



Robert Eller Associates, Inc.

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

LIGHTWEIGHT COMPOSITES AND NATURAL FIBERS IN AUTO INTERIORS

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PREPARED FOR:

PLASTICS IN AUTO INTERIORS

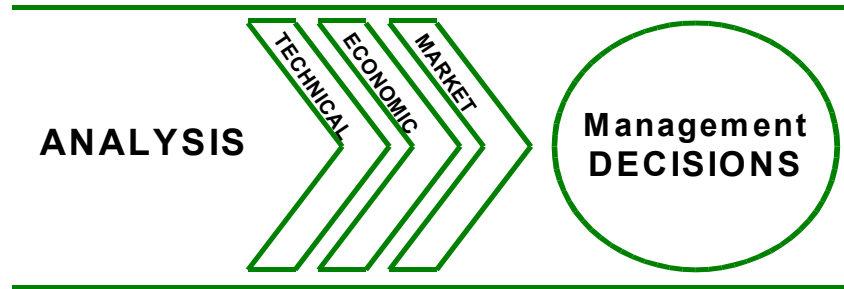
Frankfurt, Germany

January 19, 2005

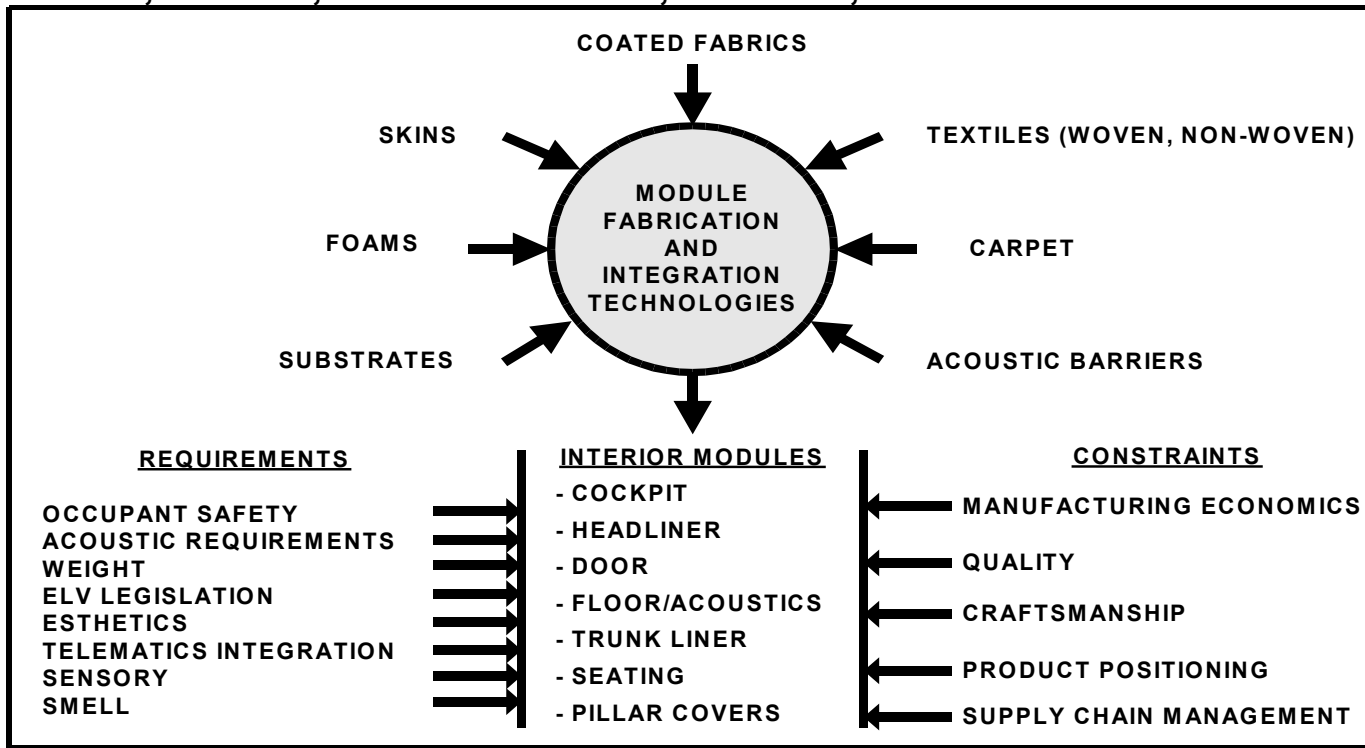
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HIGHLIGHTS

- **AUTOMOTIVE ECONOMICS/EFFECTS ON COMPOSITES INDUSTRY STRUCTURE**
- **PERFORMANCE EFFECTS ON MKT POTENTIAL**
- **LIGHTWEIGHT COMPOSITES MARKET POSITION**
- **COMPETITION WITH NON-COMPOSITES**
- **INTRA-COMPOSITE COMPETITION**
- **INDUSTRY STRUCTURE SHIFTS**



Automotive Interior Soft Trim: Skins, Foams, Coated Fabrics, Textiles, and Acoustic Barriers



Prospectus for a Global Multiclient Industry Analysis
Robert Eller Associates, Inc.

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Support of Management Decisionmaking*

