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TECHNICAL / ECONOMIC / MARKET ANALYSIS & MANAGEMENT DECISIONS**

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AUTOMOTIVE INTERIOR TEXTILES... KEY TRENDS AND THE ROLE OF NONWOVENS IN VALUE ADDED SUPPLY CHAIN SHIFTS

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Presented by: Robert Eller

ABSTRACT

Intense automotive OEM price pressures are driving fundamental changes in the structure of both the value and supply chains that provide modules to the vehicle assembly line. Conventional textiles and nonwovens play a key role in the technologies evolving to meet the new challenges, especially in auto interiors. This paper reviews trends in materials and fabrication technologies used in auto interiors and how these affect textiles in general and nonwovens in particular

The presentation is based on:

- An (in process) study of advanced nonwovens in auto applications (Reference 1).
- REA's recently completed automotive interior soft trim multiclient study (Reference 2)
- Observations at the NAIAS (Detroit) Auto Show, January 2004 (Reference 3)

Current Automotive Conditions Driving Textile Changes- Several key hypotheses to be examined in this paper include:

- Raw material price increases coupled with severe OEM price pressures have put textile suppliers in an unusually severe profitability squeeze
- Intense OEM cost pressures will drive (see Exhibit 1):
 - Fabrication technology shifts
 - Materials innovation
 - Nonwovens use increase

- Advanced nonwovens technologies and new polyolefin resin technologies offer (currently under-exploited) benefits to automotive interior module fabricators
- The supply chain and value chains for delivering modules and components to the auto assembly line are:
 - Inefficient
 - Wasted materials
 - Based on older technologies which meet global quality requirements with difficulty
- The N. American automotive market is targeting European esthetics and quality standards, especially for interior applications
- European and Japanese materials and module fabrication technologies are in advance of those used in N. America but the rate of convergence between the regions is accelerating
- European End of Life Vehicle (ELV) legislation is driving mono-materials constructions and this will encourage the use of polyolefin nonwovens (PO-NWs) in constructions with PO-foams and PP substrates
- An increased penetration of PO foams will pull PO-NWs into the interiors market due to the materials and process technology competitive interface between non-wovens and foams
- Most major interior modules will undergo construction and fabrication process changes (especially headliner, floor/acoustics and trunk) that will offer opportunities for nonwovens to gain market share and enhance added value
- Acoustic performance and energy absorption will be major technology shift drivers
- Odor-free and low V.O.C. interiors will influence materials substitution
- Growth in non-structural composites will drive shifts in textile usage (especially in headliner and floor modules)
- Foams (especially polyolefin foams) are a key element in shifting textile technology
- The penetration of European Tier 1s into the N. American interiors market is introducing new fabrication technology and shifting the textile usage pattern.
- Foams and lightweight fibers compete for acoustic applications
- Occupant protection pressures will translate from NAFTA to Europe
- European Tier 1s will continue to penetrate the NAFTA market

- Recently developed PO resin technology can be used to make elastic nonwovens. These elastic nonwoven constructions create value via improved craftsmanship and reduced processing costs

Europe/NAFTA Nonwoven Differences -- There are substantial differences between Europe and NAFTA in the patterns of textile and nonwoven use in interiors as illustrated below:

COMPARISON OF EUROPE/NAFTA DRIVING FORCES AND NONWOVEN USE

Target Module/Key Parameter	Nonwoven Position
Growth of trunk/floor module	-Development target in both regions -European “beer crate” legislation will influence designs -“Tall cars” increasing faster in NAFTA -European spare tire cover designs more advanced
Recycling pressures	-Higher in Europe -Favors polyolefin mono-material constructions
Weight save pressures	-Higher in Europe -Will accelerate in NAFTA from -fuel prices -revised CAFE regulations? -profitability pressures on light trucks
Headliner face fabric	-More highly penetrated by NWs in Europe
Carpet surface	-Higher NW penetration in Europe(see Exhibit 10)
Acoustic performance	-Same
Cost pressures	-More severe in NAFTA

Value Add Strategies-Several classes of strategy are possible for adding value. These include:

- Improved textile performance (for example elastic nonwovens, micro-denier nonwovens)
- Shifting position in the value chain (of particular interest to textile suppliers)
- Materials cost savings (substitution of nonwovens for woven/knitted textiles)
- Process cost reduction (for example in-mold textile/substrate combination)
- Adding both value and functional capabilities (potentially with a cost saving)

Value Chain Shift -- Some examples of the possibility for shifting position in the value chain are given in the table below:

STRATEGIES FOR ADDING VALUE ALONG THE TEXTILE SUPPLY CHAIN

STRATEGY	EXAMPLE
Forward/Backward Integration	<ul style="list-style-type: none"> - Textile suppliers → cut/sew and lamination - Textile supplier/molder partnering for process development
Outsourcing	<ul style="list-style-type: none"> - Foaming seat pads, headrests - Foam lamination
New Textile Technologies	<ul style="list-style-type: none"> - Elastic NWs - Polyolefin foam lamination - Back-molding of knits and NWs for pillar trim - Alternatives to flame lamination
Sandwich Layer Consolidation	<ul style="list-style-type: none"> - On-board acoustics - Micro-denier integration into NW constructions
Reduce Secondary Operations	<ul style="list-style-type: none"> - Back injection - In-mold airbag door scoring - In-mold trim and assembly

SOURCE: ROBERT ELLER ASSOCIATES, SOFT TRIM MULTI-CLIENT STUDY, 2003

Process Cost Savings --Cost savings are possible via a shift to manufacturing technologies with fewer steps, lower scrap rates and (sometimes) faster cycle times. Current module fabrication methods are inefficient as shown by the schematic diagram in Exhibit 2 and the conceptual future module fabrication scheme shown in Exhibit 3. Examples of process cost savings are given below:

PROCESS COST SAVINGS WITH TEXTILES IN AUTOMOTIVE INTERIOR SOFT TRIM

STRATEGY	EXAMPLE/APPLICATION
In-line forming/ In mold decoration	<ul style="list-style-type: none"> - In mold textile forming and substrate molding(a) - EPP foam/textile - Door trim medallions - Decorative films
Back molding of textiles	<ul style="list-style-type: none"> - Widely used in Europe - Favors polyolefin textiles
Sandwich Consolidation	<ul style="list-style-type: none"> - Floor acoustics/Trunk module - Door trim acoustics - Headliner energy absorption

Note: (a) Facilitated by elastic nonwovens

SOURCE: ROBERT ELLER ASSOCIATES, SOFT TRIM MULTI-CLIENT STUDY, 2003

Adding Value and Improving Functional Characteristics -- It is possible to add both value and improve the functional performance characteristics of automotive interior soft trim. Some examples of strategies for achieving this are given below:

ADDING VALUE WITH IMPROVED TEXTILE FUNCTIONAL CHARACTERISTICS

STRATEGY	EXAMPLE
In-mold Decoration	- Textiles
Lightweight Fibers	- Floor/Acoustics
Surface Esthetics	- Micro-denier nonwovens - Negative forming
Micro-denier Nonwovens	- Better acoustics - Improved drape - Reduced wrinkling
Craftsmanship	- JCI CraFTec® process
Luxury Fabrics	- Penetrating seating, door trim, instrument panel

SOURCE: ROBERT ELLER ASSOCIATES, SOFT TRIM MULTI-CLIENT STUDY, 2003

The Foam/Textile Interface— Most interior soft trim constructions are based on:

- Surfacing material (skin or textile)
- Foam (polyurethane or [recently] polyolefin)
- Substrate (polypropylene or engineering thermoplastic)

Foam plays a key role in the technology and cost structure of the sandwich. A competition is evolving between polyolefin foams and the polyurethane foams (the dominant foam incumbent). The automotive foam/textile interfaces are shown in Exhibit 4.

