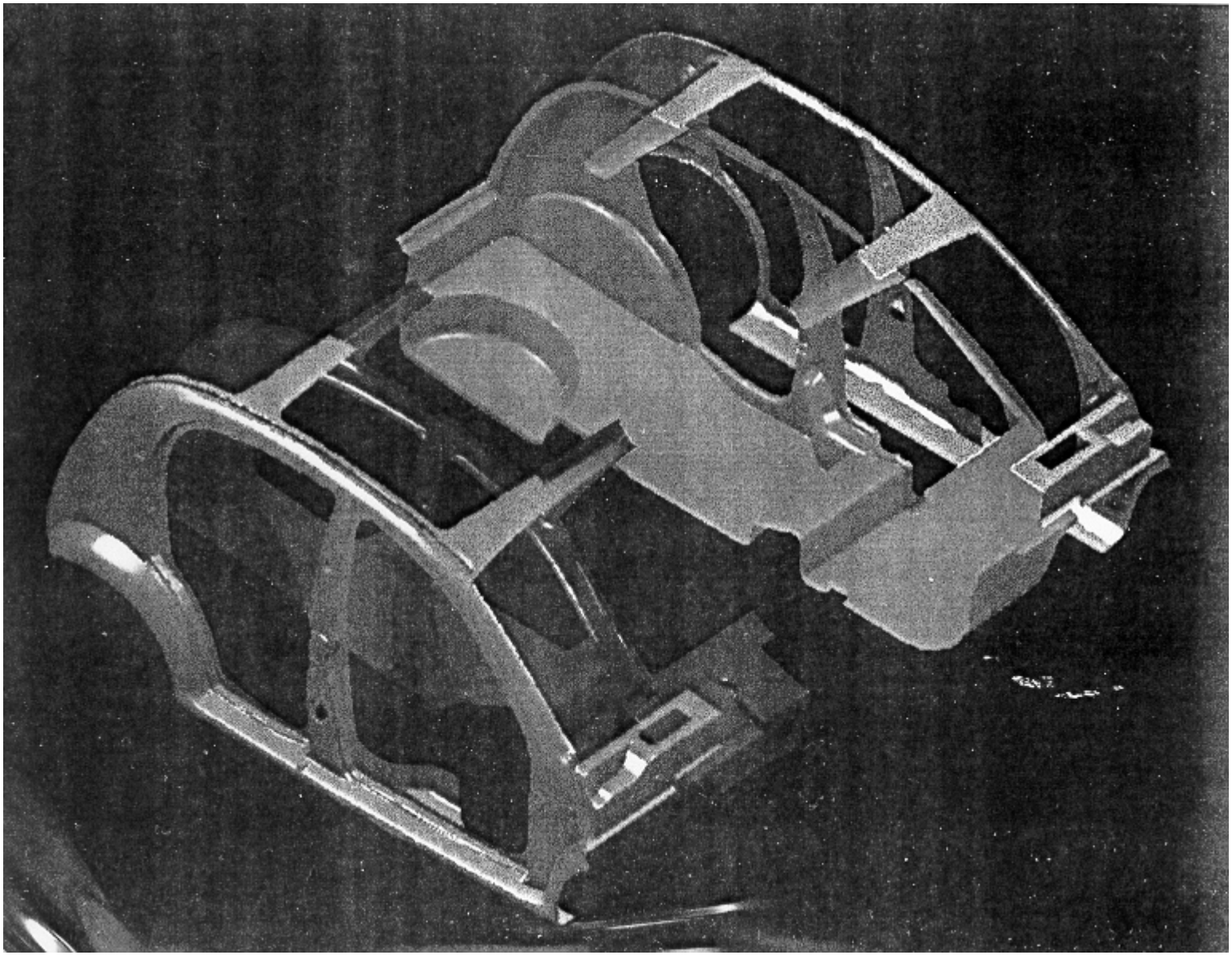
Composites Design, Materials and Processes Must Be Compatible and Fit the Application