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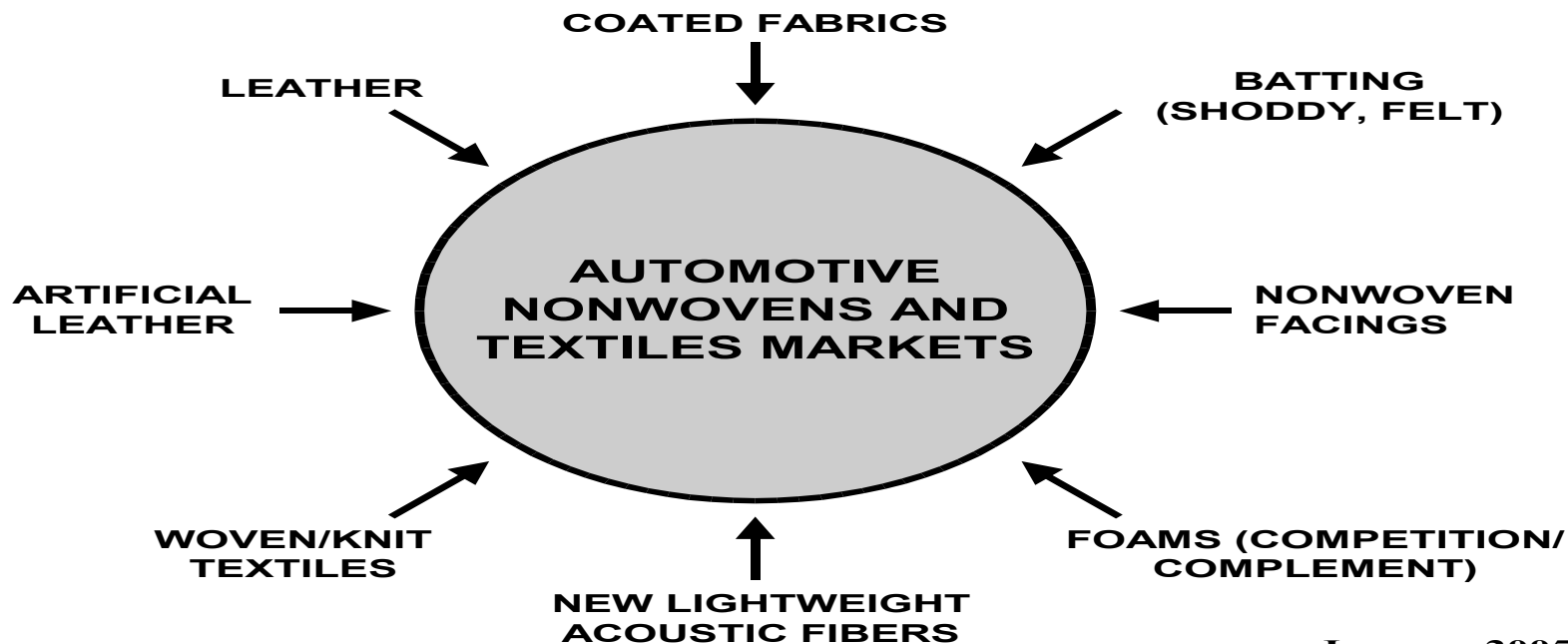
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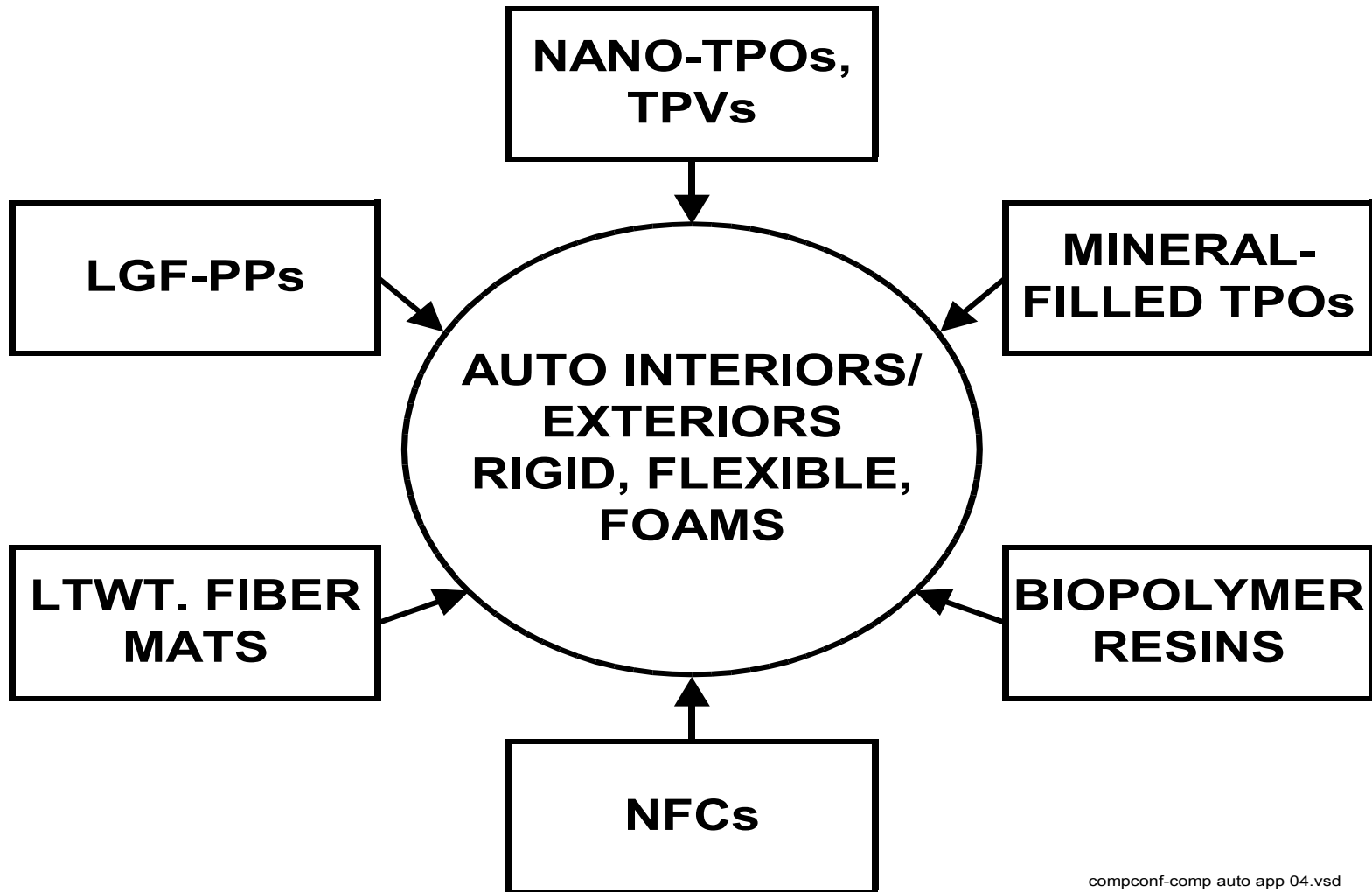
**Prospectus for a Multiclient Study
Completed December 2004**

**Opportunities for Advanced Technology
Nonwovens for Automotive Surface and Construction
Applications in N. America and Europe**