In Mold Forming and Sandwich Consolidation -- Numerous sandwich consolidation methods are available. An example of combining textile with expanded polypropylene (EPP) bead foam molding is given in Exhibit 5. Polyolefin foam/textile laminates are also evolving in the European fleet. These are initially based on PET textiles but PO nonwoven / PO foam laminates show potential for market entry.

Driving Factors for Polyolefin Foam Substitution -- Polyolefin foams are gaining share in automotive interiors (References 1 and 2) and affect the interface with textiles. Some of the factors that will accelerate the growth of polyolefin foams are:

- The development of in-mold textile/EPP foam combination processes (illustrated Exhibit 5)
- The growth of polyolefin microcellular technology in sheet foams
- The proliferation of radiation crosslinking polyolefin foam technology
- The entry of low cost, non-crosslinked and chemically crosslinked polyolefin sheet foams (facilitated by the development of high melt strength PP resins)
- The development of polyolefin foam/textile laminates (e.g., for door trim medallions and A,B,C pillars)
- The market penetration of extruded thick sheet foams (e.g., such as Dow's Strandfoam®)

Textile/Polyolefin Foam Laminates -- Textile/polyolefin foam laminates have begun to penetrate the European fleet (for example in door trim medallions), and show potential for further penetration into other interior modules based on:

- Improved thermoformability vs. textile/PU foam laminates
- Improved recyclability with the dominant polyolefin substrates
- Cost savings

The emergence of textile/polyolefin foam laminates presents the potential for the long-awaited penetration of polyolefin textiles into the auto interior. The recently improved UV resistance, abrasion resistance and elastic properties of polyolefin nonwovens will facilitate this penetration.

Textile and Foam Competition in the Floor/Acoustic Module-Acoustic sandwiches are used throughout the vehicle as illustrated in Exhibit 6.

The floor and headliner are major modules utilizing acoustic sandwiches. As illustrated in Exhibit 7, the dash mat construction typically consists of a difficult to recycle:

- Heavy layer
- Foam or lightweight fiber layer
- Carpet (tufted in NAFTA, nonwovens in Europe), as illustrated in Exhibit 7.

All of the major acoustic module suppliers are developing lightweight fiber constructions capable of either reducing or eliminating the heavy layer with minimal sacrifice in acoustic performance. An example of the lightweight fibers available from Collins & Aikman is shown in Exhibit 8.

The PET/Polyolefin Battle in Headliners – The headliner is a key module for nonwoven/knitted competition in face fabric. As illustrated in Exhibit 9, headliner face fabric usage differs between regions. The requirement for energy absorbing countermeasures, new lighting approaches (see photos in Reference 3) and improved workplace safety are placing emphasis on:

- Integrating energy absorption into the headliner construction
- Use of lighter weight acoustic solutions (opportunity for micro-denier nonwovens)
- Substituting lightweight fiber mat constructions for the dominant glass reinforced PU foam currently used for the semi-structural element of the headliner.

Bi-Component nonwoven fiber-based solutions, glass fiber/PP approaches and EPP foams are battling as substitutes for the dominant glass-fiber reinforced PU foam currently used for substrates. The latter two approaches will favor the use of polyolefin nonwovens as face fabric in order to make an all-polyolefin headliner sandwich.

Paths to Market and Value Add Opportunities for Nonwovens- The paths by which nonwovens reach the auto market and value add opportunities are illustrated in Exhibits 11 and

12. Nonwovens must compete with a variety of incumbents (textile and non-textile) as illustrated in Exhibit 13.

SUMMARY

The driving forces for nonwoven growth in auto interiors are summarized in Exhibit 14. The key current and potential trends for substitution driving forces in interior textiles are:

- The potential for adding value via shifts in textile usage and value chain position
- Introduction of elastic polyolefin nonwovens
- Growth of PO foam/textile laminates
- Growth of back-molding in the N. American market (pillar trim and door medallions)
- Competition between knits and nonwovens for face fabrics
- Increased use of 3D fabrics (in seating)
- Increased use of nonwovens in headliners (construction and face fabric)
- Increased use of micro-denier nonwovens as intermediate layers in acoustics constructions
- Continued penetration of suede-like luxury fabrics
- Growth of TPO coated fabrics

AUTHOR'S BIO

Robert Eller is President of Robert Eller Associates, Inc. (REA), a consulting company providing analysis and support of management decision-making in the automotive plastics and rubber industries. REA has offices in North America (Akron, Ohio), France, and Spain.

His firm has recently completed a multi-client study of automotive interior soft trim in North America and Europe, and has a multiclient study of advanced automotive nonwovens (Europe/NAFTA) in process. Prospectuses for REA studies and papers can be viewed on the REA website: <http://www.robertellerassoc.com>. Robert Eller can be reached via phone (330-670-9566), fax (330-670-9844), or e-mail: bobeller@prodigy.net

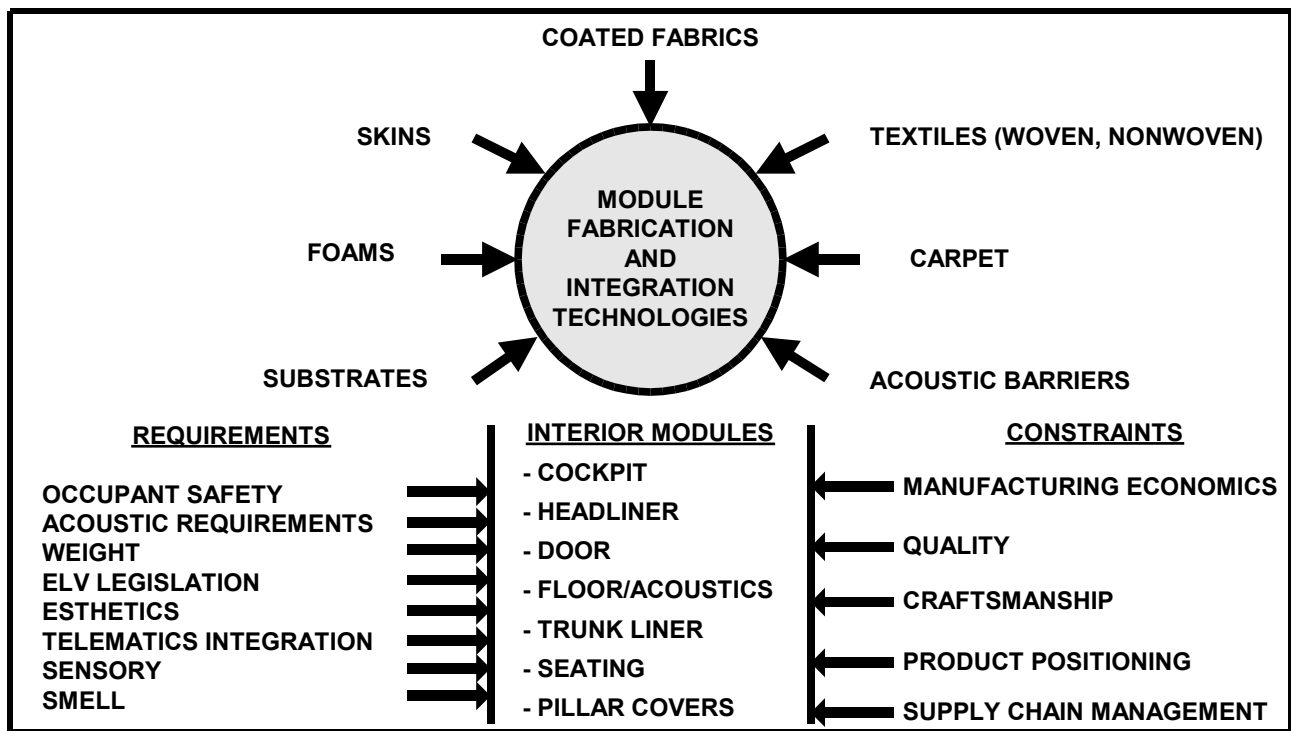
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2. Multiclient Study, "Automotive Interior Soft Trim...Skins, Foams, Coated Fabrics, Textiles, and Acoustic Barriers," Robert Eller Associates, Inc. (June 2003)
3. "Plastics at the Detroit Auto Show"—A photo/ commentary on interior and exterior autoplastics trends, Robert Eller Associates, Inc., (available on REA website)
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7. Matriaux d'habitable Automobile et Approche Sensorielle," Comfort Automobile et Ferroviaire; Le Mans, France; November 15, 2000; D. Nesa; S. Couderic; S. Crochmore.
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b/papers/techtex04



