Robert Eller Associates, Inc.
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

4000 Embassy Pkwy., Ste. 230 · Akron, OH 44333-8328 USA · Phone 330-670-9566/Fax 330-670-9844
E-mail: bobeller@prodigy.net · Home Page: http://www.robertellerassoc.com

GLOBAL TRENDS IN OLEFINC TPEs

Prepared for:
Polyolefins 2004
Houston, TX
February 23, 2004

Presented by:
Robert Eller
Robert Eller Associates, Inc.

Abstract -- This paper will review for olefinic TPEs (TPVs and TPOs) in automotive and non-automotive market sectors:

- Market forces affecting pricing and profitability
- Intermaterials competition
- Global influences on markets and technology
- Opportunities for extracting higher value
- Shifts in industry structure.

The presentation is based on:

- Recent REA research in Europe and N. America
- REA's recently completed auto interior soft trim study (1)
- Our global TPE multiclient study (2)
- Our forthcoming multiclient analysis of PP in automotive applications (3)

O-TPEs and Competitors -- O-TPEs must compete with other TPEs and with thermoset elastomers. The position of O-TPEs in the families of TPEs and some of the value-added opportunities to be discussed in this paper are shown in Exhibit 1.

Market Forces Affecting O-TPE Pricing and Profitability -- Automotive represents about 80% of the TPO market and 40% of TPV demand. It is also a major driver for the development of new technology. Economic conditions in the automotive sector therefore become a major market force affecting pricing and profitability of the O-TPEs as illustrated in Exhibit 2.

Automotive Economics/Industry Structure Effects on TPEs -- Market pressures on automotive OEMs are transferred to their materials and module suppliers. The dynamics of this pressure and the resulting responses are illustrated in Exhibit 2. These dynamics are driving a shift in the position of O-TPEs in the value chain and providing incentives for TPE growth and profitability. The current automotive economic/materials technology interface can be summarized as follows:

- Auto OEMs are operating in an extended (3 year), global economy that is just beginning to show signs of emergence from recession conditions.

- Rapid growth of global parts sourcing and the growing role of China as materials supplier and assembled parts supplier (see discussion below).

- Resin price increases (starting in late 2002) combined with vehicle price decreases have created a squeeze on Tier 1 supplier profits. This, in turn, provides incentive for O-TPE materials and process innovations capable of adding value while providing cost savings.

- Tier 1 consolidation has created a substantial increase in purchase power (pressuring prices downward) as well as incentives for in-house O-TPE compounding by fabricators. Some example applications are for body seals, acoustic damping compounds and skins formulations.

- The continuing vehicle market share loss by domestic automotive OEMs to non-domestic competition is stimulating the entry of Japanese and European compound and process technology. (Some examples of Japanese and European TPE technology contributions are shown in Exhibit 3.)

- High volume (sometimes global), multi-vehicle platforms have increased, raising the stakes for successful participation. There are now approximately 15 platforms in the global fleet with vehicle volumes of 1-2.5MM units.

The ability of O-TPEs to meet automotive process and materials requirements and the competitive interface with rubber are illustrated in Exhibits 4-6.

TPE Industry Structure Shift -- The structure of the O-TPE supplier industry is changing as:

- Asian imports (primarily from China) are setting global market prices for parts (thereby attracting compounders and O-TPE suppliers).

- Major O-TPE compounders are broadening their product lines (e.g., DSM/GLS joint venture, SEP and A. Schulman entering the TPV sector).

- TPV concentrates with good rheological properties are being offered to specialty compounders and major fabricators.

- TPV compounding technology has proliferated to a broad range of compounders

- Fabricators have the potential for entering in-line compounding of O-TPE during fabrication thereby saving on the costs of the intermediate pelletizing step (see Exhibit 2).

- TPE compounders form partnerships with customers (AES/DS Chemie, SEP/TRS).

- Co-processing (injection molding, blow molding, extrusion) encourages resin suppliers to provide rigid/flexible package offerings.

Role of Japanese and European o-TPE Compounders and Technology in N. America -- The continuing share loss by domestic OEM automakers in N. America to non-domestic competition is stimulating the entry of Japanese and European O-TPE compound and process technology. Japanese compounders, in particular, have gained a major share of the high value TPO applications in N. American vehicle exteriors (primarily fascia) and interiors. Some examples of Japanese and European leadership in O-TPE technology are given in Exhibit 3. Furthermore, the relatively high profitability of the non-domestic automotive OEMs sustains a higher level of product and process development.

Role of China in O-TPEs -- The rapid growth of automotive and non-automotive markets in China will affect the global distribution of O-TPE production and pricing.

Vehicle sales in China will reach 6-7MM units by 2008 from the current level of 4MM vehicles and will absorb the announced vehicle production capacity expansions (see Exhibit 7). Japanese PP and O-TPE compounders have been present in the region for several years. Recently several TPV compounders have announced Asian expansions to meet automotive and non-automotive demand. Some examples are:

- AES joint venture with Sei-Woo Rubber (new plant to be built)
- Teknor Apex acquisition of Singapore Polymer Corp.
- Taiwan Nantex Co. Ltd. produces TPV in Taiwan.