January 2005

COMPOSITES COMPETITION FOR AUTOMOTIVE APPLICATIONS



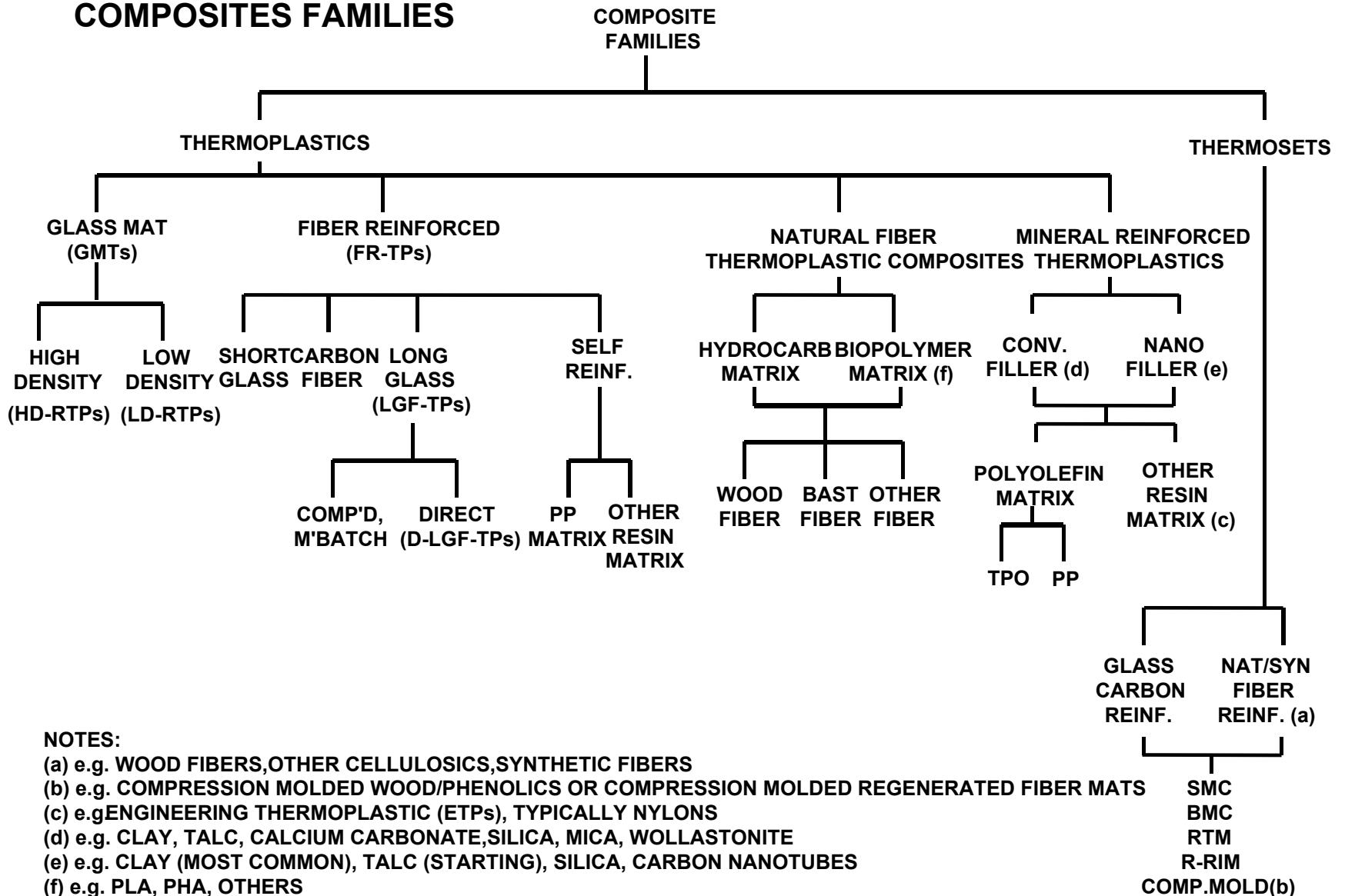
OPERATING HYPOTHESES

- **COMPOSITE TARGET CLASSES INCLUDE:**
 - **STRUCTURAL (XC BEAM, FLOOR, ROOF)**
 - **SEMI-STRUCTURAL (FLR MODULE, HL)**
 - **MECHANICAL**
 - **NON-STRUCTURAL (SEAT BACKS, DOOR TRIM)**
- **INTER-MATERIAL AND INTER-PROCESS COMPETITION**
- **ENERGY ABSORPTION IS A DRIVER**
- **INTEGRATION OF EA AND ACOUSTICS**
- **THERMOPLASTICS WHERE POSSIBLE**
- **WEIGHT SAVINGS INCENTIVES INCREASE**
- **SPACE SAVINGS ARE VALUED**

OPERATING HYPOTHESES (CONT'D)

- **NATURAL FIBERS CAN/WILL COMPETE**
- **NATURAL FIBER CHALLENGE TO GLASS FIBERS**
- **GROWTH OF “TALL CARS”: FLR MODULE GROWTH**
- **FLOOR MODULES: LARGER, MORE COMPLEX**
- **EUROPEAN FEM GROWTH: STIMULATE COMPOSITES**
- **COMPOSITES SUPPLY CHAIN CONSOLIDATION**
- **BIOMATERIALS ENTERING: FIBERS/MATRICES**
- **NANO-COMPOSITE TECHNOLOGY: N. AMERICA MORE ADVANCED**

COMPOSITES FAMILIES



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

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AUTO INDUSTRY EFFECTS

- **SLOW EMERGENCE FROM RECESSION?**
- **TIER 1 PROFITABILITY SQUEEZE**
- **GLOBAL PARTS SOURCING (CHINA)**
- **TIER 1 CONSOLIDATION: INCREASE PURCHASE POWER**
- **DOMESTIC OEM MKT SHARE LOSS**
- **HIGH VOLUME PLATFORM GROWTH**

COMPOSITES SUPPLY CHAIN SHIFT

- **BROADENED COMPOUNDER PROD. LINES**
- **FIBER/NANO-CONCENTRATES STARTING**
- **DIRECT COMPOUNDING GROWING**
- **NATURAL FIBERS, BIOPOLYMERS, NANO
COMPETING**
- **MODULARIZATION:INTEGRATION VIA
COMPOSITES**
- **COMPOSITES ENTERING NEW VEHICLE
MODULES/FUNCTIONS**

INTRA-COMPOSITE COMPETITION

- **LD-RTPs VS. HD-RTPs: SEMI-STRUCTURAL**
- **NANO VS. CONVENTIONAL MINERAL FILLERS**
- **NANO VS. LGF-PPs**
- **NFCs VS. GF-TPs**