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



Prospectus for a Global Multiclient Industry Analysis
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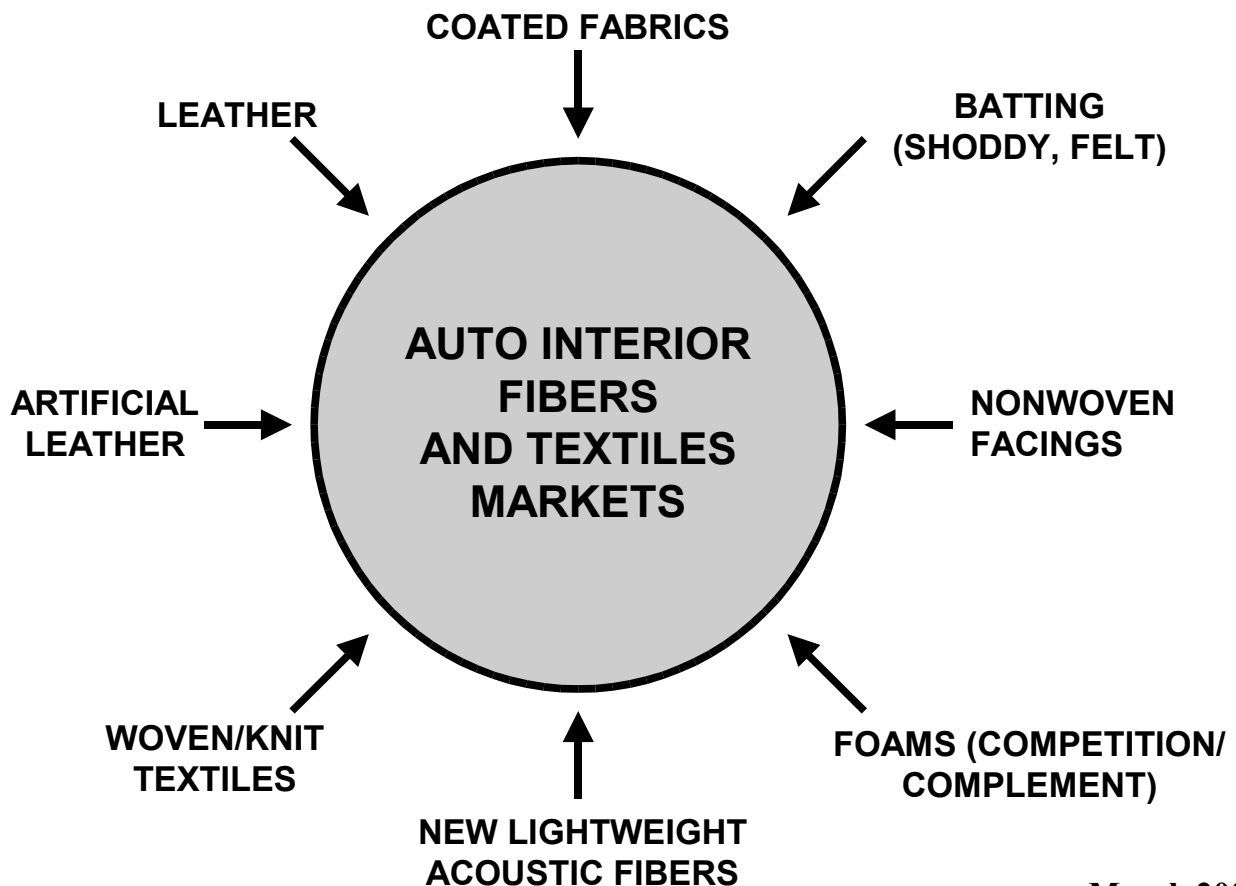
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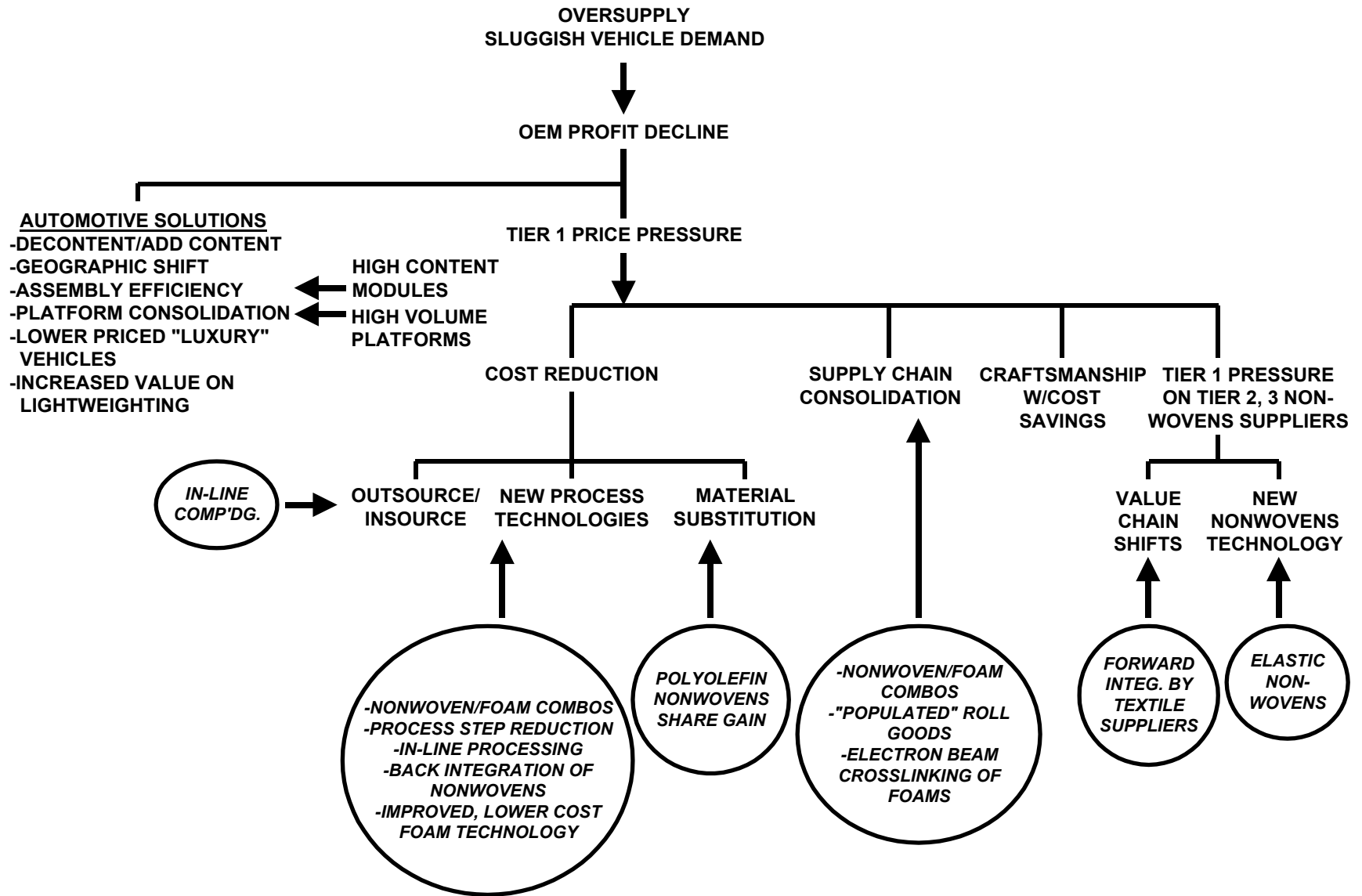
**Opportunities for Advanced Technology
Nonwoven Fabrics for Automotive Interior
Surface and Construction Applications
in NAFTA and Europe**



