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**OVERVIEW OF TPE TECHNOLOGY, MARKETS, INDUSTRY
STRUCTURE, AND VALUE ADDED GROWTH OPPORTUNITIES**

Prepared for:
THERMOPLASTIC ELASTOMERS-ASIA
Bangkok, Thailand
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Presented by:
Robert Eller

Abstract – Although volume growth has remained higher than for most other polymers, customer price pressures, high raw material prices, in-house compounding by fabricators, and inter-TPE competition have impacted prices and profitability of TPEs. Finding paths to profitable growth opportunities via new fabrication and materials technology thus become priorities. This paper will examine:

- Current market and economic conditions affecting the TPE industry
- TPE technology drivers
- Key markets and intra-TPE competition in Europe and N. America
- Opportunities for value-added TPEs
- TPE industry structure and path to market shifts
- The implications of the penetration of TPEs into developing automotive applications
- The role of Asian participation in TPE markets.

The presentation is based on REA's recently completed auto interior soft trim study (1) and our global TPE multiclient study (2).

TPE Families and New Technologies – The TPE families present in the marketplace and the impact of new technologies are illustrated in Exhibit 1 and summarized in Exhibit 2. Price erosion, customer pressures, the drive for systems cost savings, and penetration into new market sectors are major drivers for technical change.

A review of the listing in these exhibits suggests several trends in TPE technologies:

- Increased interest in foams
- New TPV classes extending the property range to more effectively compete with thermoset rubber (TSR) (see Exhibit 7)
- Strong TPE presence in automotive markets
- The use of systems technologies to add value to TPEs
- Continued growth of co-processing (injection, extrusion, blow molding)
- Evolution in both processing and polymer technology
- PVC improvements to remain competitive.

The Role of Foams -- Foaming adds value to TPEs as a result of increased softness, energy absorption (depending on thickness and foam structure), acoustic properties (when open-celled), and the potential for cost savings when they are integral with the skin or other surface material (e.g., textiles). The combination of foaming with two-shot molding and sheet extrusion offers the potential for both cost savings and the addition of value to the constructions in which they are used. Thus far, the potential added value of TPE foams has been under-exploited but is being developed for TPVs, COPE, SEBS and TPOs.

TPE Industry Structure Shift -- The structure and geographic center of the TPE supplier industry is shifting:

- Compounding technology has proliferated to both compounders and fabricators.
- Partnering has increased (see Exhibit 3).
- Asian exports are setting global market prices for fabricated parts and some TPEs.
- TPE concentrates are more widely available to specialty compounders and fabricators.
- Some major fabricator customers are back integrated to TPE production.
- In-line compounding/fabrication of TPEs is showing signs of becoming feasible.
- TPE product lines are broadening (encouraging bundled offerings of TPEs and commodity resins).

TPEs and the Economy -- TPE growth rates were less affected by the extended recessionary global economy than other plastics and elastomers. The SBC and TPV-type TPEs, for example, experienced double-digit growth in the past three years. Profitability, however, has been impacted by severe price pressures, particularly in the automotive sector, which typically accounts for about 40% of TPE demand in N. America and Europe, and by increased competitive intensity in the supply-side of the TPE market. If the global economy continues to improve, volume growth of TPEs can be expected to accelerate, but profitability is unlikely to improve for the commodity TPEs.

Price Erosion – Although there has been some recent recovery, TPE resin and compound prices have eroded over the past several years for a variety of reasons:

- Intensified global competition (especially for neat SEBS resins and TPVs)
- Global sourcing for molded parts
- The rapid increase in the number of TPE compounders
- The demonstrated ability of lower priced TPEs (SEBS, p-TPVs) to take share from higher priced TPEs
- The entry by metallocene-catalyzed polyolefins and reactor-based compounds
- The proliferation of TPV compounding technology.

Price Swings and Rubber Competition -- Thermoset rubber (TSR) has been a traditional target for TPEs, but thus far only a minor share of TPE growth has been at the expense of TSRs (see Reference 7). The recent introduction of high performance TPVs (see Exhibit 7) and the evolution of rigid/flexible systems will accelerate TPE competition with TSR (see Exhibits 8 and 9).

The post-9/11 period has seen severe raw material price swings. In early 2004, price swings for most plastics, rubber, and TPEs have recovered from the mid-2002 trough, but raw material costs are squeezing profits for TPE producers, and TPE prices are squeezing profits for molders attempting to compete in the severely price pressured automotive sector. The low prices for thermoset rubbers in the trough made TPE competition more difficult in those applications in which direct substitution rather than systems cost savings was sought.

TPE Markets -- TPEs participate in a broad range of market sectors as shown by the demand estimate for SEBS and TPVs listed in Exhibit 4 for N. America and Europe. Although their property profile and market sector distributions are somewhat different, SEBS compounds and TPV compete directly in most markets.

Automotive as TPE Technology Driver -- The automotive sector represents 40-50% of total demand for SEBS and TPVs in N. America and Europe and is a key technology driver for new TPE technologies, which are often adapted in other sectors. Examples are 3D blow molding, foam extrusion, coated fabrics, and two-shot molding of large parts. The ability of TPEs to meet automotive requirements is illustrated in Exhibit 6.

Automotive as Price Driver – The intense price discounting in the U.S., which has (recently) extended to Europe, is a major driver for price reduction and technology evolution as illustrated in Exhibit 5, which shows the dynamics of the interaction between auto OEMs and Tier 1 customers as it affects TPE technologies and markets.

Auto Interior Soft Trim and the Role of Two-shot Molding -- Auto interiors are emerging as a major growth opportunity in automotive TPE applications (see References 1 and 2). Keys among these interior growth applications are skins, skin/foam laminates, coated fabrics, airbag doors, and non-carpet flooring. Substitution of TPO skins (initially vacuum formed) started in Europe and has spread to N. America and Japan.