A shift to Chinese production of consumer goods, especially in the electronics sector, is shifting the global location of O-TPE compounding facilities. The early presence of VW in China and their continuing strong market share attracted European TPO bumper fascia (and PP) compounders as early as 1994.

Price Erosion -- O-TPE prices have eroded over the past several years for a variety of reasons:

- The proliferation of TPV compounding technology
- The entry by Asian O-TPE producers into European and N. American markets
- Pricing for molded automotive and non-automotive parts based on global (especially Asian) sourcing
- The rapid increase in the number of O-TPE compounders
- The demonstrated ability of lower priced TPEs to take share from higher priced O-TPEs
- The entry by metallocene-catalyzed polyolefins and reactor-based compounds has placed pressure on the TPO segment
- The pressure to meet rubber pricing in order to get a foothold in the automotive body seals market
- Competition from increasingly sophisticated PVC and SEBS compounds

- Penetration of partially crosslinked TPVs (p-TPVs) into some markets previously dominated by fully crosslinked (f-TPVs).

Value Added Opportunities -- TPEs are used alone as a molded part, but a substantial portion of the applications is in combination with other materials such as:

- Glass (e.g., in automotive and non-automotive glazing seals)
- Fibers (e.g., in reinforced hose, belting, and [recently] coated fabrics)
- Other TPEs (e.g., in multi-TPE co-processed assemblies)
- Other resin families (e.g., in rigid/flexible assemblies, soft touch parts, gasketing applications)
- Metals (e.g., in sealing applications).

This participation in a system (and the associated potential for system cost savings) is a major driver for adding (or retaining) value in new O-TPE applications. The association with other materials during fabrication (using co-processing methods) has resulted in a focus on research to improve rheological characteristics and surface properties for adhesion.

Consumer/Industrial Sector Added-value Developments -- Bondable TPVs add value to the base TPV and present the opportunity for cost saving systems, especially in soft/hard combinations. These are used for high-end TPV-based consumer grips, textile laminates for hose constructions, integrated seals/buttons.

Value is also gained as hardness decreases. Recently TPVs with hardness below 30 Shore A have been introduced.

The hotly contested interface between TPV and SEBS is becoming fuzzier as TPV/SEBS alloys are introduced and as TPVs enter the cap/closure seal market in competition with EVA and SEBS compounds.

Automotive Body/Glazing Seals -- As shown in Exhibit 5, body seals are an automotive and appliance application target in which TPVs must compete with EPDM rubber and PVC compounds. SEBS-based TPEs are also targeting this application with some recent success. This is a potentially high growth sector (see Reference 2) which is a major target of TPV producers developing the fabrication technology, foaming methods, profile designs, and surface coating technology to offer systems cost savings vs. incumbent EPDM-based compounds. The ability to offer a rigid/flexible combination is a key advantage for the TPVs. Thus far, it does not appear that TPVs will penetrate the high volume primary door seals sector due to property limitations.

Coated Fabrics -- In combination with leather, PVC coated fabrics are widely used for automotive seating. Coated fabrics represent a large potential market for TPOs (and some SBC-type TPE competitors). Recent compound developments and receptivity by European and Japanese auto OEMs suggest that penetration of the coated fabrics sector by both styrenic and O-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 Role of Foams -- Foaming brings value to O-TPEs as a result of softness, energy absorption (depending on thickness and foam structure), acoustic properties, and the potential for cost savings when they are integral with the skin or other surface material (e.g., textiles). The ability to achieve high quality foams is a requirement for participation in the high growth body seals sector.

The rheological properties of O-TPEs can be adjusted to accommodate the foaming process.

The combination of foaming with two-shot molding offers the potential for both cost savings and the addition of value to the constructions in which they are used.

Polyolefin foam sheets are being combined with textiles (e.g., the door trim medallion of the Renault Laguna II has a polyester textile/polyolefin foam sheet laminate). Thus far, the potential added value of O- TPE foams has been under-exploited.

SUMMARY

Automotive applications remain a key driver for O-TPE technology and market growth. The resulting intense cost pressures are providing incentives for the development of new technology capable of providing cost savings primarily in auto interiors.

The structure of the O-TPE industry is shifting as fabricators enter in-house compounding, compound technology diffuses, Europe/U.S. automotive practices converge, and China emerges as a significant market and O-TPE producing region.

Despite these conditions, the market offers opportunities for value-added offerings based on both property improvements and systems cost savings.

b/mydox/papers/polyolefins04.doc

REFERENCES

1. Multiclient Study, "Automotive Interior Soft Trim: Skins, Foams, Coated Fabrics, Textiles and Acoustic Barriers," Robert Eller Associates, Inc. (August 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, "Polypropylene in Automotive Applications in Europe and North America," Robert Eller Associates, Inc. (May 2004)

4. Multiclient Study, "Advanced Nonwovens in Automotive Applications," Robert Eller Associates, Inc. (March 2004)

5. "TPE Value and Growth Opportunities: Markets, Economics, Intermaterials Competition, and the Role of Plastomers," RAPRA TPE 2003, Brussels, September 16, 2003; Robert Eller