March 2004

PROSPECTUS FOR A MULTICLIENT STUDY

**EXHIBIT 1
AUTOMOTIVE OEM/SUPPLIER DYNAMICS AND EFFECT ON NONWOVENS**

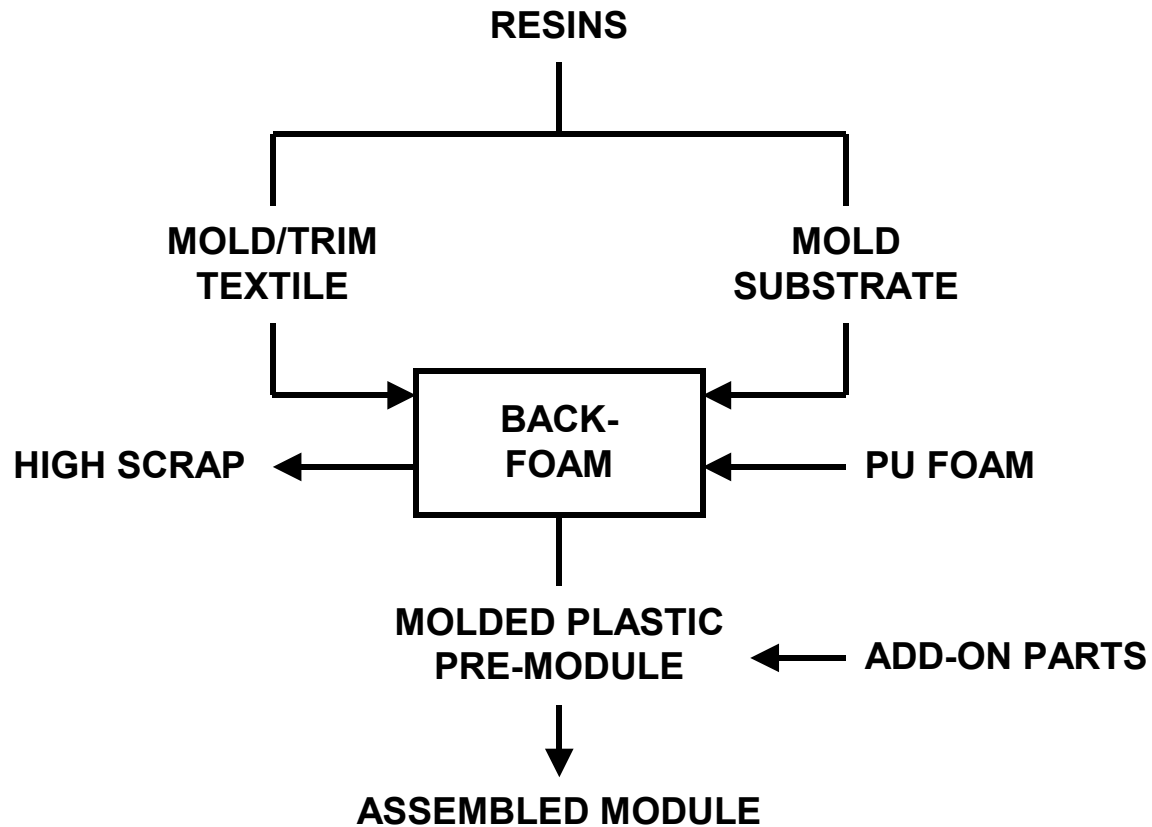


SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

re/mydox/nwmc/nw04-autooemdyn 04.vsd
lg/myfiles/visio/nw04-autooemdyn 04.vsd

EXHIBIT 2

CURRENT MODULE FABRICATION (INEFFICIENT)



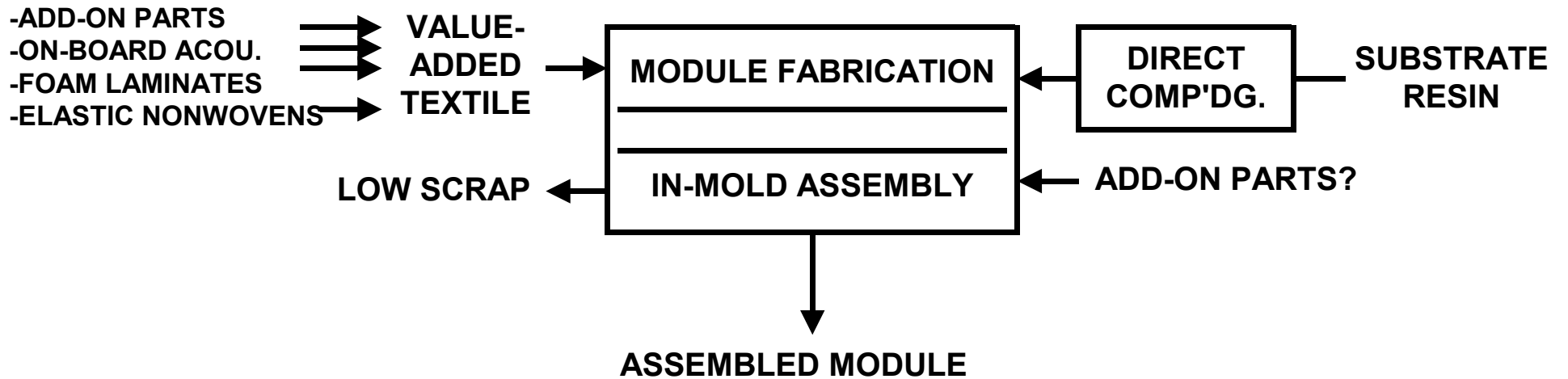
4-STEP OPERATION

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

slide-mod fab 03.vsd

EXHIBIT 3

FUTURE MODULE FABRICATION (IDEAL)