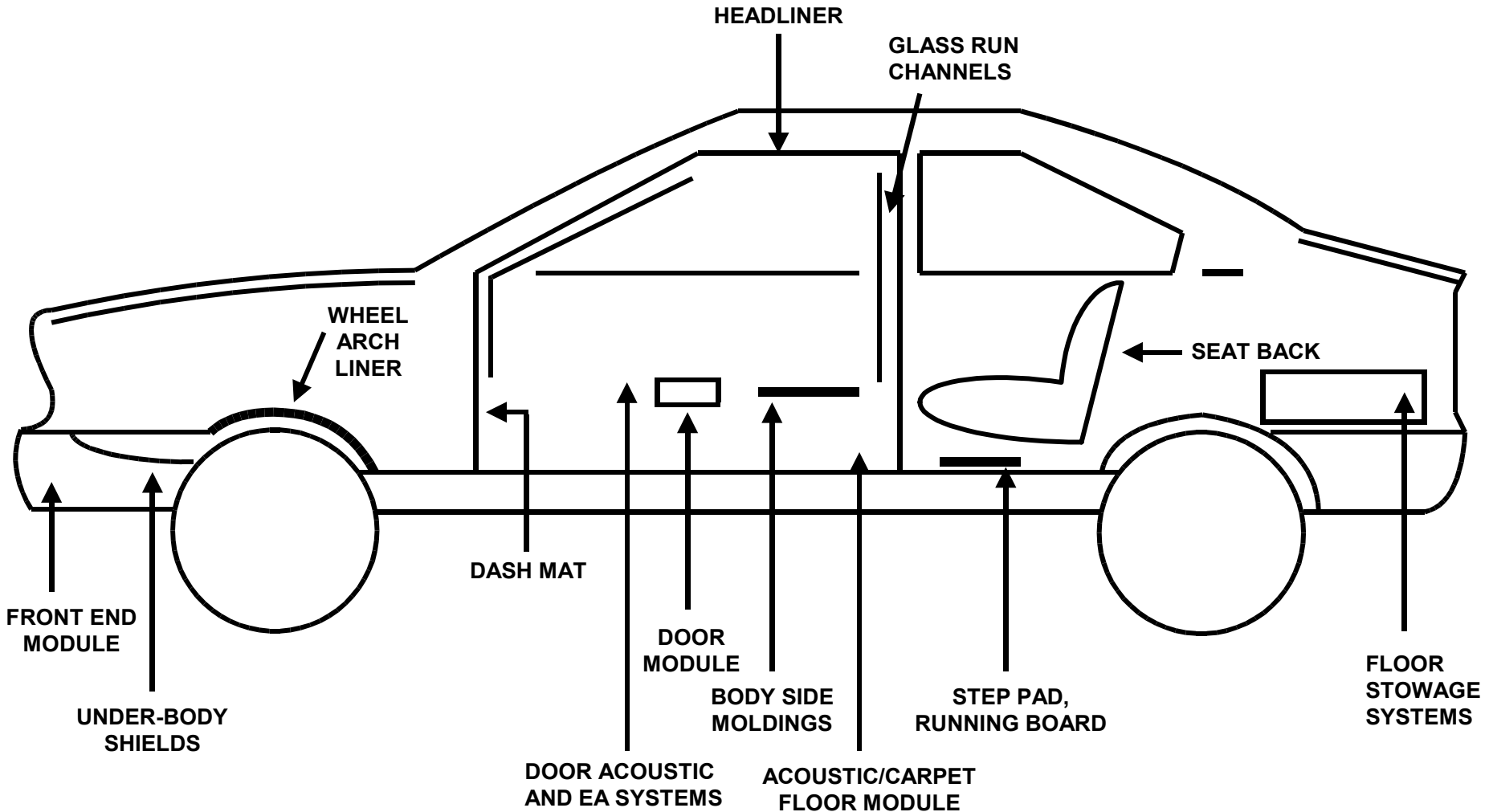
AUTO COMPOSITES INDUSTRY STRUCTURE SHIFTS

- **HEAVY GMT SUPPLIERS ENTER LT WT GMT**
- **GLASS FIBER SUPPLIERS ENTER LGF-TP COMPOSITE PRODUCTION**
- **COMPOUNDERS ENTER NANO-COMPOSITE AND LGF-TP CONCENTRATES**
- **DIRECT COMPOUNDING OF LGF-TPs BY:**
 - **CUSTOM AUTO MOLDERS**
 - **BACK INTEGRATED TIER 1s**
- **ENTRY OF NATURAL FIBER PRODUCERS (SOME VIA BACK INTEGRATION BY AUTO OEMs AND TIER 1s)**
- **EMERGENCE OF BIOPOLYMER SUPPLIERS**

COMPOSITES VS. OTHER CLASSES

- **LD-RTPs IN WHEEL ARCH LINERS**
- **LD-RTPs VS. FOAM/SKIN LAMINATES (FLOOR)**
- **LD-RTPs VS. PU, PP FOAMS (H-LINER)**
- **NANO IN FUEL TANKS, SYSTEMS**
- **NANO VS. PVC: (BODY SIDE MOLDINGS)**
- **LD-GMTs AND LGF-TPs: NO COMPETITION**

COMPOSITES TARGETS



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

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LD-GMT THERMOPLASTICS (CONT'D)

- **FMVSS 201**
- **INTEGRATION OF FOAM/ENERGY ABSORBING ELEMENTS INTO SUPPORT LAYER**
- **COMPETES W/ FOAM CORE SOLUTIONS**
- **REQUIRES ACOUSTIC PERFORMANCE**
- **INTEGRATES TEXTILES**
- **VARIETY OF TRIM OPTIONS**
- **HIGH PRIORITY ON SPACE CONSERVATION**
- **VALUE ADDED POTENTIAL**

LOW DENSITY GLASS MAT THERMOPLASTICS (LD-GMT)

- **GENERATION 1 HIGH DENSITY GMTs
DECLINING**
- **LD-GMTs IN GROWTH STAGES (DOOR TRIM,
INSTRUMENT PANEL, HEADLINER, FLOOR)**
- **CHALLENGE TO INJECTION MOLDING IN
INSTRUMENT PANEL & DOOR TRIM HARDWARE
MODULE**
- **NATURAL FIBERS ENTERING**
- **INCREASED NUMBER OF SUPPLIERS**

INTRA-COMPOSITE COMPETITION

APPLICATIONS	THERMOPLASTIC COMPOSITE CANDIDATES							
	LD-RTP	HD-GMT	SGF-TP	LGF-TP	HC-NFC	MIN-TP	NANO-TP	OTHER (a)
ACOUSTIC BARRIERS	X							X
BODY SIDE MOLDINGS				X		X	X	X
BUMPER FASCIA						X	X	X
DOOR TRIM PANELS					X	X	X?	X
DOOR MODULES	X	X?	X	X				
ELEC. CONNECTORS			X				X	X
FLOOR MODULES	X	X			X			X
FEMs		X(b)		X				X
FUEL LINES							X	X
FUEL TANKS							X	X
HEADLINER	X							X
IN MOLD DECORATION							X	X