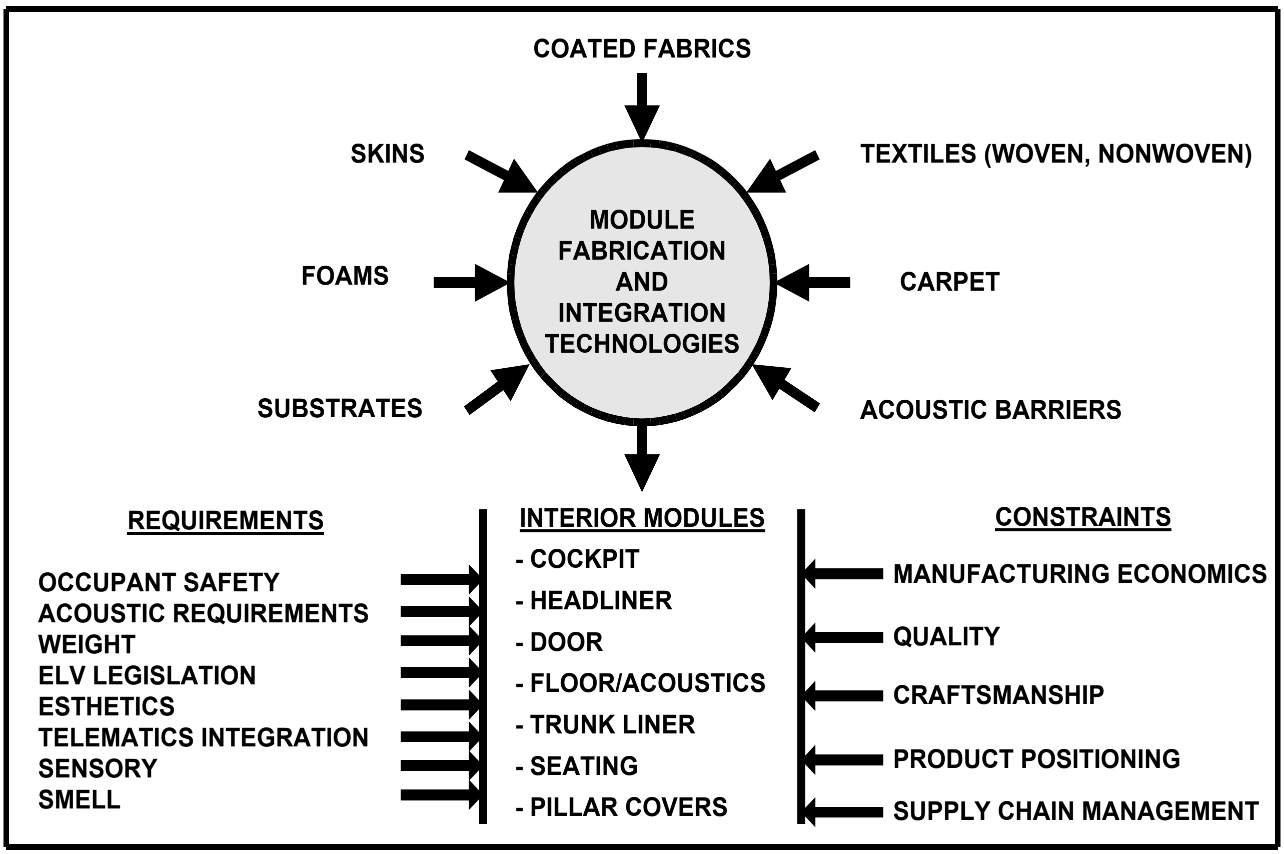
6. "Matériaux d'habitacle Automobile et Approche Sensorielle," Comfort Automobile et Ferroviaire; Le Mans, France; Nov. 15, 2000; D. Nesa, S. Couderic, S. Crochmore

7. "Trends in the Automotive Interior Textiles Market," IFAI Expo, Las Vegas, NV; Oct. 1, 2003; Robert Eller

8. "Acoustic Barriers -- Material Substitution and Industry Structure Drivers," *Automotive and Transportation Interiors*, p. 46; November 1999; Robert Eller

Automotive Interior Soft Trim:

Skins, Foams, Coated Fabrics, Textiles, and Acoustic Barriers



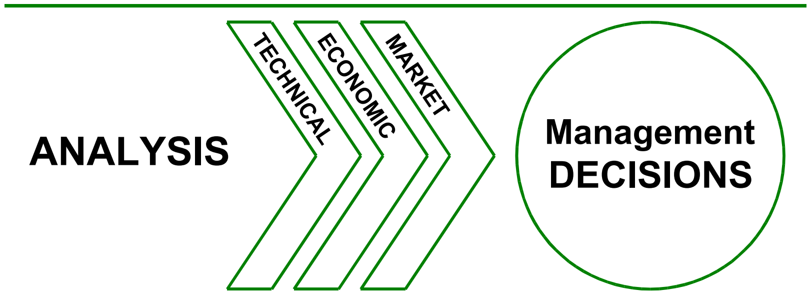
Prospectus for a Global Multiclient Industry Analysis **July 2001**

Robert Eller Associates, Inc.