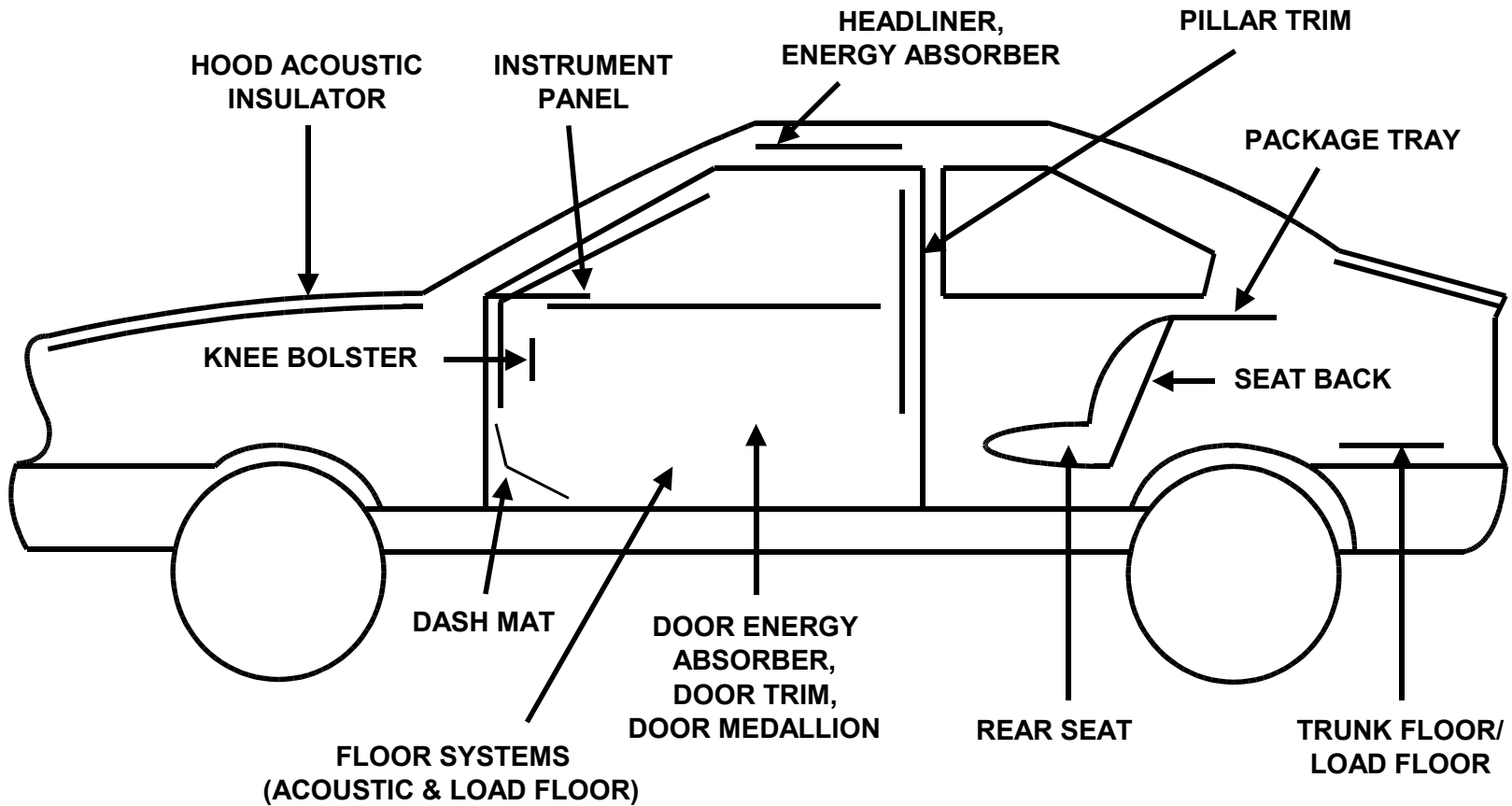


(IDEAL) 1-STEP OPERATION

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

slide-one step 03.vsd

AUTOMOTIVE FOAM/TEXTILE INTERFACES



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

slide-auto fm tex intf

EXHIBIT 5

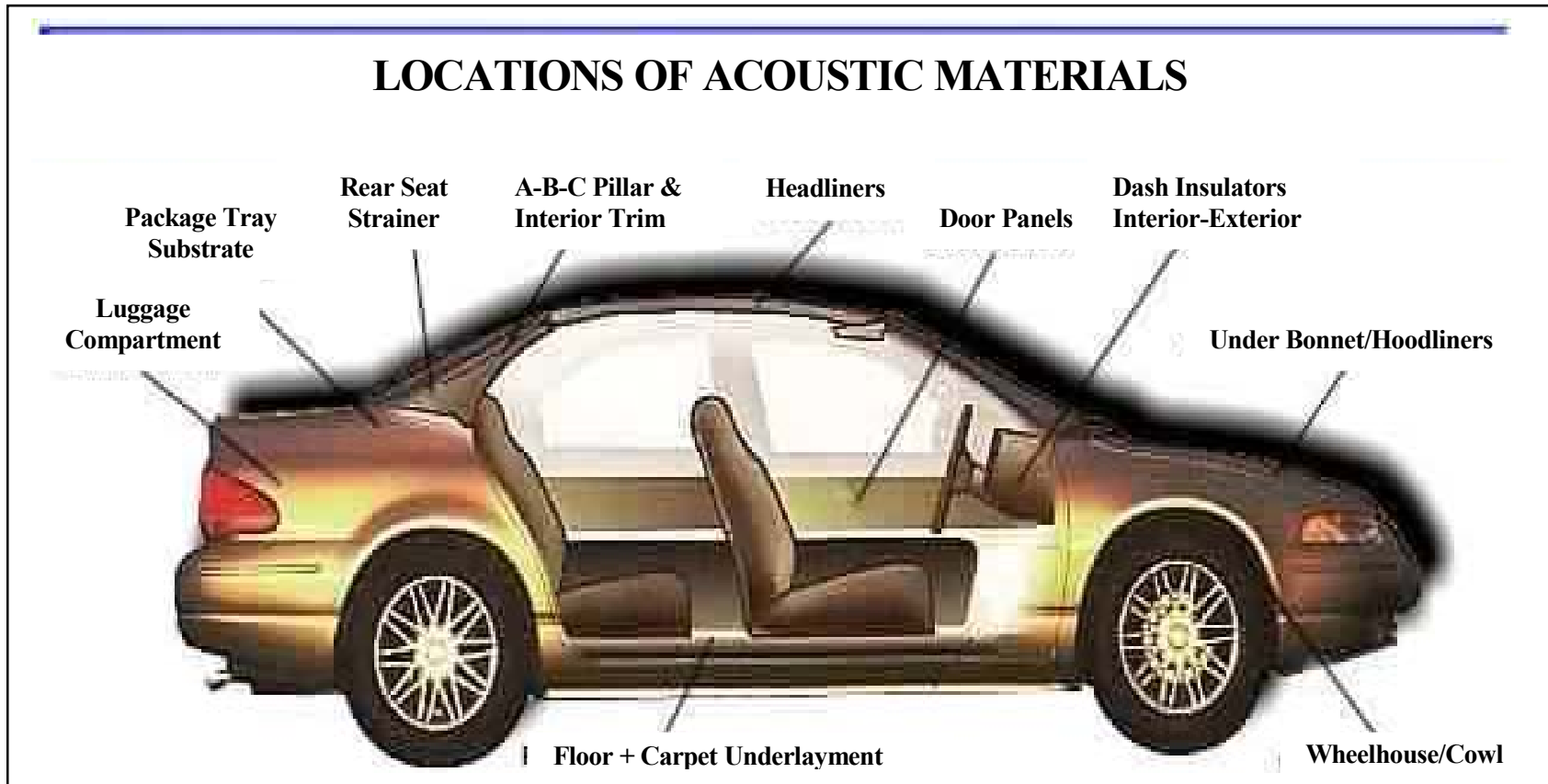
EPP SEMI-STRUCTURE/TEXTILE COVERING CONCEPT (TEXTILE DETAIL)