INTRA-COMPETITION FOR AUTOMOTIVE APPLICATIONS (CONT'D)

APPLICATIONS	THERMOPLASTIC COMPOSITE CANDIDATES							
	LD-RTP	HD-GMT	SGF-TP	LGF-TP	HC-NFC	MIN-TP	NANO-TP	OTHER (a)
INTERIOR SKINS								X
IP SUBSTRATES				X	X	X		X
MECHANICAL COMPONENTS			X			X	X?	X
ROCKER PANELS						X	X	X
RUNNING BOARDS				X			X	X
STEP PADS				X			X	X
WHEEL ARCH LINER	X					X		X

NOTES:

- (a) **OTHER INCLUDES NON-COMPOSITE COMPETITION FROM:**
 - **FOAMS** -UNFILLED POLYMERS (PRIMARILY ETPs, PVC)
 - **NONWOVENS** -METAL/PLASTIC HYBRIDS
 - **FOAM/SKIN LAMINATES** -REGENERATED FIBER MATS (SHODDY)
 - **THERMOSETS (PU, PET)**
- (b) **HD-GMTs HAVE LOST SHARE IN FEMs**

COMPARISON OF LD-GMTs AND LGF-PPs

PARAMETER	LGF-TP	LD-GMT
DENSITY, GSM		LOWER, 700-2000 (a)
TOOLING COST		LOWER (b)
TYPICAL PROCESS	INJECTION, COMPRESSION	COMPRESSION, THERMOFORMING
TYPICAL GLASS CONCENTRATION, %	40, 32	40-55%
DIRECT/COMPOUND/ FABRICATION POSSIBLE	YES, COMMON	YES, POSSIBLE; NOT COMMONLY USED
TYPICAL PART	COMPLEX	SIMPLE
PART SIZE	SMALL	LARGE
PART THICKNESS	THICKER	THINNER

COMPARISON OF LD-GMTs AND LGF-PPs (CONT'D)

PARAMETER	LGF-TP	LD-GMT
USE IN LAMINATES	USUALLY NOT	YES ('c)
EXAMPLE APPLICATION	MECHANICAL (d), SEMI-STRUCTURAL (e)	WHEEL ARCH LINER HEADLINER (f) UNDERBODY SHIELDS
LOAD BEARING CAPACITY	HIGHER	

NOTES:

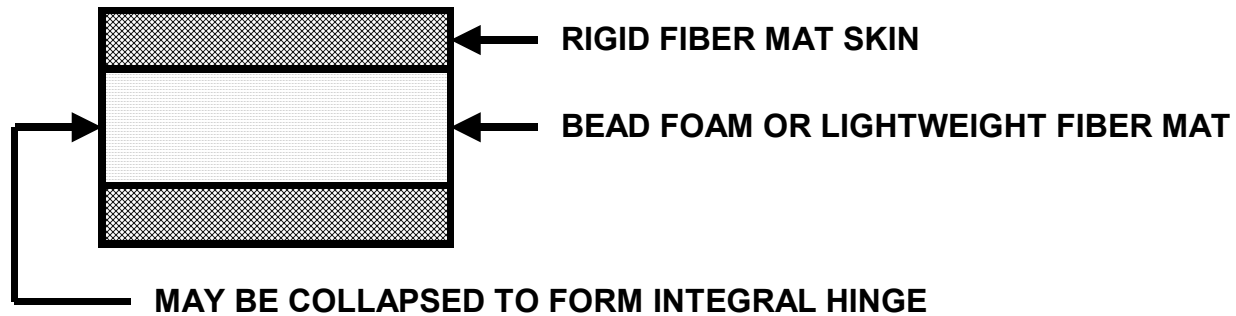
- (a) LD-GMTs CAN BE LOFTED TO REDUCE DENSITY**
- (b) ALUMINUM OR EPOXY TOOLS CAN BE USED**
- (c) FOR EXAMPLE IN FLOOR MODULES**
- (d) E.G. DIE CAST METAL REPLACEMENT**
- (e) E.G. RUNNING BOARDS (NANO-COMPOSITES COMPETE IN THIS APPLICATION)**
- (f) ALSO OTHER INTERIOR SEMI-STRUCTURAL APPLICATIONS**

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

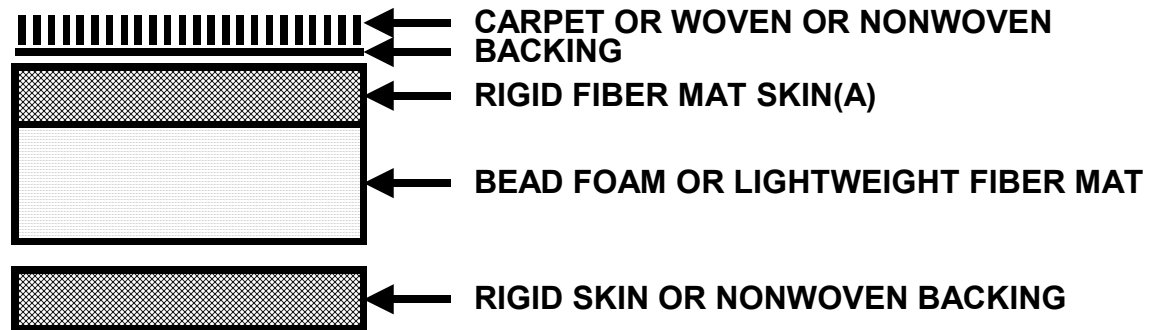
HEADLINER CORE

- **FOAM VS. COMPOSITE BATTLEGROUND**
- **LD-GMTs HAVE PENETRATED**
- **ENERGY ABSORPTION REQ'D (FMVSS 201)**
- **ACOUSTIC PERFORMANCE REQUIRED**
- **ON BOARD EA, ACOUSTICS STARTING**
- **TEXTILE INTEGRATION START?**
- **NEW SUPPLY CHAIN PARTICIPANTS ENTER**
- **SPACE CONSERVATION VALUED**
- **A VALUE ADDED TARGET**

RIGID SEMI-STRUCTURAL FOAM SANDWICH FLOOR STRUCTURE



CARPET/NONWOVEN/WOVEN TEXTILE LAMINATE:



NOTE:

(A) MAY ALSO BE EXTRUDED FOAM SHEET (E.G., FAGERDALA XPP)