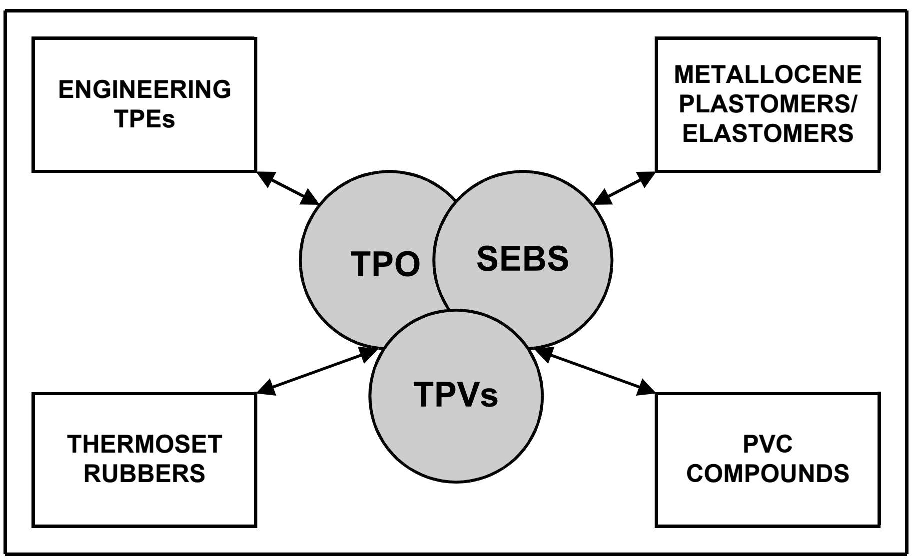
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

4000 Embassy Pkwy., Ste. 230, Akron, OH 44333-8328 USA· Phone 330-670-9566/Fax 330-670-9844
Internet Home Page: http://www.robertellerassoc.com E-mail: bobeller@prodigy.net

USA · EUROPE · JAPAN · MEXICO · LATIN AMERICA



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

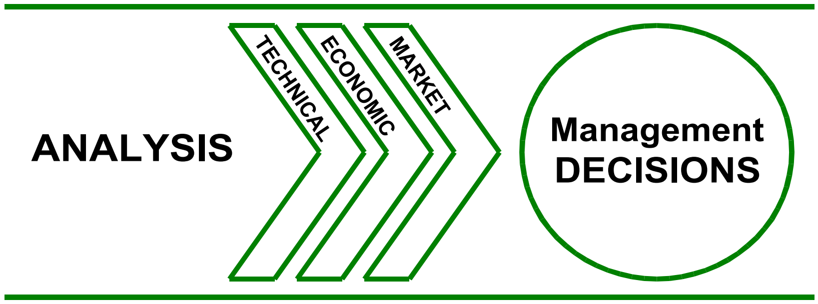
January 2000

Robert Eller Associates, Inc.

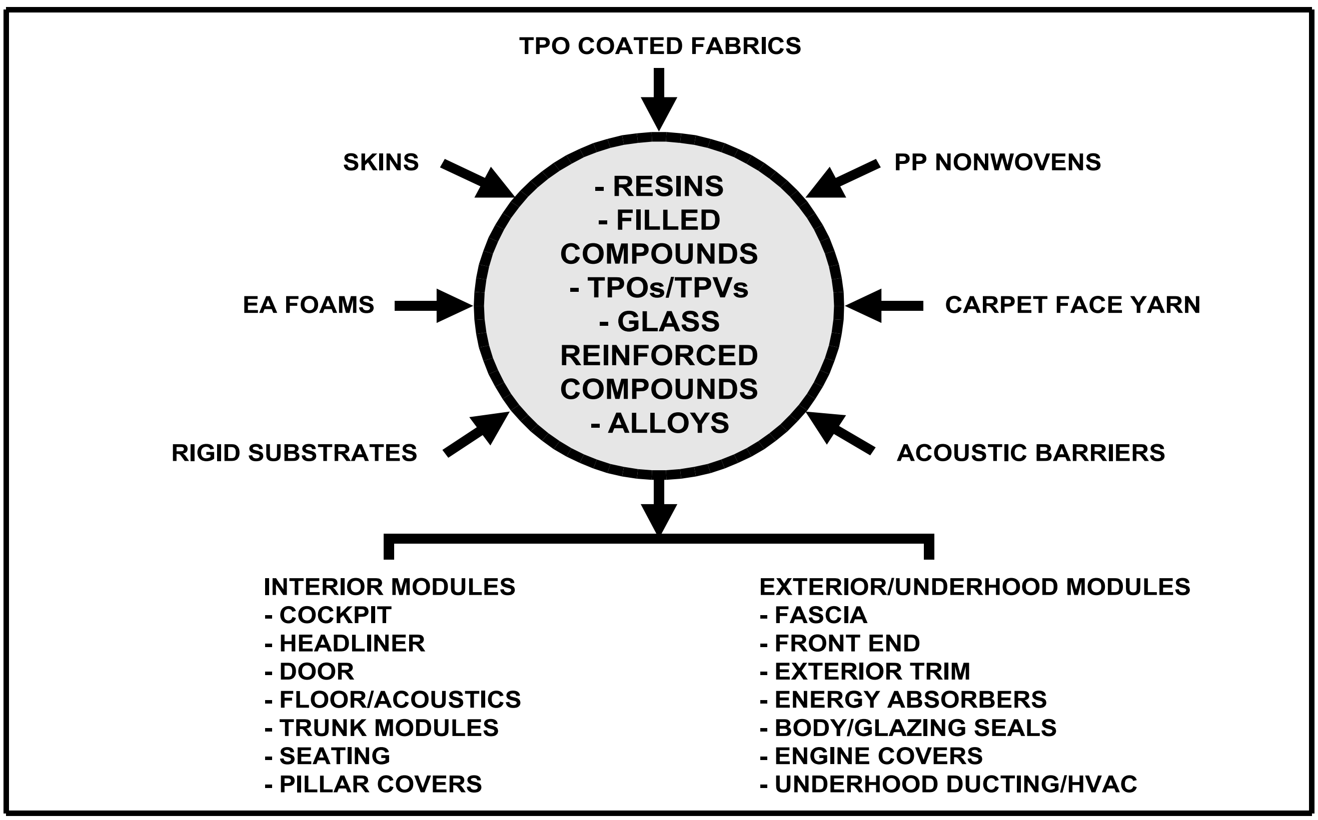
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