Most interior soft trim assemblies are made by relatively inefficient, multi-step processes (skin preform, substrate molding, back-foaming). Using two-shot molding methods developed for grips, knobs, and toothbrushes, molding machine makers have developed technology for molding large area skin/substrate parts (door trim panels, for example) in a single, multi-shot operation which:

- Saves process steps
- Reduces trimming operations
- Reduces scrap (when running to specification)
- Eliminates adhesives
- Allows the molding of integral skin/foam surfaces (thereby permitting further cost savings)
- Improves grain formation (compared to vacuum formed skins).

Initial applications for two-shot molding of large parts with TPE surfaces are likely to be in door trim panels and rocker panels with the potential for extension to instrument panels. Ube is an early equipment leader in this sector.

Coated Fabrics -- PVC coated fabrics are currently used in conjunction with leather for automotive seating. Coated fabrics represent a large potential market for TPO and some SBC-type TPE competitors (e.g., from Asahi Kasei). Recent compound developments and receptivity by European and Japanese auto OEMs suggest that penetration of the coated fabrics sector by both styrenic and olefinic TPE coated fabrics will begin in the next model year in seating and security shades. The development of RF sealing methods for TPOs will facilitate this penetration.

The Asian Role in TPE -- The emergence of Asian manufacturing and associated TPE resin supply are changing the global footprint of TPE markets and setting the pricing floor:

- Large populations (especially in China with 1.3 billion people) provide high growth domestic markets.
- Raw material costs are relatively low.
- Parts manufacturing costs are low:

Labor rates are typically \$0.30-0.50/hr.

The government provides many social costs.

Electricity costs are at least 30% lower than in Europe and N. America.

Taxes are relatively low and tax benefits are available.

Environmental and regulatory burdens are lower.

Quality is improving to meet global standards.

- The recent pricing pressures in the automotive market have encouraged imports of molded parts, some containing TPES:

Ford will increase Chinese parts imports from \$1 billion in 2002 to \$10 billion in 2010.

GM will import \$10 billion worth of auto parts by 2009 from Delphi, Visteon, and Lear in China. This is an increase from \$3 billion in 2003.

- Japanese TPE suppliers have entered the N. American market (and captured significant shares, especially in the TPO, SEBS, and TPV sectors) and are being followed by Asian suppliers from Korea (e.g., LG) and Taiwan (e.g., TSRC in SEBS; Formosa Plastics in O-TPEs).

SUMMARY

New materials and process substitutions are developing in response to severe pricing pressures from OEM customers in both the automotive and non-automotive sectors. The substitution of TPEs (especially TPVs) for EPDM and other TSRs will provide major stimulus to the growth of the TPV sector and the development of improved extrusion and foaming technology.

The use of TPEs presents opportunities for systems cost savings and added value materials combinations via both materials and processing technologies. Most of these opportunities are under-exploited.

The structure of the TPE supplier industry and paths to market are changing as:

- Compounding technology proliferates
- The use of concentrates becomes more common
- The potential for direct compounding/fabrication is more fully explored by major Tier 1 fabricators
- New high performance TPVs enter the market to challenge TSRs
- Asia assumes a significant role as TPE customer and materials supplier.

The differences in TPE fabrication and materials technologies between Japan, Europe and N. America are converging rapidly, driven by high volume global platforms, the increasingly porous boundaries to the transfer of technology, and the strong incentives to replace the current inefficient automotive constructions.

The quest for profitability in TPE supply is driving systems development, foam technology, new partnering combinations, and the introduction of new classes of high performance TPVs and SBCs capable of competing in established TSR markets.

REFERENCES

1. Multiclient Study, "Automotive Interior Soft Trim . . . Skins, Foams, Coated Fabrics, Textiles, and Acoustic Barriers," Robert Eller Associates, Inc. (June 2003)
2. Multiclient Study, "SEBS, TPV, and TPO-type Thermoplastic Elastomers . . . Markets, Economics, Technology, Intermaterials Competition, and the Role of Metallocene Resins," Robert Eller Associates, Inc. (2000)
3. Multiclient Study, "Strategic Global Outlook for Automotive Polyolefins in Europe, North America and Asia," Robert Eller Associates, Inc. (2004)
4. "TPEs . . . Finding Value through Materials and Process Innovation," SPE TPE Topcon 2003; Akron, Ohio (USA); September 22, 2003; Robert Eller
5. "North American Instrument Panel Compact Disc -- 2003," REA's Photo/Supplier Database
6. "Olefinic and Styrenic TPEs: Markets, Economics, Intermaterials Competition, and the Role of Plastomers," RAPRA TPE 2001; Amsterdam; June 18, 2001; Robert Eller
7. "An Automotive World Without Elastomers?" Annual IISRP Meeting; Naples; May 14, 2002; Robert Eller

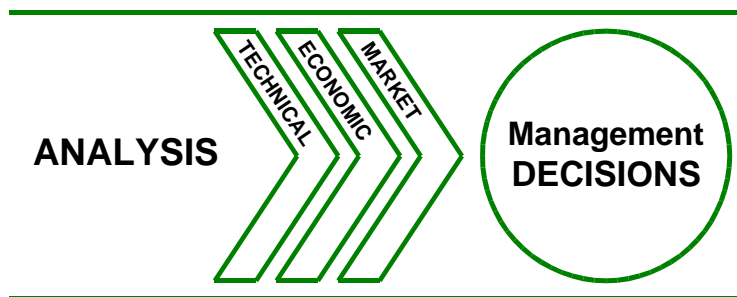
AUTHOR'S BIOGRAPHY

Robert Eller is President of Robert Eller Associates, Inc. (REA). His company provides technical, economic, and market analysis in support of management decision-making in the global plastics and rubber industries from offices in the U.S. and Europe. REA has completed multiclient studies of automotive interior soft trim, TPEs, and is currently preparing analyses of automotive nonwovens and polyolefin resins.