SOURCE: TARACELL

EXHIBIT 6

LOCATIONS OF ACOUSTIC MATERIALS



SOURCE: JANESVILLE PRODUCTS

EXHIBIT 7

EXAMPLE OF DASH MAT LAYER CONSTRUCTION



HEAVY LAYER

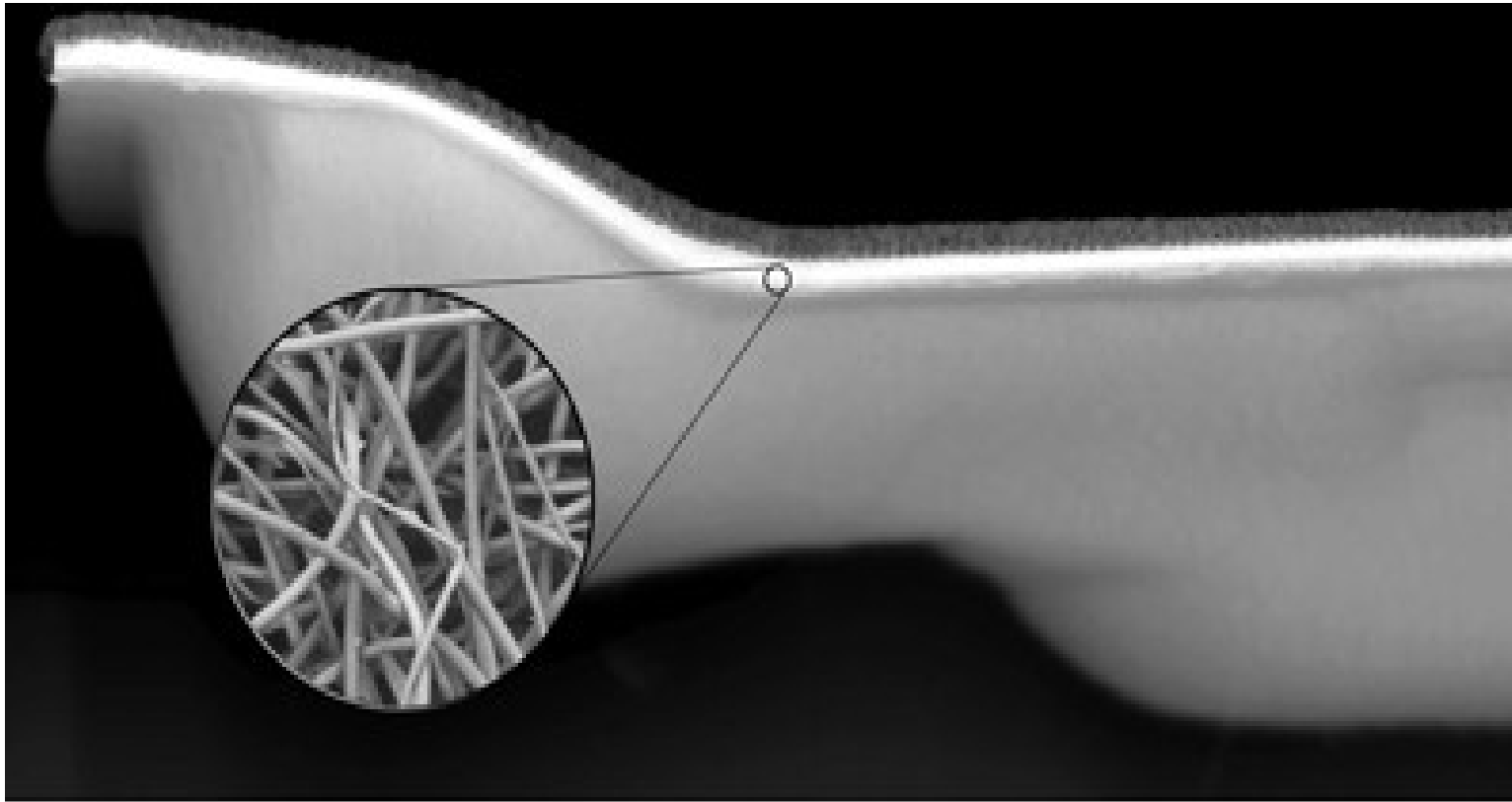
ACOUSTIC BATTING

CARPET

SOURCE: COLLINS & AIKMAN

EXHIBIT 8

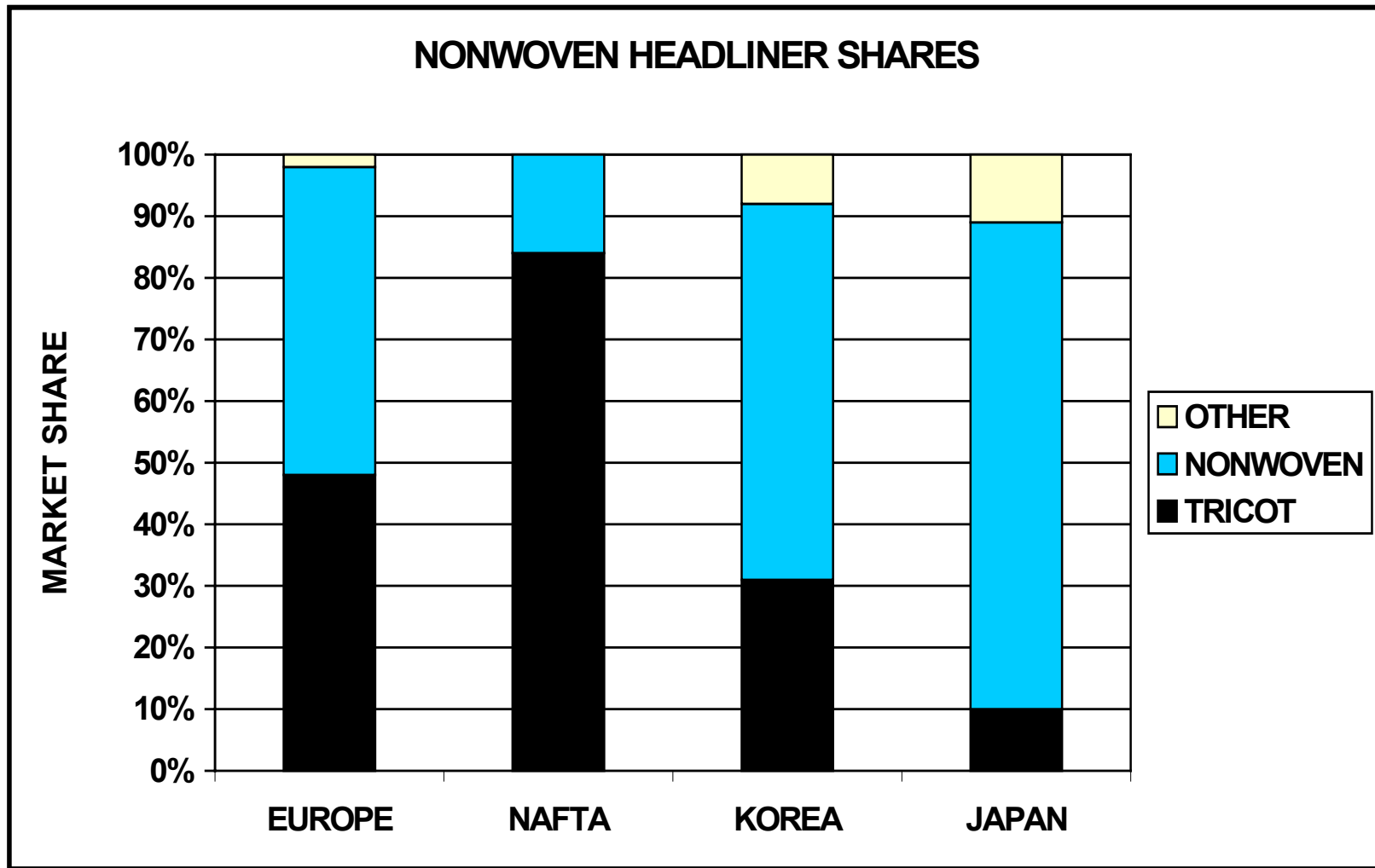
EXAMPLE OF ACOUSTICALLY TUNABLE FIBER



AcTfiber Sample of lightweight molded carpet system utilizing AcTfiber. Acoustically tuned by controlling fiber length, blend and treated to increase densification where needed.