4000 Embassy Pkwy., Ste. 230, Akron, OH 44333-8328 USA· Phone 330-670-9566/Fax 330-670-9844
Internet Home Page: http://www.robertellerassoc.com E-mail: bobeller@prodigy.net

USA · EUROPE · JAPAN · MEXICO · LATIN AMERICA



Automotive Polypropylene in Europe and North America



Prospectus for a Europe/N. America Multiclient Analysis **Jan. 2004**

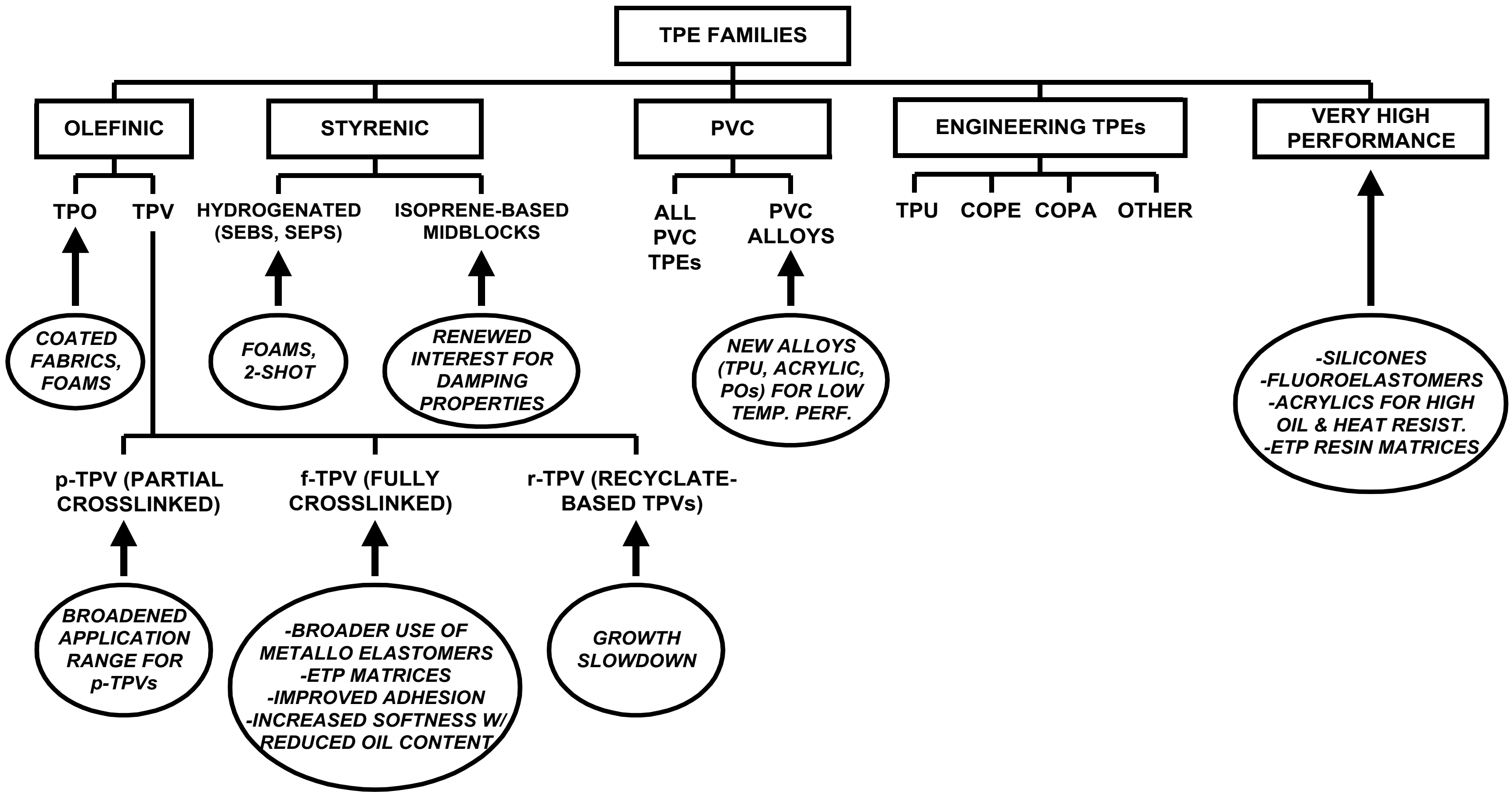
Robert Eller Associates, Inc.
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