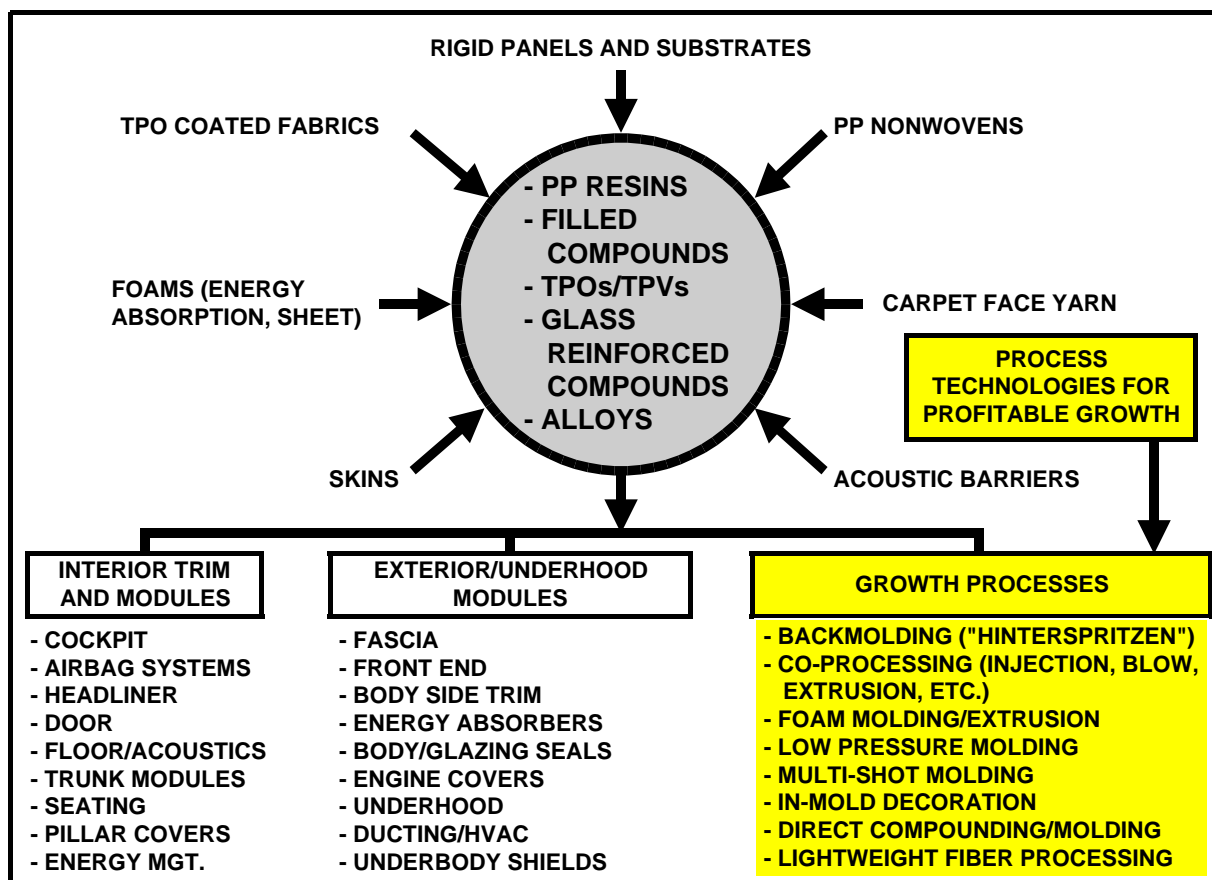
Bob is a graduate of M.I.T. and has served as General Manager of Multibase (USA), a compounder of TPEs, and has directed consulting analyses at A. D. Little. Information on REA capabilities and study prospectuses can be downloaded from the REA Web Site - robertellerassoc.com - or requested via e-mail at bobeller@prodigy.net.

GLOSSARY OF ABBREVIATIONS

c-TPO	-	COMMODITY TPO (E.G., BUMPER FASCIA)
COPA	-	COPOLYAMIDE
COPE	-	COPOLYESTER TYPE TPEs
ESI	-	ETHYLENE STYRENE INTERPOLYMER (E.G., DOW'S INDEX)
f-TPV	-	FULLY CROSSLINKED TPV
IP	-	INSTRUMENT PANEL
m-PO	-	METALLOCENE POLYOLEFIN
MID	-	MOLDED-IN DECORATION
NVH	-	NOISE, VIBRATION, HARSHNESS (PERFORMANCE DRIVER FOR INTERIORS)
OEM	-	ORIGINAL EQUIPMENT MANUFACTURER (E.G., THE AUTOMAKER)
p-TPV	-	PARTIALLY CROSSLINKED TPV
r-TPV	-	RECYCLATE-BASED TPV
s-TPO	-	SPECIALTY TPO (E.G., MEDICAL, AUTO BODY SIDE MOLDINGS, BUILDING/CONSTRUCTION)
SBC	-	STYRENE BLOCK COPOLYMER TPEs (SEBS, SBC)
SBS	-	STYRENE-BUTADIENE-STYRENE TYPE TPE
SEBS	-	STYRENE-ETHYLENE-BUTADIENE-STYRENE TPEs
TF	-	THERMOFORMING
TPV	-	THERMOPLASTIC VULCANIZATE
TSR	-	THERMOSET RUBBER



Strategic Global Outlook for Automotive Polyolefins in Europe, North America and Asia



Prospectus for a Europe/N. America Multiclient Analysis

Feb. 2004

Robert Eller Associates, Inc.