A Typical Simultaneous Engineering Vehicle Development Process







Benefits of Structural Adhesive Bonding

- Compatible with New, Lightweight Materials (Composites)
  - Decrease Vehicle Weight
  - Improve Fuel Economy
  - Meet New Government Fuel Economy Regulations (CAFE, Etc.)
  - Improve Consumer Perception of Product
- Benefits of Structural Bonding over Mechanical Fastening
  - Better Strength to Weight Ratio
  - Improved Ability to Join Dissimilar Materials
  - Increased Design Flexibility
  - Better Stress Distribution
- Composites Mandate “New” Joining Techniques
  - Thermoset Polymer Composites Can Not Be Welded

An Adhesive Bonding Requirement Impacting Design

BEWARE

A Bond Joint one inch wide provides at best

600 PSI ⇒ 600 lbs/in.

Most Often 600 PSI x 0.7 BMF ⇒ 420 lbs/in.

Marginally 600 PSI x 0.5 BMF ⇒ 300 lbs/in.

A Bond Joint 1/2 in. wide provides at best

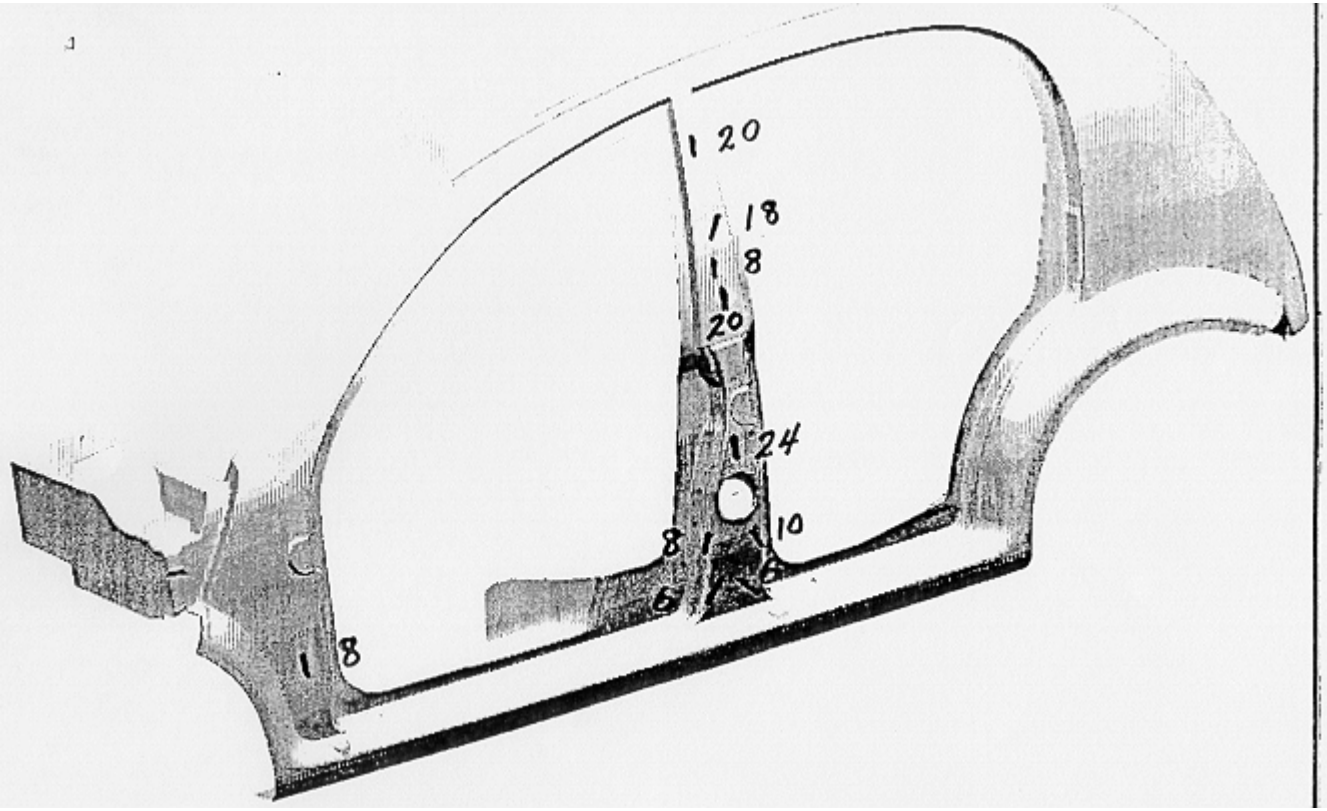
600 PSI ⇒ 300 lbs/in.