4000 Embassy Pkwy., Ste. 230, Akron, OH 44333-8328 USA· Phone 330-670-9566/Fax 330-670-9844
Internet Home Page: http://www.robertellerassoc.com E-mail: bobeller@prodigy.net

USA · EUROPE · JAPAN · MEXICO · LATIN AMERICA

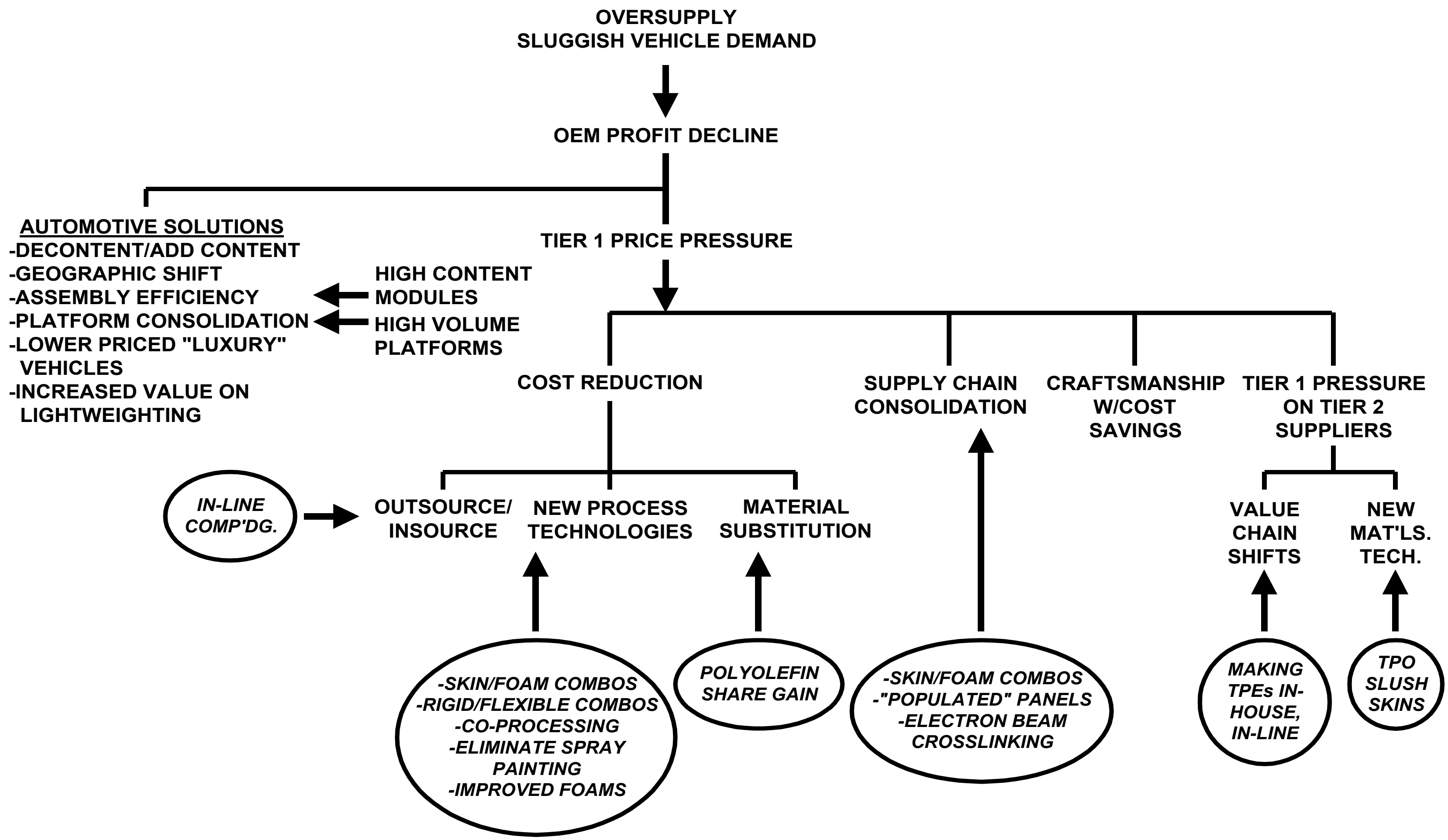
EXHIBIT 1

GROWTH AND VALUE OPPORTUNITIES IN THE TPE FAMILIES



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003
re/mydox/papers/PO04-growth oppys tpe 03.vsd

EXHIBIT 2
AUTOMOTIVE OEM/SUPPLIER DYNAMICS AND EFFECT ON O-TPEs



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003
re/mydox/papers/PO04-autooemdyn 03.vsd