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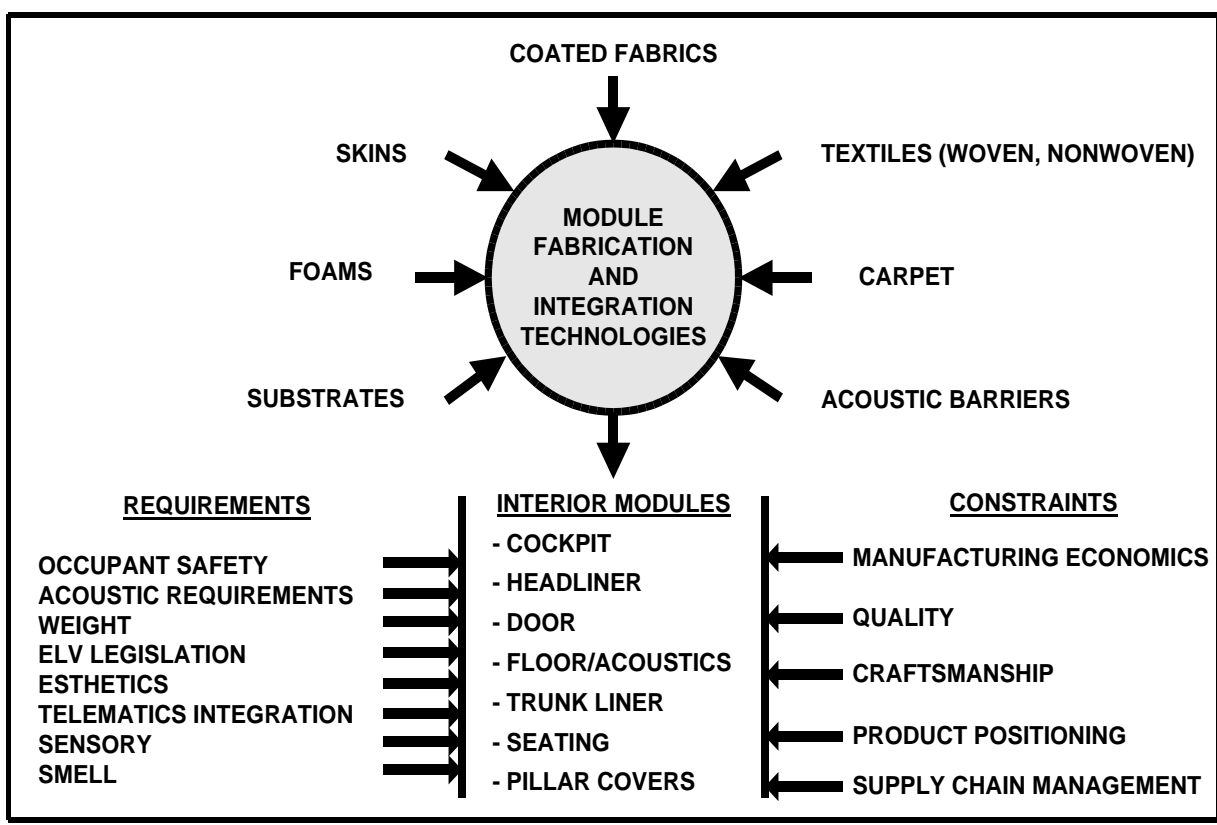
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**Automotive Interior Soft Trim:
Skins, Foams, Coated Fabrics, Textiles, and Acoustic Barriers**



Prospectus for a Global Multiclient Industry Analysis

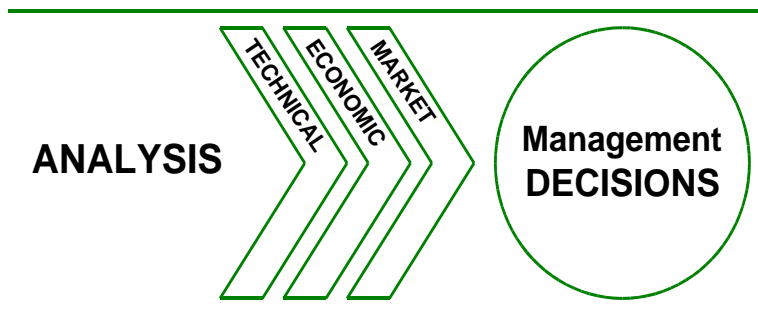
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Robert Eller Associates, Inc.

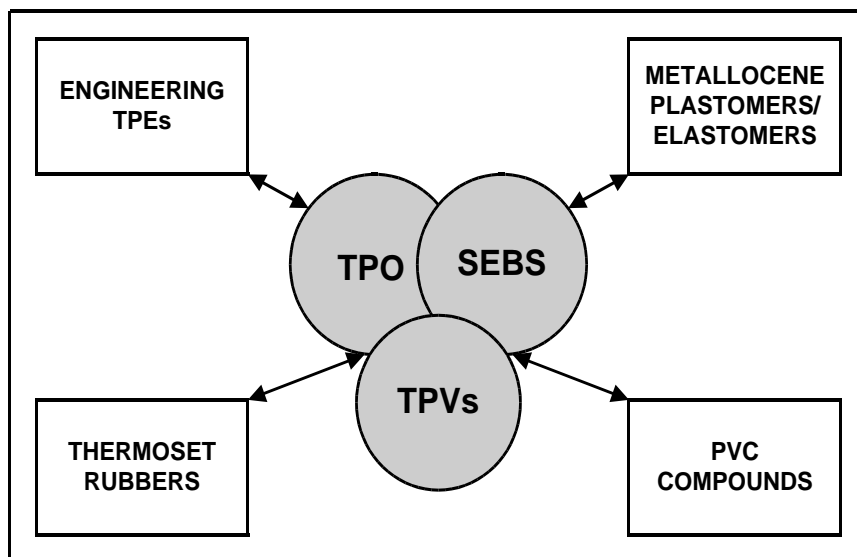
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SEBS, TPV, and TPO-type Thermoplastic Elastomers ... Markets, Economics, Technology, Intermaterials Competition, and the Role of Metallocene Resins



Prospectus for a Euro/US/Japan Multiclient Industry Analysis

January 2000

Robert Eller Associates, Inc.