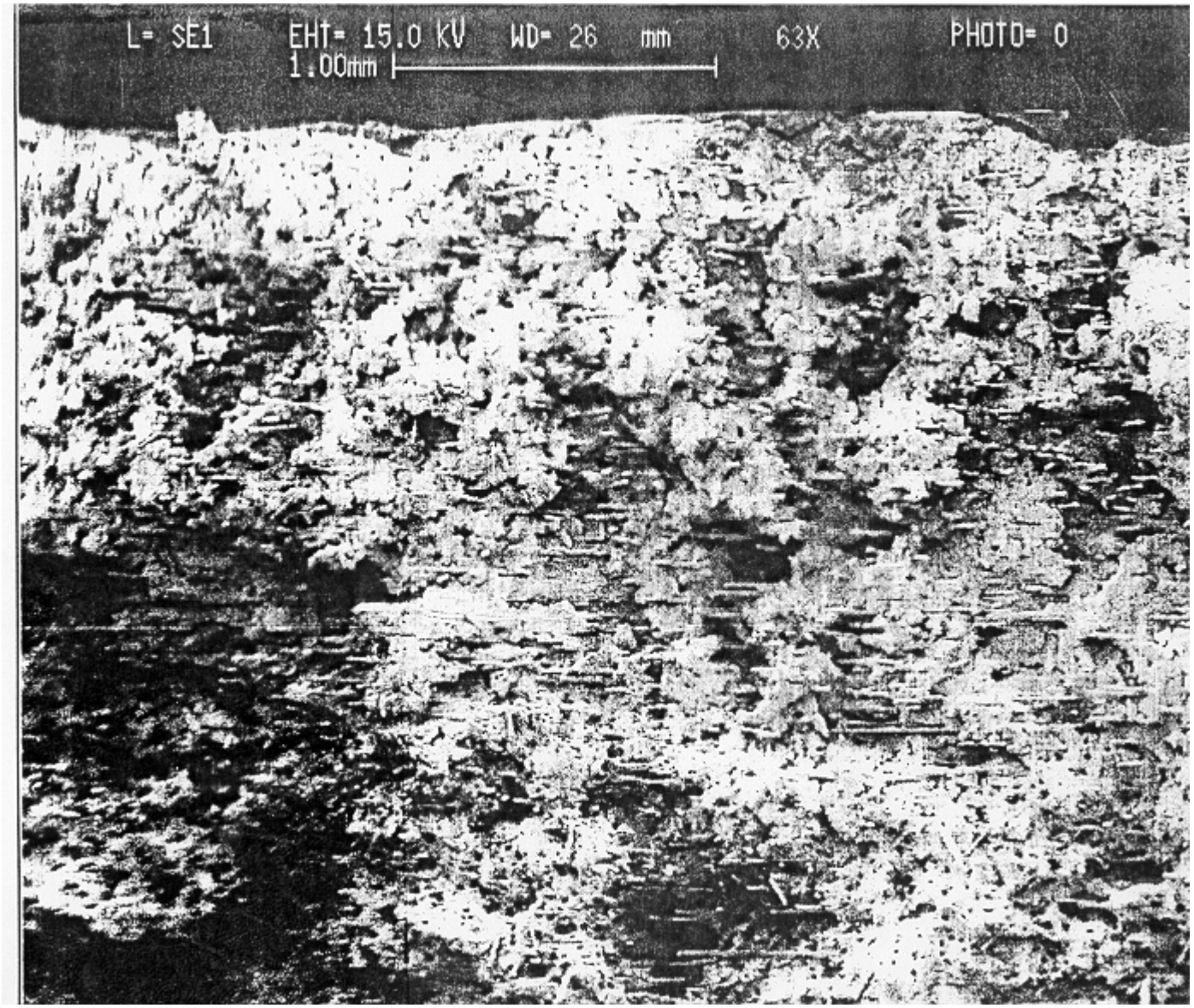
Most Often 600 PSI x 0.7 BMF ⇒ 210 lbs/in.