EXHIBIT 3

EXAMPLES OF EUROPEAN/JAPANESE O-TPE INTERIOR TECHNOLOGIES

O-TPE TECHNOLOGY	SOURCE	NOTE
TPO SLUSH MOLDING COMP'D.	J(A)	-PENETRATING EUROPE, JAPAN, NORTH AMERICA IP SKINS
TOYOTA TSOP TECHNOLOGY	J	-WIDELY USED AND LICENSED -SELLING AT 2X CONVENTIONAL COMPOUNDS
TPO VAC FORMED SKINS	J	-FIRST TPO DROP-IN VAC FORMED SKIN
TPO COATED FABRICS	E	-FIRST COMMERCIAL APPLICATIONS IN EUROPE
SOFT TOUCH CO-EXTRUDED SHEET	E	
ALL-PO CARPET SYSTEM	E	
GLAZING/BODY SEALS	J, E	
NON-CARPET FLOORING	E	-GLOSS CONTROL IMPORTANT -DECORATION OPTIONS
2-SHOT MOLDING OF DOOR TRIM PANELS/SKINS	J	-FROM UBE
TPV BODY SEALS	J	-FIRST APPLICATIONS IN JAPAN
SKIN OR TEXTILE/EPP FOAM MOLDING	E	-IN EUROPE FOR IP AND DOOR TRIM

NOTE:

(A) FROM SUMITOMO

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003

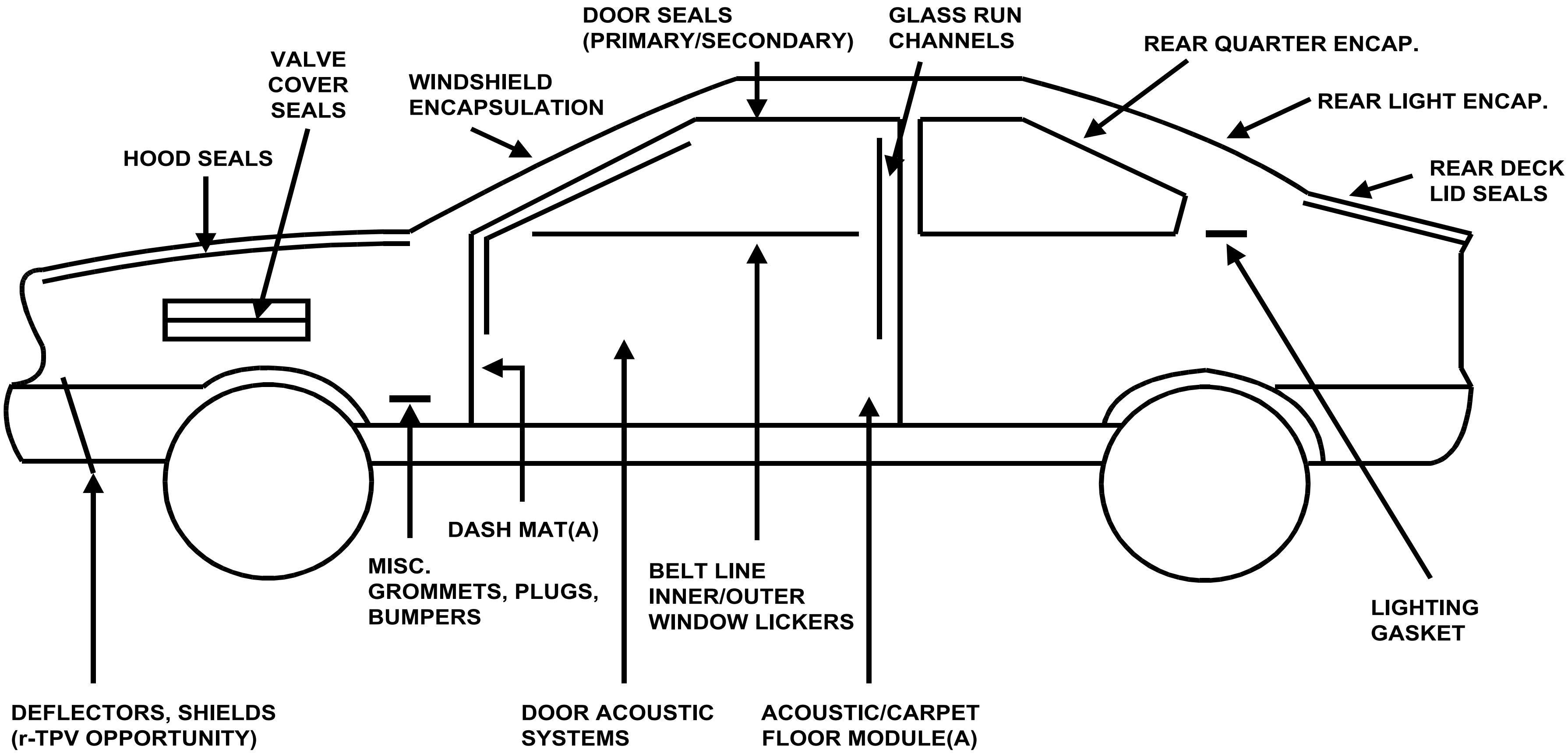
EXHIBIT 4

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 -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 (REF. 1)