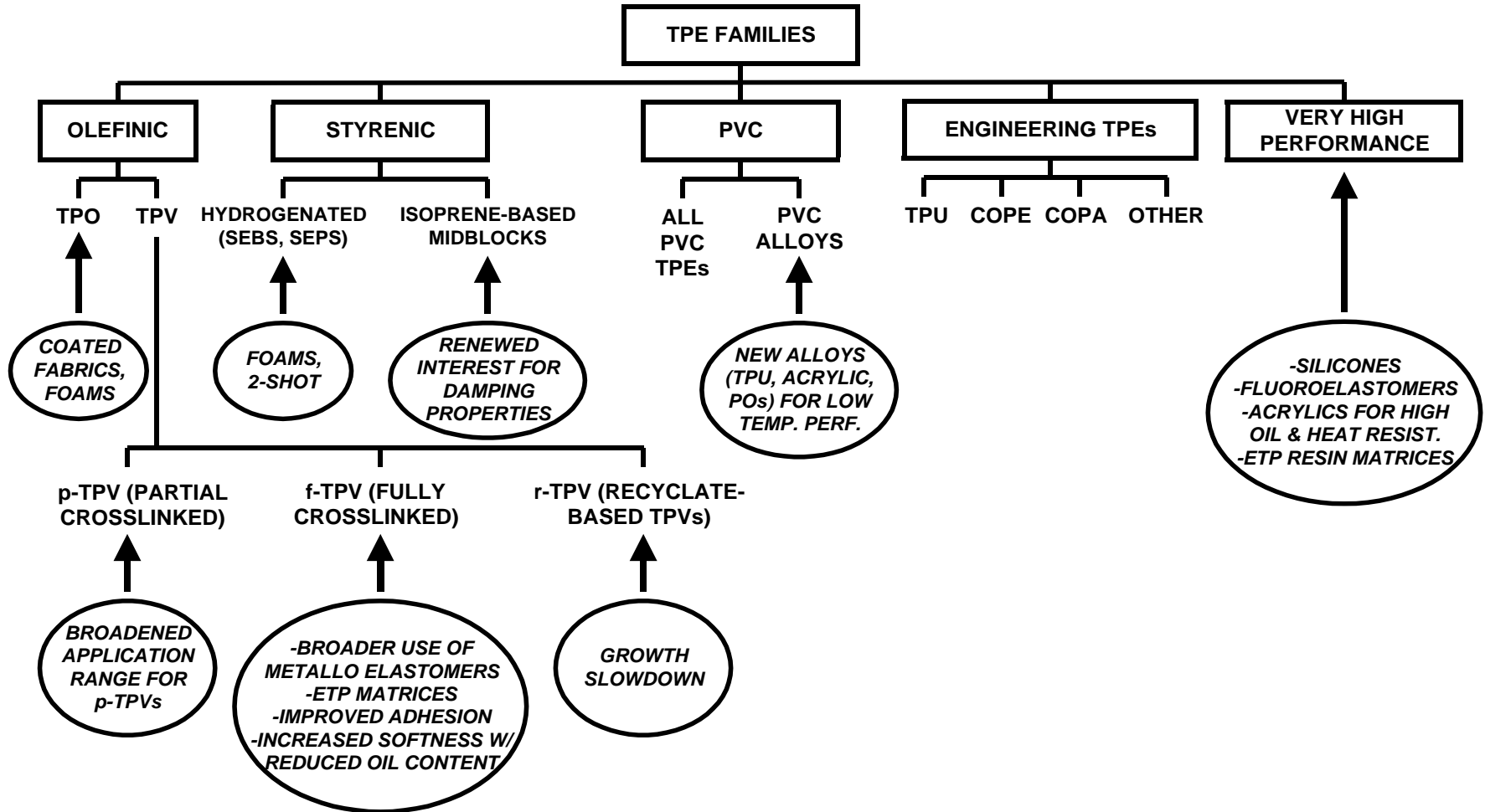
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EXHIBIT 1

GROWTH AND VALUE OPPORTUNITIES IN THE TPE FAMILIES



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

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EXHIBIT 2**RECENT TPE TECHNOLOGIES AND THEIR IMPLICATIONS**

TPE TECHNOLOGY	NOTE/IMPLICATION
SEBS FOAMS (SHEET, PROFILES)	-PROFILES WILL COMPETE WITH TPV -SHEET FOAMS COULD OPEN IP SKINS
IMPROVED TPV FOAM TECHNOLOGY (SHEET, PROFILES)	-COULD ACCELERATE BODY SEAL GROWTH
COEXTRUDED SKIN/FOAM SHEET	-FOR REDUCED COST IP SKINS
FOAM COPE	-FROM TOYOBO
COPE-BASED TPV	-FROM DuPONT -COMPETE WITH TSR -AUTO TARGET: HOSE, ENGINE MOUNTS, BODY PLUGS
TPO SLUSH MOLDING COMPOUND	-FROM SUMITOMO -PENETRATING EUROPE, JAPAN, N. AMERICA IP SKINS
PVC ALLOY SLUSH MOLDING COMPOUND	-FOR IP SKINS -LOW TEMP. AIRBAG DEPLOYMENT
COEXTRUDED SKIN/FOAM SHEET	-FOR IP SKINS
TPV BELTING	-LARGE POTENTIAL MARKET
TPO VACUUM FORMED IP SKINS	-GROWTH RE-STARTING STIMULATED BY NEGATIVE FORMING
TPO COATED FABRICS	-FIRST COMMERCIAL APPLICATIONS IN EUROPEAN AUTO SEATING AND SECURITY SHADES
SBC REPLACEMENT FOR DOW'S ESI	-FROM ASAHI KASEI
ISOPRENE-BASED MIDBLOCK SBCs	-FOR VIBRATION DAMPING
2-SHOT MOLDING OF LARGE AREA PARTS	-FROM UBE -POTENTIAL FOR IP, DOOR TRIM, ROCKER PANELS -ELIMINATE SEPARATE SKINS
SEBS/PP AND TPV/PP IN GLAZING FRAMES	-EXAMPLE OF RIGID/HARD SYSTEM
TOYOTA TSOP TECHNOLOGY	-WIDELY USED AND LICENSED -SELLING AT 2X CONVENTIONAL PP COMPOUND PRICES