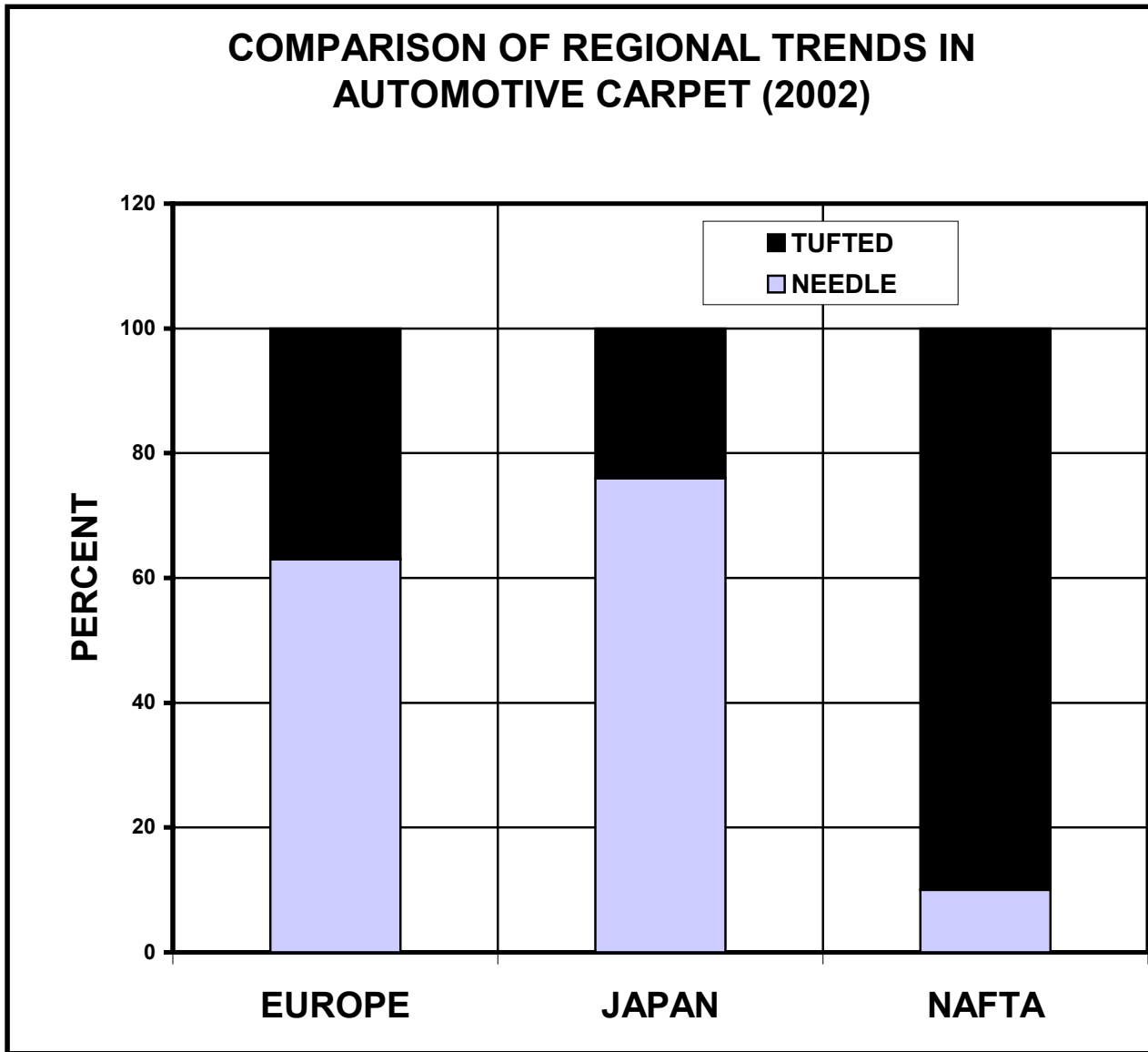
SOURCE: COLLINS & AIKMAN

EXHIBIT 9



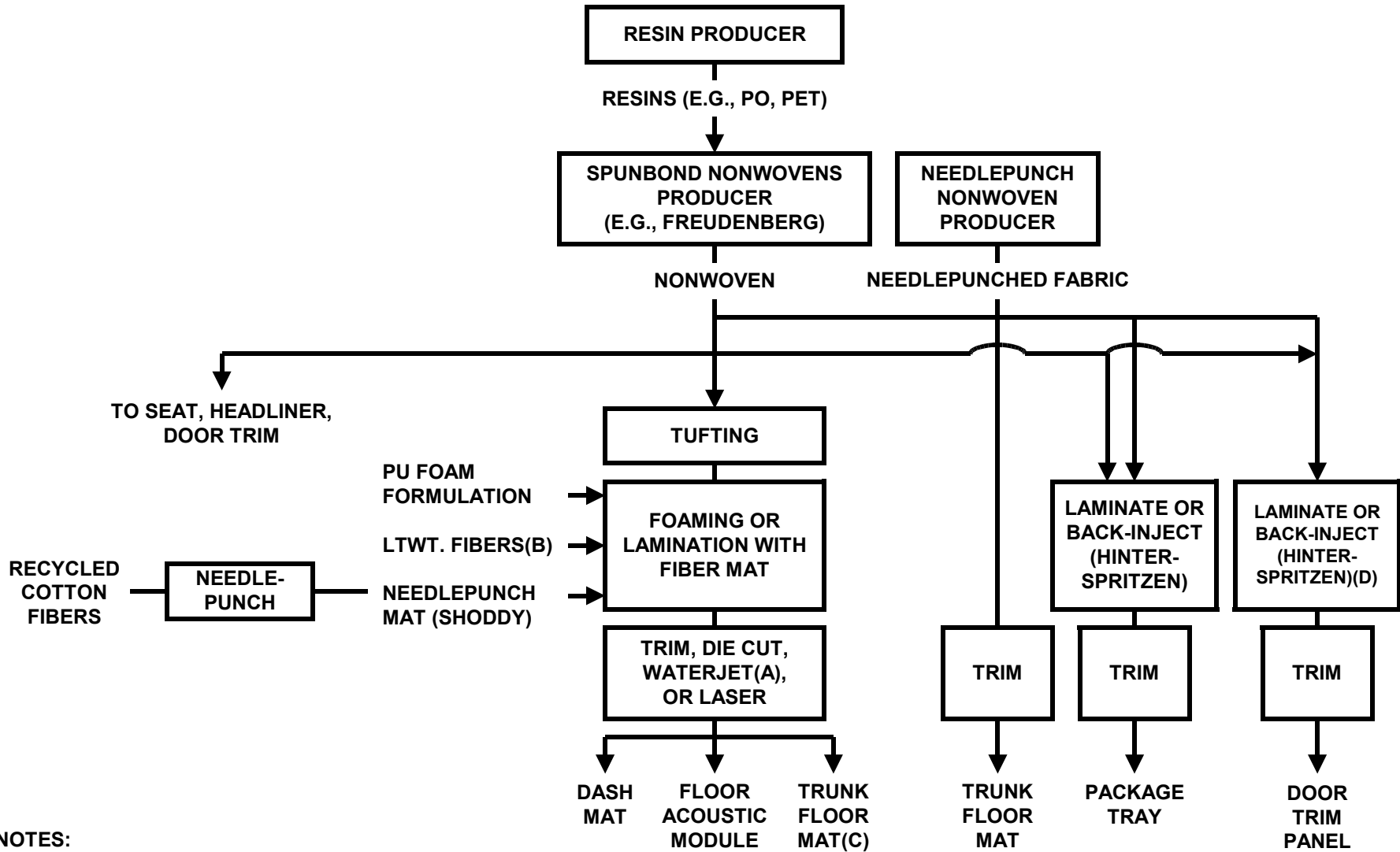
SOURCE: FREUDENBERG VITECH

EXHIBIT 10



SOURCE: ROBERT ELLER ASSOCIATES, INC.;
SOFT TRIM MULTICLIENT STUDY

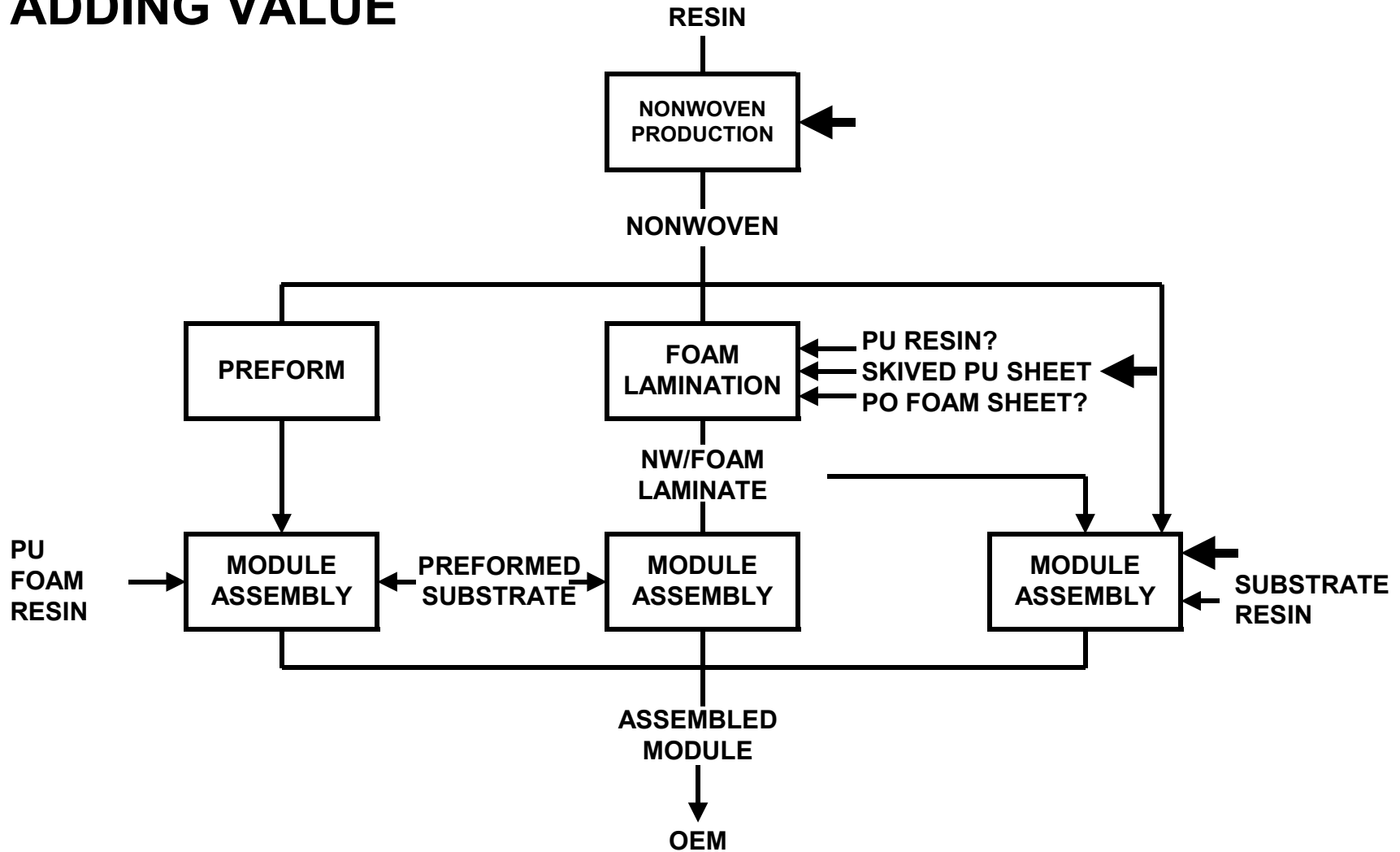
EXHIBIT 11 PATHS TO MARKET FOR AUTOMOTIVE NONWOVENS



- NOTES:
 OMITTS HYDROENTANGLED (ABOUT 6% MKT. SHARE)
 (A) DOMINANT METHOD
 (B) E.G., AcT™ (C+A), ULTRALIGHT™ (RIETER), SonoTec AT (LEAR), DUAL IMPEDANCE FIBER (PELZER)
 (C) HIGH END VEHICLES ONLY
 (D) EPP FOAMS MAY BE USED FOR HINTERSPRITZEN

SOURCE: ROBERT ELLER ASSOCIATES, INC. 2004

NONWOVEN PATH-TO-MARKET OPPORTUNITY FOR ADDING VALUE



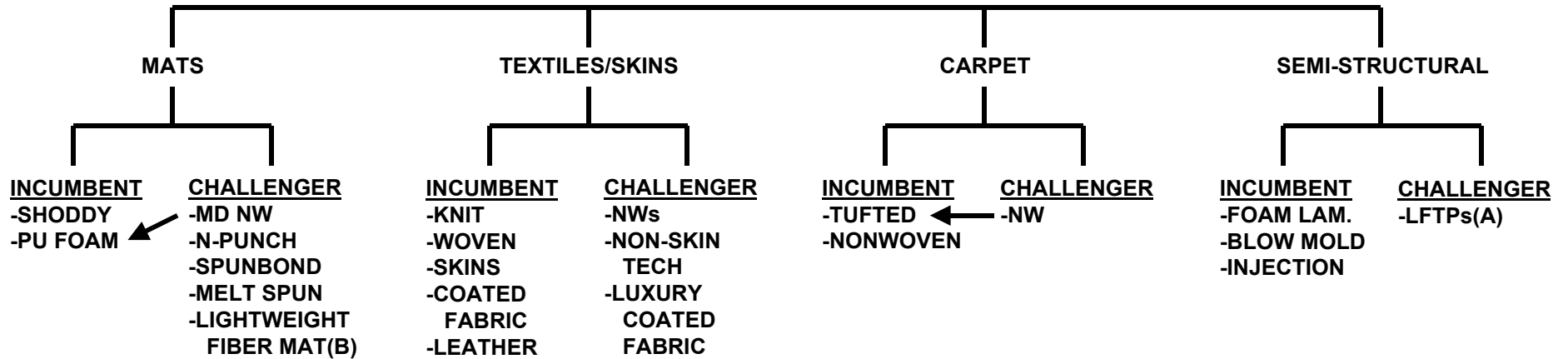
NOTE: ➔ = VALUE ADD OPPORTUNITIES FOR NONWOVENS

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

nw op val ad 03.vsd

EXHIBIT 13

NONWOVENS TARGET TREE (BY CONSTRUCTION TYPE)



NOTES:

- (A) AZDEL SUPERLITE®, SYMALITE
- (B) FROM RIETER, C+A, LEAR, PELZER

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

lg/myfiles/visio/NW Target Tree 04.vsd

**EXHIBIT 14
DRIVING FORCES FOR NONWOVEN GROWTH**

DRIVING FORCE	ACTUAL OR POTENTIAL CHANGE	NONWOVENS/PROCESS IMPLICATIONS