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2005

LONG GLASS FIBER THERMOPLASTICS

- **FEMs (VS. HYBRIDS AND HD GMT)**
- **RUNNING BOARDS (VS. NANO COMPOSITES)**
- **DOOR MODULE (VS. SGF-PP, ETP, NFCs)**
- **LOAD FLOORS (VS. LD GMTs, FOAM SANDWICHES)**
- **IP SUBSTRATES**
- **DIRECT COMPOUNDING STARTING**

NANOCOMPOSITES TARGETS

TARGET	KEY PROPERTIES	STATUS	NOTE
EXTERIOR:			
BODY PANEL	STIFFNESS PAINTABILITY, THIN WALL	SEVERAL AT GM	HIGH GROWTH POT'L
GLAZING	LIGHT TRANSMISSION SCRATCH RESISTANCE WEATHERABILITY	EXTENSIVE PRIOR DEVELOPMENT	TARGET FOR GE/EXATEC
BUMPER REINFORCEMENT BEAM	STIFFNESS, IMPACT	CONCEPT	
STEP/RUNNING BOARDS	STIFFNESS	STARTED ON GM VANS IN 2002	GROWTH APPLICATION FOR LG-PP
MIRROR HOUSING	WEATHERABILITY, PAINTABILITY, IMPACT	ABANDONED	TOO EXPENSIVE VS. INCUMBENT

NANOCOMPOSITES TARGETS (CONT'D)

TARGET	KEY PROPERTIES	STATUS	NOTE
INTERIOR:			
FIBERS	LOW DENIER	TORAY INTRODUCTION	NANO-CARBON
STRUCTURAL SEAT BACK	IMPACT	STARTED AT HONDA	EUROPEAN "BEER CRATE" LEGISLATION WILL DRIVE
SIDE IMPACT BEAM	IMPACT, STIFFNESS	CONCEPT	
TRIM		CONTRACT IN PLACE	EUROPE

NANOCOMPOSITES TARGETS (CONT'D)

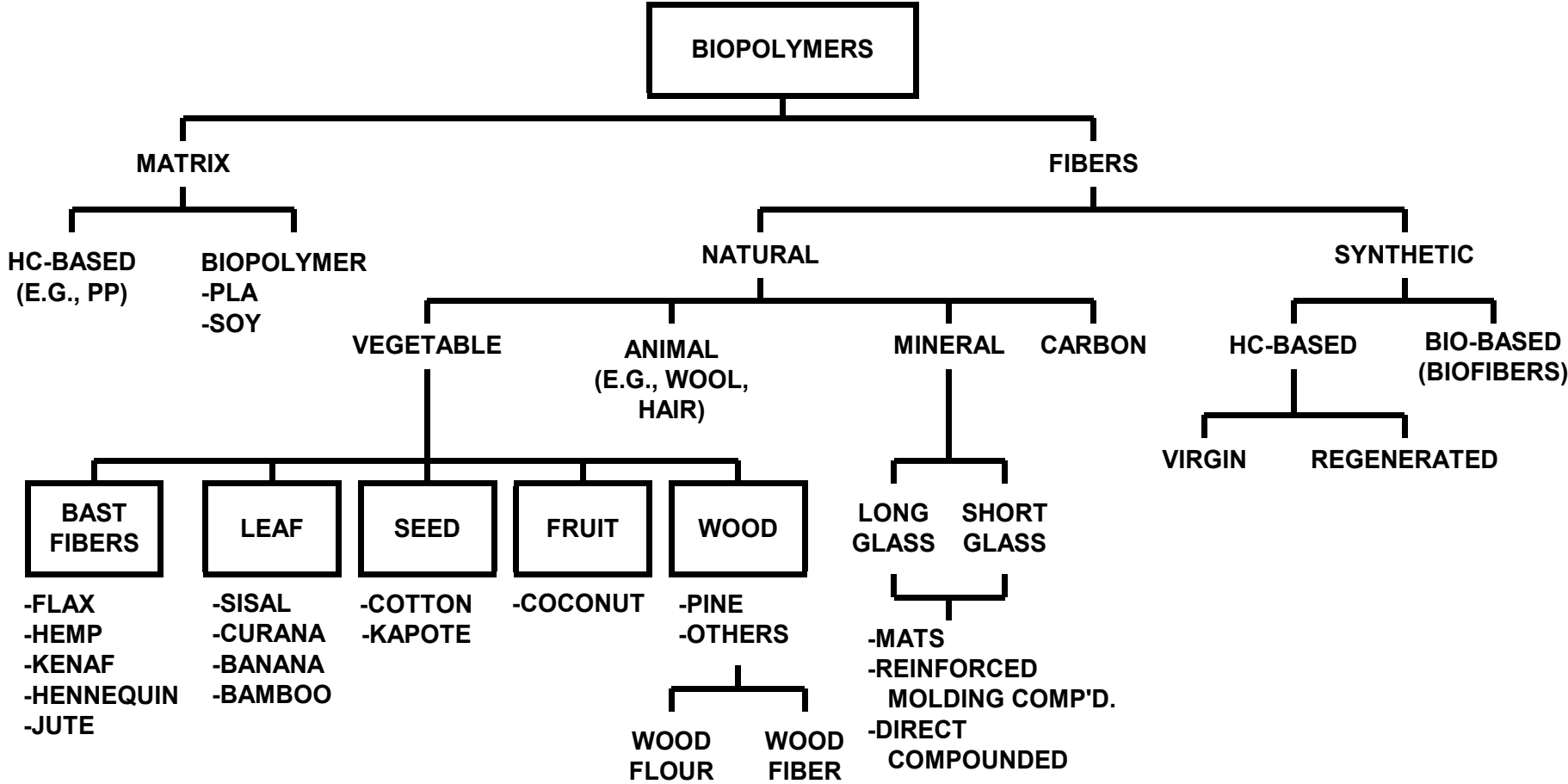
TARGET	KEY PROPERTIES	STATUS	NOTE
UNDERHOOD/FUEL			
FUEL TANK	BARRIER	GROWTH WITH THERMOFORMING	REPLACE EVOH?
FUEL LINE	BARRIER	COMMERCIAL IN JAPAN	EARLY APP IN NYLON NANO-ACETAL (JAPAN)
ENGINE COVER		mitsubishi on GDI MODELS	POOR IMPACT RESULTS AT BASF
TIMING BELT COVER	HEAT RESISTANCE	ABANDONED	

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

NATURAL FIBER COMPOSITES (NFCs)

- **WOOD FIBERS WIDELY USED**
- **BOTH HYDROCARBON AND BIOPOLYMER MATRICES**
- **SYNTHESIZED BIOPOLYMERS STARTING**
- **BROAD FIBER RANGE POSSIBLE**
- **BOTH MAT AND MOLDED PARTS**
- **COMPETE WITH NANO AND GLASS FIBERS?**