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

EXHIBIT 3

EXAMPLES OF TPE PARTNERING

PARTNERS	TPE TYPE	LIKELY OBJECTIVES
DSM/GLS	SEBS/TPV	-BROADEN PRODUCT OFFERING
AES/DS CHEMIE	TPV	-FACILITATE ACCESS TO BOTTLE CAP MARKET
AES/LG	TPV	-DEVELOP ASIAN MARKETS
SEP/TRS	TPV	-DEVELOP BODY SEALS MARKETS
TOYOBO/DSM TPE	TPV, COPE	-DEVELOP JAPAN MARKETS -DEVELOP FOAM TECHNOLOGY
TOYOBO/DSM/YOUNGBO	TPV, COPE	-DEVELOP FOAM TPE TECHNOLOGY

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

EXHIBIT 4**TPV AND SEBS MARKETS IN EUROPE AND N. AMERICA (2003)**

MARKET SECTOR	TPV (a)	SEBS (b)	NOTE
AUTO	XX	X	TPV GROWTH IN BODY SEALS
FLUID HANDLING	XX	X	SEBS GROWTH IN FOODS
BUILDING/CONSTRUCTION	X	XX	SEBS STRONG IN EUROPEAN NON-AUTO GLAZING
CONSUMER/HOUSEWARE	X	XX	SEBS STRENGTH IN CONSUMER SOFT TOUCH
MEDICAL	X	XX	TPV WHERE C-SET, HEAT RESISTANCE REQUIRED
FOOD/PHARMA PKG.	X	XX	GROWTH BOTH TYPES (E.G., CAP SEALS, WINE)
APPLIANCE/TOOL	X	X	SOFT TOUCH. TPV WHERE HEAT/OIL RESIST. REQ'D.
WIRE/CABLE	X	X	
SPORTS/LEISURE	X	X	
PERSONAL CARE	X	XX	
FOOTWEAR	X	X	SBS COMPOUNDS DOMINATE
CONSUMER ELECTRONICS	X	X	STRONG GROWTH IN ASIA
COATED FABRICS		X	COULD BE GROWTH SECTOR
OTHER			
TOTAL(kT)	150	150	

NOTES:

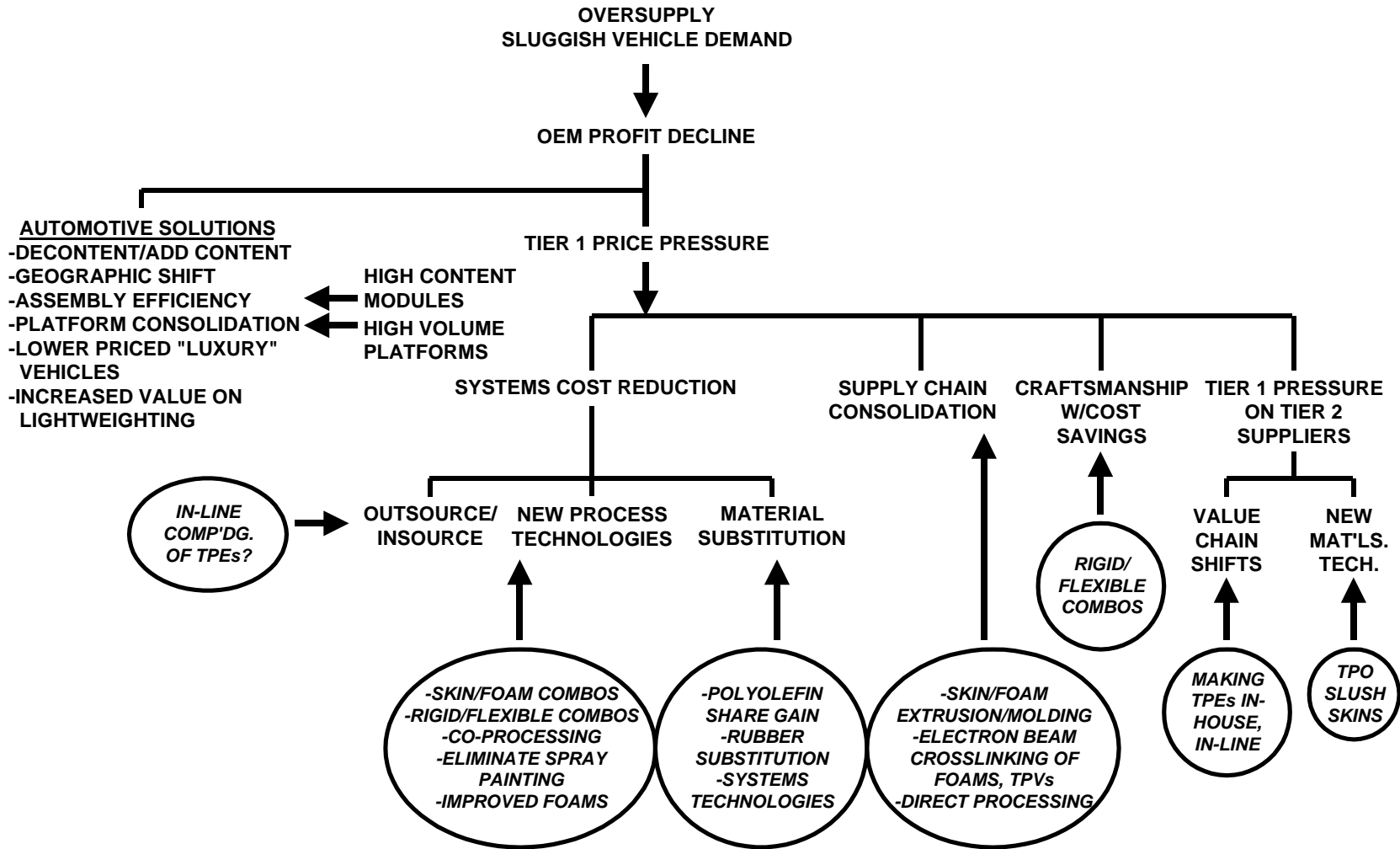
XX INDICATES HIGHER PRESENCE IN THIS MARKET SECTOR

(a) INCLUDES f-TPV AND p-TPVs

(b) SEBS COMPOUNDS ONLY

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

**EXHIBIT 5
AUTOMOTIVE OEM/SUPPLIER DYNAMICS AND EFFECT ON TPEs**



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

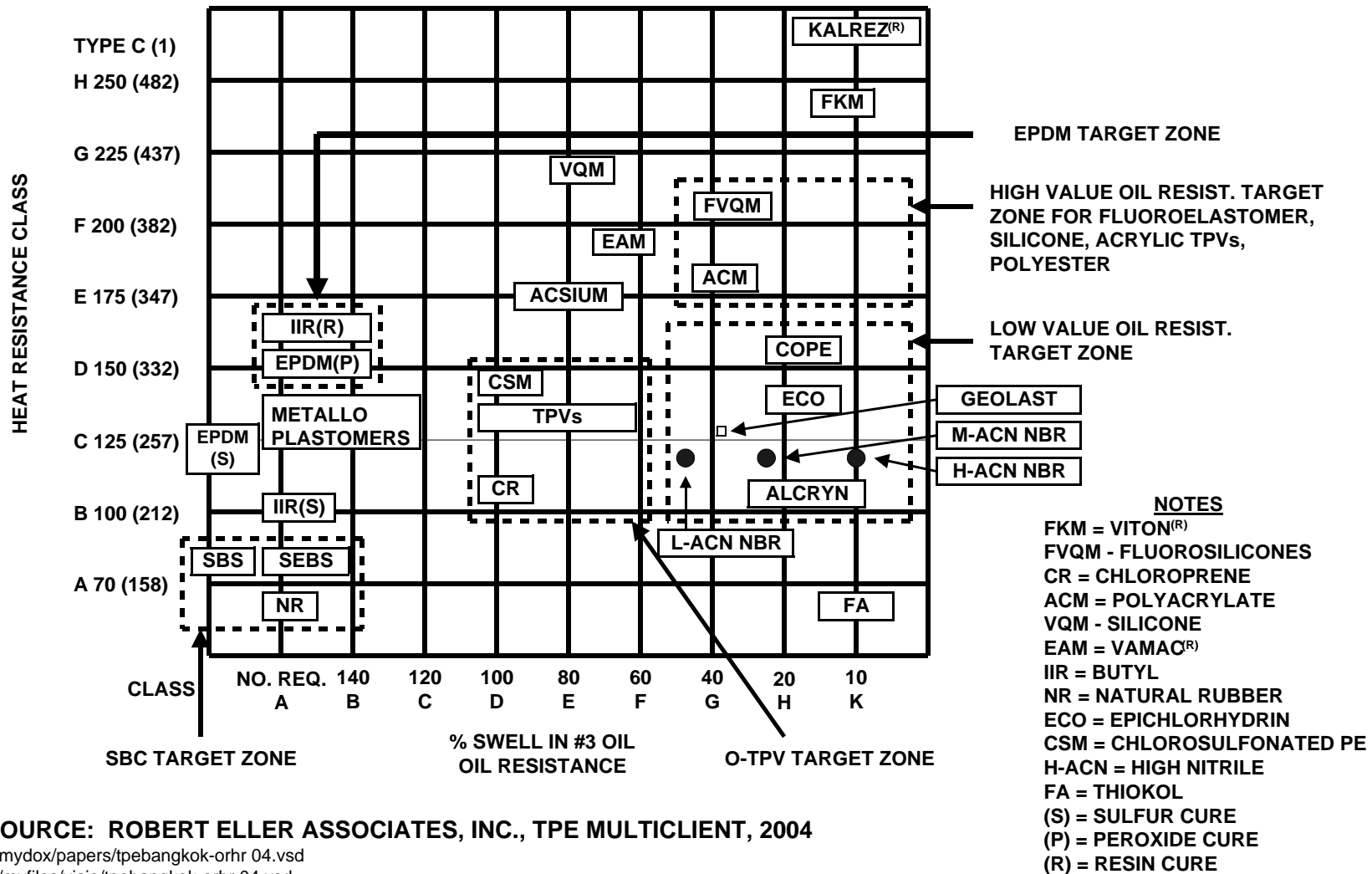
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EXHIBIT 6**TPEs' ABILITY TO MEET AUTOMOTIVE MATERIAL/PROCESS REQUIREMENTS**

SYSTEMS COST SAVINGS	TPE IMPLICATIONS/EXAMPLES
SYSTEMS COST SAVINGS	-RIGID/FLEXIBLE COMBINATIONS -TPE BODY SEALS -TWO-SHOT MOLDING OF LARGE PARTS
WEIGHT SAVINGS	-INCREASED TPE FOAM USE -SUBSTITUTE FOAMS FOR HEAVY LAYER
SOFT TOUCH	-TWO-SHOT MOLDING (ESPECIALLY LARGE PARTS) -COEXTRUSION OF SOFT TOUCH SURFACED TPEs
LOW GLOSS	-A TPE BENEFIT FOR SEBS
OIL RESISTANCE	-IMPROVED LOW OIL TPEs (METALLO INGREDIENTS)
INVISIBLE AIRBAG DOORS	-MAJOR DRIVER FOR p-TPV INSTRUMENT PANEL SKINS AND (RECENTLY) PVC ALLOY SKINS
ODOR-FREE INTERIORS	-PLASTICIZER REDUCTION -SUBSTITUTE OLEFINS FOR OTHER FAMILIES
ELIMINATION OF COATINGS	-IMPROVED SCRATCH/MAR TPE GRADES -IN-MOLD DECORATION -INCREASED COEXTRUSION
BODY COLOR MATCH	-EPDM REPLACEMENT IN BODY SEALS
MOLDED-IN COLOR	-TPEs WITH IMPROVED COLOR CONTROL (ESP TPVs) -LOWER FILLER LEVELS
IMPROVED NOISE, VIBRATION, HARSHNESS CONTROL	-TPEs WITH INTEGRAL FOAM LAYERS -ISOPRENE-BASED GRADES
ACOUSTIC PERFORMANCE	-ISOPRENE-BASED GRADES -CONTROLLED DENSITY FOAMS -ELIMINATION OF HEAVY LAYER CONSTRUCTIONS
ENERGY ABSORPTION (OCCUPANT SAFETY)	-ON-BOARD FOAM CONSTRUCTIONS
RECYCLABILITY	-TPE ROLE IN ALL-POLYOLEFIN CONSTRUCTIONS