Marginally 600 PSI x 0.5 BMF ⇒ 150 lbs/in. *Not Good!*

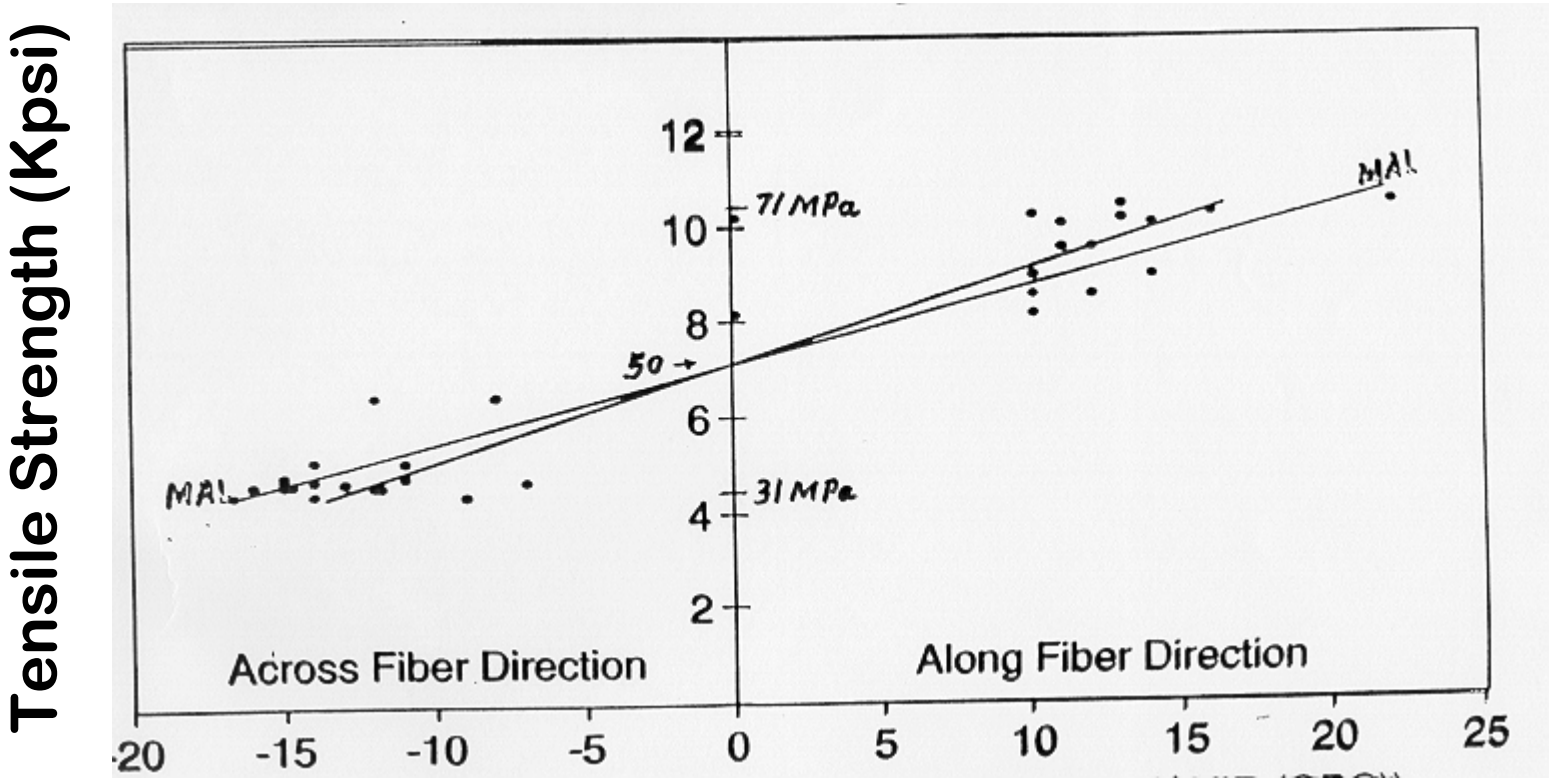
Steel body spot welds provide (varies widely) ~ 1100 lbs each (at best) 550 lbs/in.