BIOPOLYMER CANDIDATES FOR AUTOMOTIVE APPLICATIONS



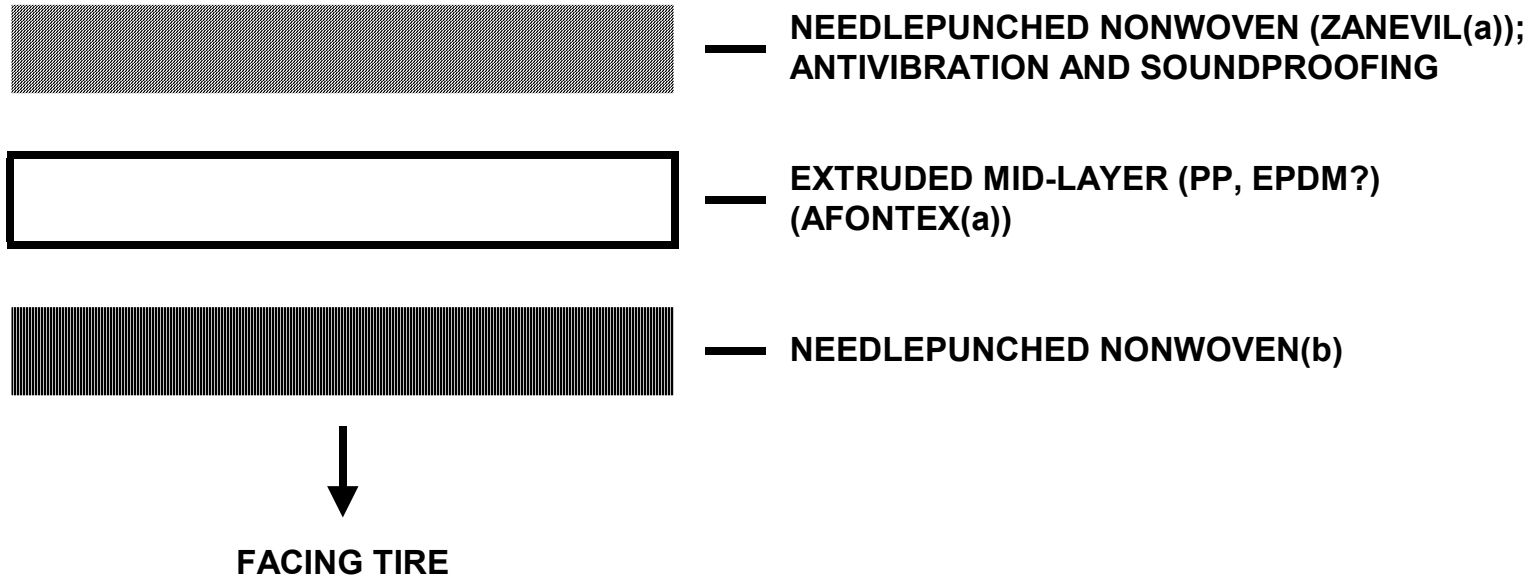
SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

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NATURAL FIBER COMPONENTS IN MERCEDES C-CLASS



CONSTRUCTION OF NONWOVEN WHEEL ARCH LINER



NOTES:

(a) PROPRIETARY BRAND FROM SAN VALERIANO

(b) FIBERS ARE VERTICALLY ALIGNED

SOURCE: SAN VALERIANO

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lg/myfiles/visio/nw04-wheel arch liner 04.vsd



MERCURY MARINER

MERCURY MARINER --

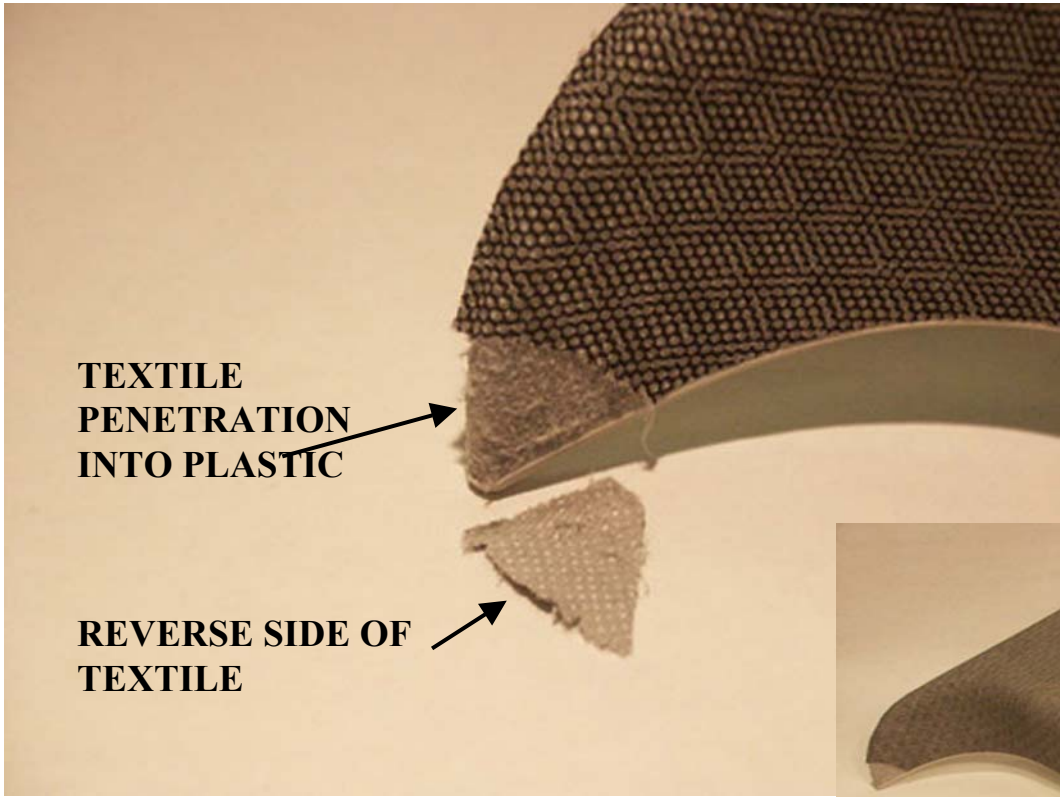
- HARD ABC PILLAR
- VISIBLE PASSENGER AIRBAG DOOR
- KNITTED HEADLINER
- HARD DOOR TRIM PANEL (CLOTH INSERTS)
- HARD INSTRUMENT PANEL
- METAL TRIM ON CONSOLE