PROCESS COST REDUCTION	-MODULARIZATION -PARTS CONSOLIDATION -SANDWICH CONSOLIDAT'N.	- ON-BOARD ACOUSTICS -"POPULATED" PANELS -GROWTH OF ELASTIC NWs -BACKMOLDING
ACOUSTIC PERFORMANCE	-REDUCED NOISE -ACOUSTIC DESIGN INTEGR'N -TAILORED ACOUSTICS	-MICRO-DENIER USE ALONE -MICRODENIER IN ACOUSTIC SANDWICH
CRAFTSMANSHIP	INTEGRATE CRAFTSMANSHIP WITH FABRICATION	-JCI CRAFTEC PROCESS -IN-MOLD TEXTILE PROCESSES -BACKMOLDING TEXTILES -ELASTIC NWs
INTERIOR EMISSIONS REDUCTION	-NO-SMELL INTERIOR -REDUCED V.O.C. -REDUCED FOGGING	-REDUCED COATINGS -MATERIAL SHIFT -BINDERS? -SUBST. PO FOAMS FOR PU FOAMS
OCCUPANT SAFETY	HEAD/SIDE IMPACT REG'S	-ENERGY ABSORBING FOAMS GROWTH -INTEGRATE EA FOAM WITH STRUCTURE -INCREASED AIRBAG POSITIONS
END OF LIFE	ELV LEGISLATION IMPLEMENTATION IN EUROPE AND JAPAN	-MONOMATERIAL SANDWICHES -ALL PO CONSTRUCTIONS -RECYCLATE CONTENT, NFCs
FLOOR SPACE MANAGEMENT	-SEMI-STRUCTURAL SANDWICHES -GROWTH OF TRUNK MODULE	-AZDEL SUPERLITE®, QUADRANT SYMALITE -BEAD FOAMS, NONWOVENS IN STRUCTURE
UTILITY FUNCTION/LOOK	-NON-CARPET FLOOR -INVISIBLE AIRBAG DOORS	-IMPROVED ESTHETICS -INCREASED MICRODENIER NW USE -CRAFTSMANSHIP PROCESSES

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004