SOURCE: ROBERT ELLER ASSOCIATES, INC., SOFT TRIM MULTICLIENT STUDY -- 2003 (REF. 1)

**EXHIBIT 7
OIL RESISTANCE/HEAT RESISTANCE OF TPEs AND THERMOSET RUBBERS**

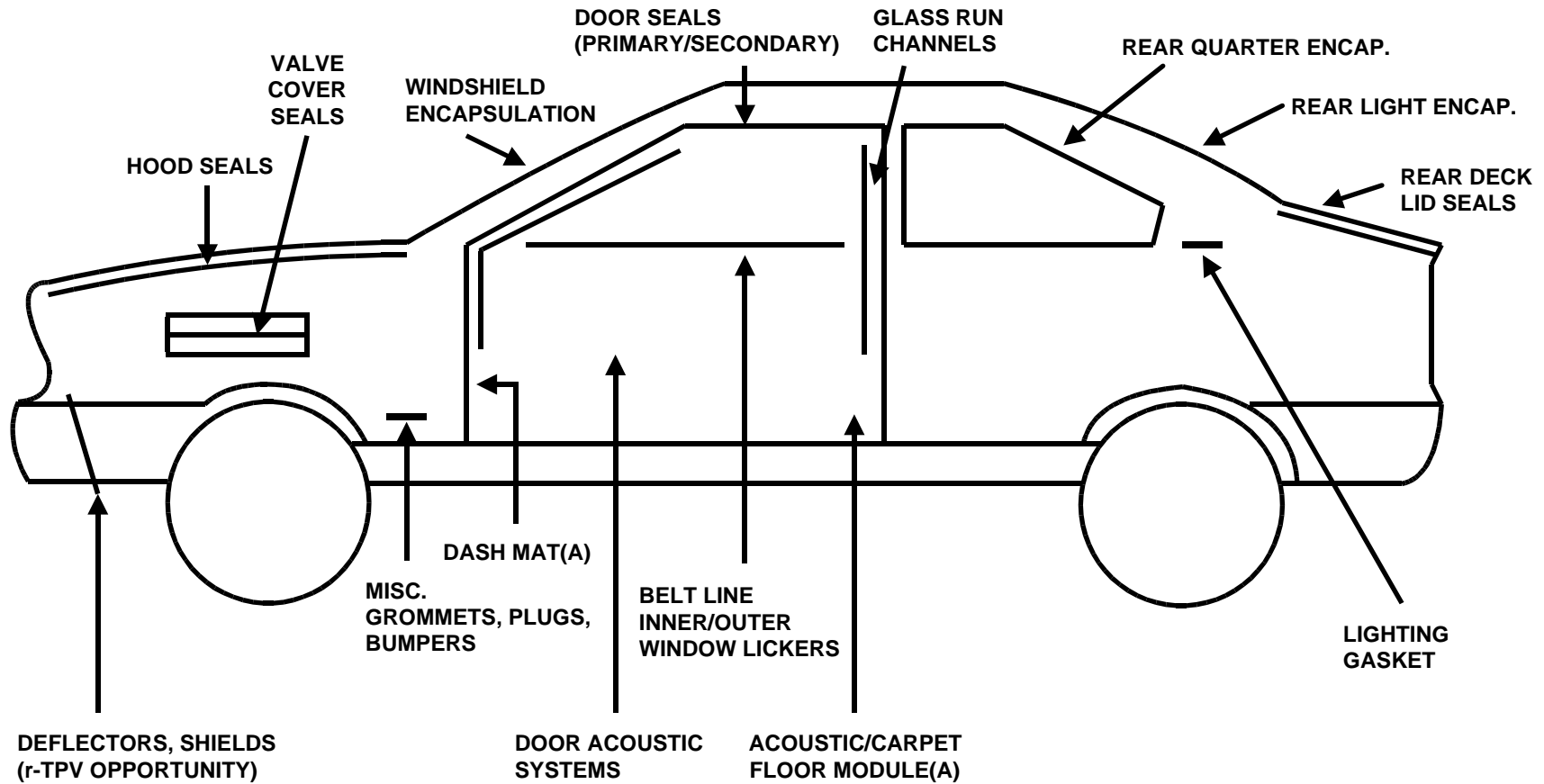


SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE MULTICLIENT, 2004

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EXHIBIT 8

TPE/RUBBER COMPETITIVE INTERFACE IN AUTO APPLICATIONS



NOTE: (A) ACQUSTIC/FOAM OPPORTUNITY

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2004

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EXHIBIT 9**TPE CHALLENGERS TO MAJOR AUTOMOTIVE RUBBER
AND PVC INCUMBENTS**

APPLICATION	TPE CHALLENGER							
	PVC	TPV	SEBS	TPO	TPU	COPE	r-TPV	OTHER
ACOUSTIC BARRIERS			X					
AIRBAG DOORS	X		X	X		X		
BELTING		X			X	X		
BODY PLUGS		X	X			X		
BODY SEALS		X	X					
BOOTS/BELLOWS		X				X		
COATED FABRIC				X	?			
DAMPER MOUNTS		X	X					
ENGINE MOUNTS						X		
FLOOR MATS				X				
FUEL SYSTEMS								X
GLAZING SEALS	X	X	X					
HIGH PERFORMANCE GASKETS								X
IN-MOLD DECORATION				X	X			X
INTERIOR SKINS	X	X		X	X	X?		
NON-CARPET FLOOR				X				
UNDERHOOD DEFLECTORS							X	X
WIRE/CABLE		X	X					

**SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE AND SOFT TRIM
MULTICLIENTS, 2000 and 2003 (References 1 and 2)**