More Definitive Info obtained from M.E.

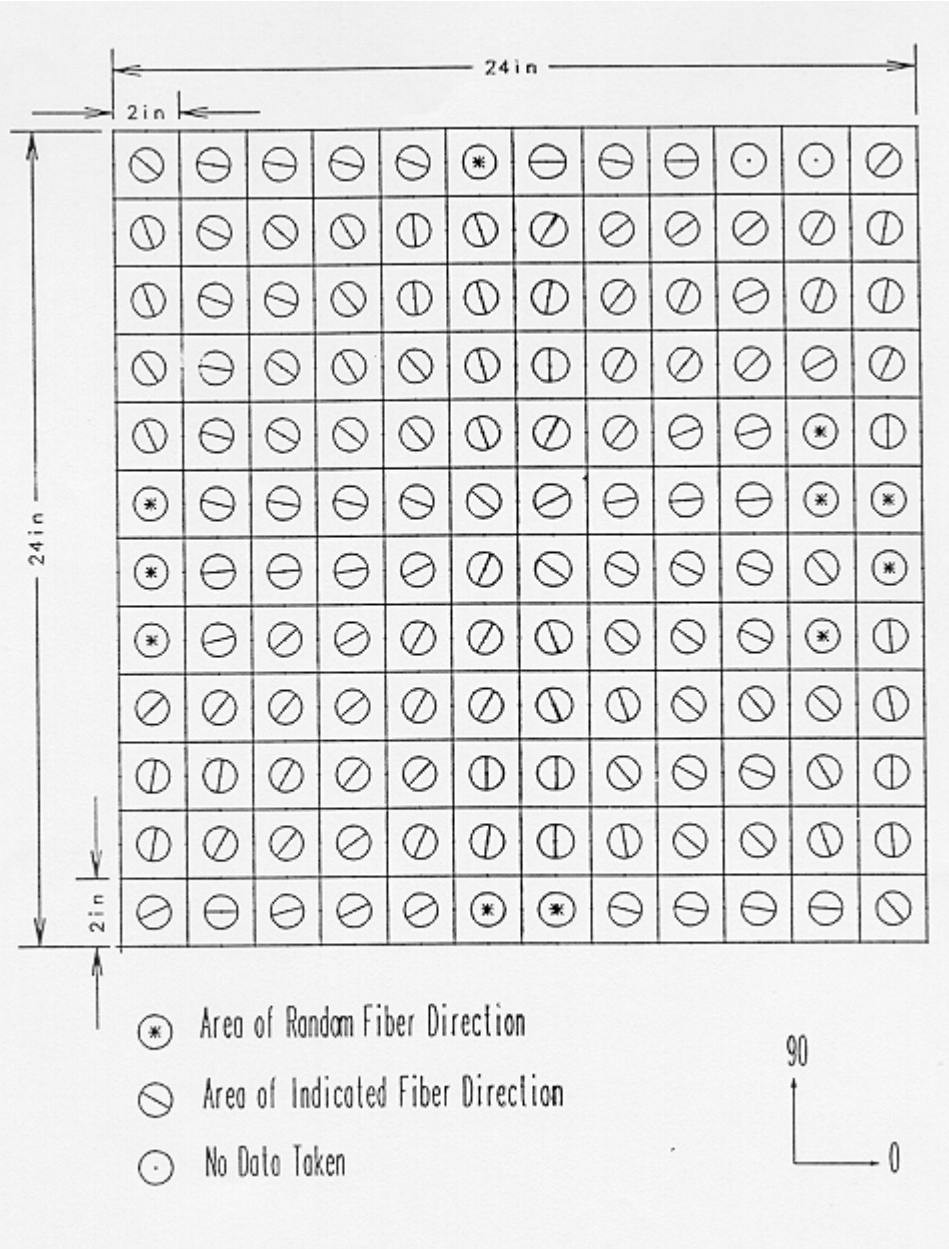
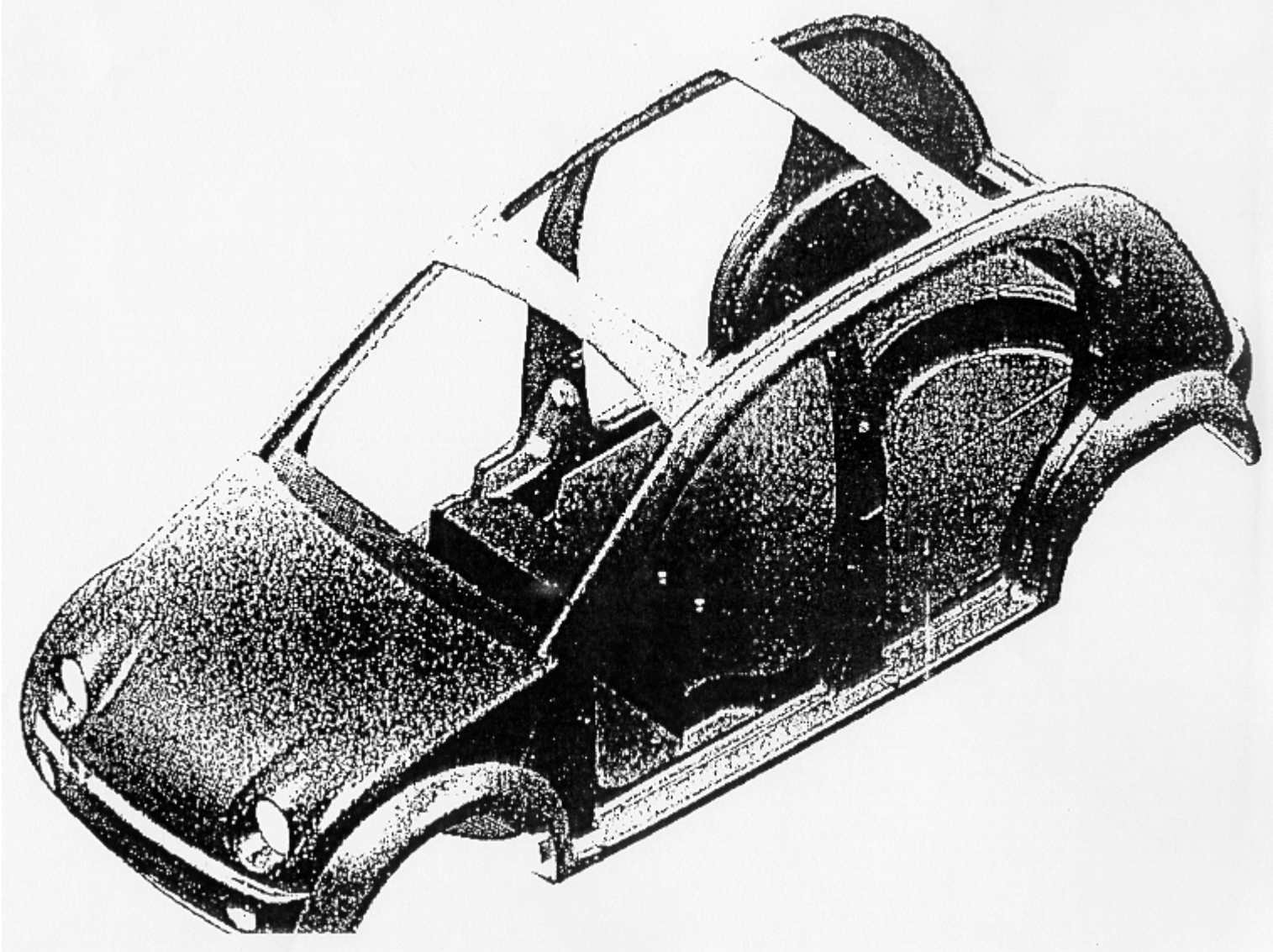

20
18
8
20
24
10
8
6
8


L= SE1
EHT= 15.0 kV
WD= 26 mm
63X
PHOTO= 0
1.00mm

Tensile Strength vs. Fiber Orientation for Glass-Fiber Reinforced, Injection Molded PET



Maximum Change in Velocity - Indicator Reading (ΔVIR)


24 in
2 in
24 in
2 in
Area of Random Fiber Direction
Area of Indicated Fiber Direction
No Data Taken
90
0