MERCURY MARINER

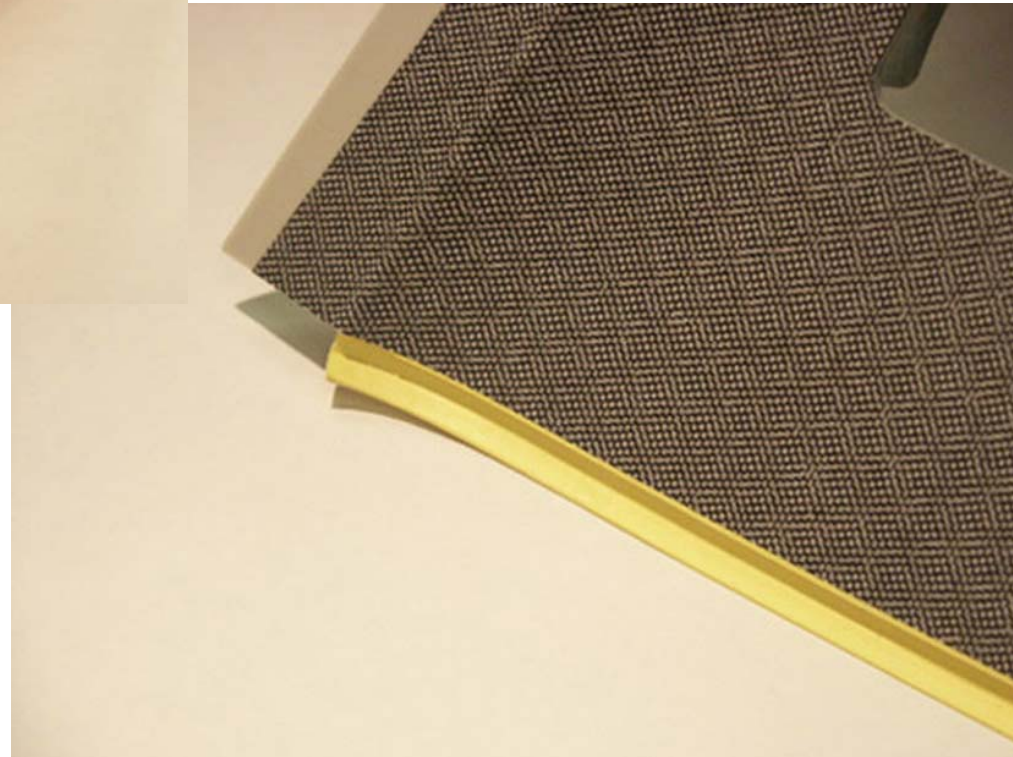
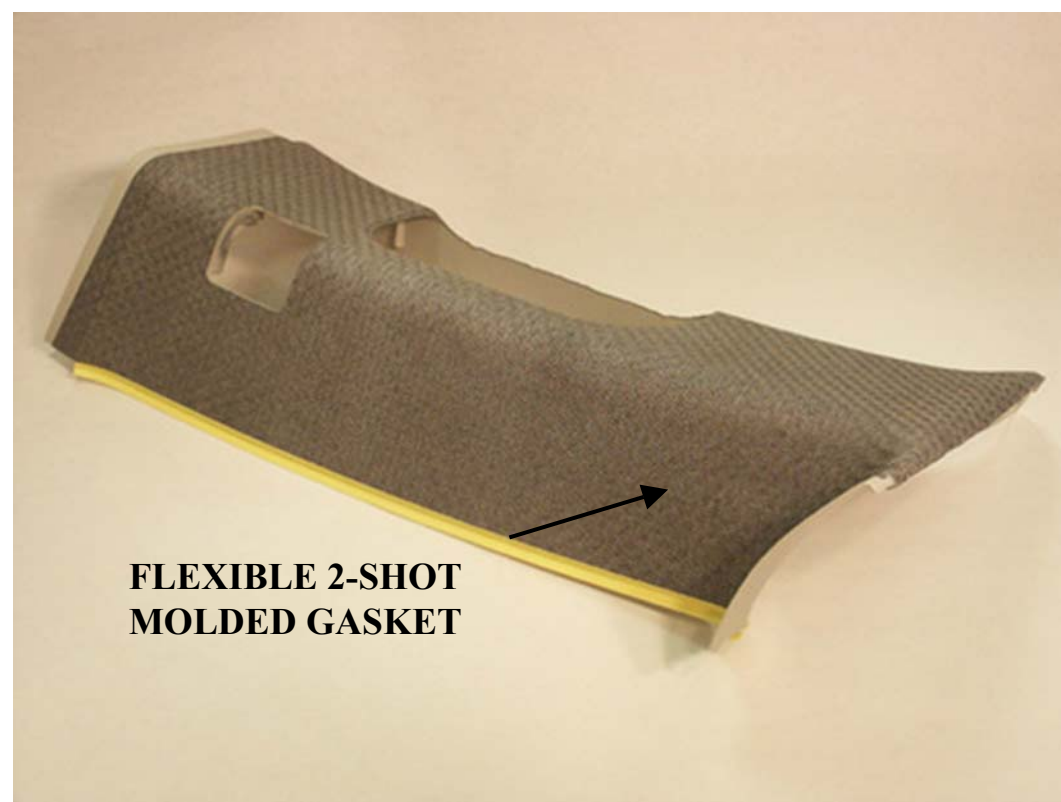
- SHODDY ACOUSTIC BATTING
- HARDBOARD/EPP FOAM STC

EXAMPLE OF BACK MOLDED PILLAR TRIM



SOURCE: FREUDENBERG, REA PHOTOS

EXAMPLE OF BACK MOLDED PILLAR TRIM WITH NONWOVEN TEXTILES



SOURCE: FREUDENBERG, REA PHOTOS

**EXAMPLE OF NONWOVEN
TEXTILE (MICROFIBER
SUEDE) IN LUXURY
TEXTILE APPLICATION**



SOURCE: ALCANTARA 2004

SUMMARY

- **AUTO PRICE PRESSURES:**
 - **COMPOSITES INTO LARGER MODULES**
 - **VALUE ADDED OPPORTUNITIES**
 - **COMPOSITE SUPPLY CHAIN SHIFT**
- **COMPOSITE OFFERINGS BROADENING**
- **RANGE OF PERFORMANCE LEVELS**
- **INTRA-COMPOSITE COMPETITION**
- **EXPANDED PROPERTY ENVELOPE**