EXHIBIT 5
TPE/RUBBER COMPETITIVE INTERFACE IN AUTO APPLICATIONS



NOTE: (A) ACOUSTIC/FOAM OPPORTUNITY

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003

PO04-tperintface 03.vsd

EXHIBIT 6

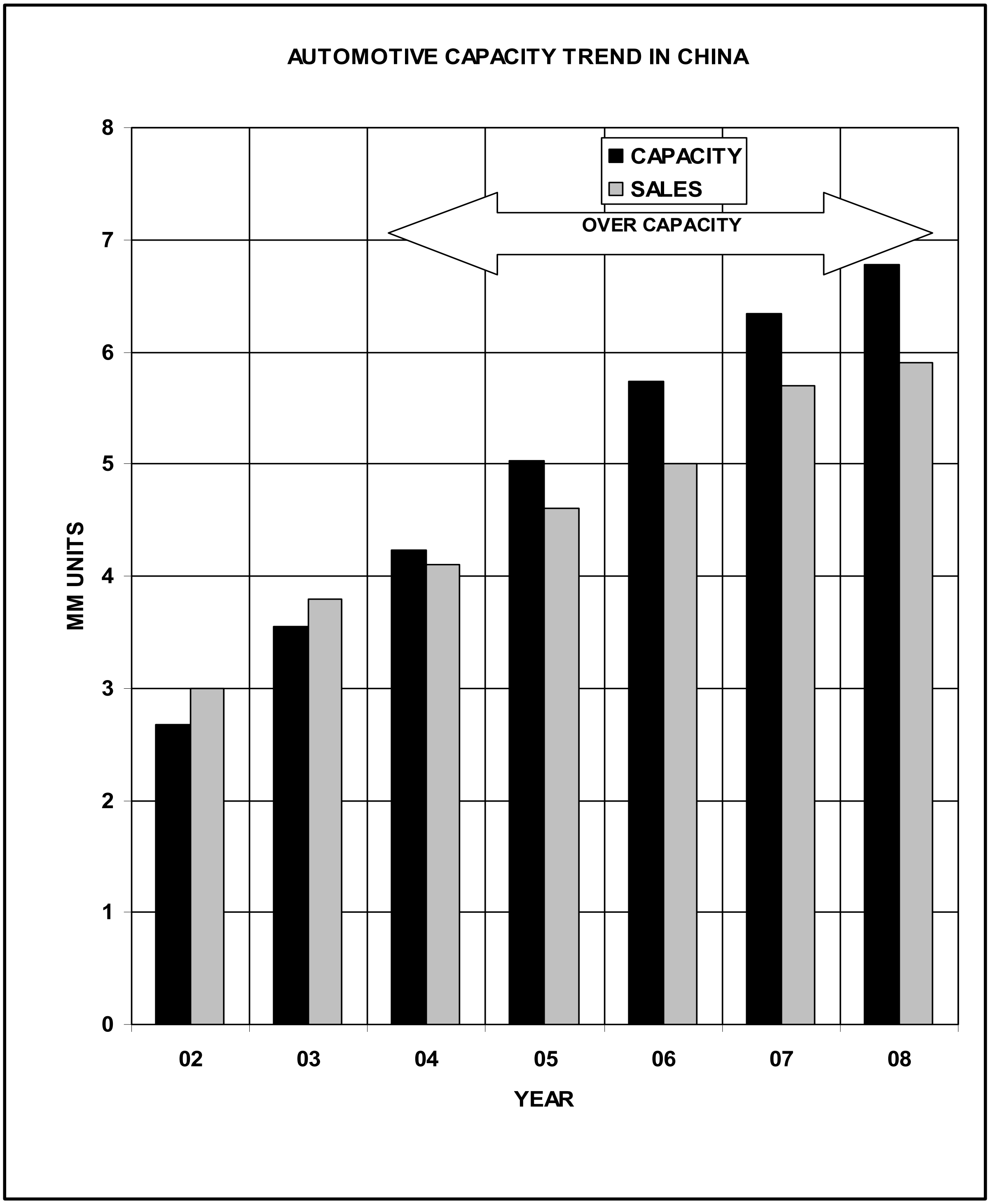
TPE CHALLENGERS TO MAJOR AUTOMOTIVE RUBBER AND PVC INCUMBENTS

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 SEALS		X	X					
BOOTS/BELLOWS		X				X		
COATED FABRIC	X			X	?			
DAMPER MOUNTS		X	X					
ELECTRIC		X	X					
FLOOR MATS				X				
FUEL SYSTEMS								X
GLAZING SEALS	X	X	X					
HIGH PERFORMANCE GASKETS								X
INTERIOR SKINS	X	X		X	X			
NON-CARPET FLOOR	X	X		X				
UNDERHOOD DEFLECTORS							X	X
IN-MOLD DECORATION		X						X

SOURCE: ROBERT ELLER ASSOCIATES TPE AND SOFT TRIM MULTICLIENTS (References 1 and 2)

EXHIBIT 7

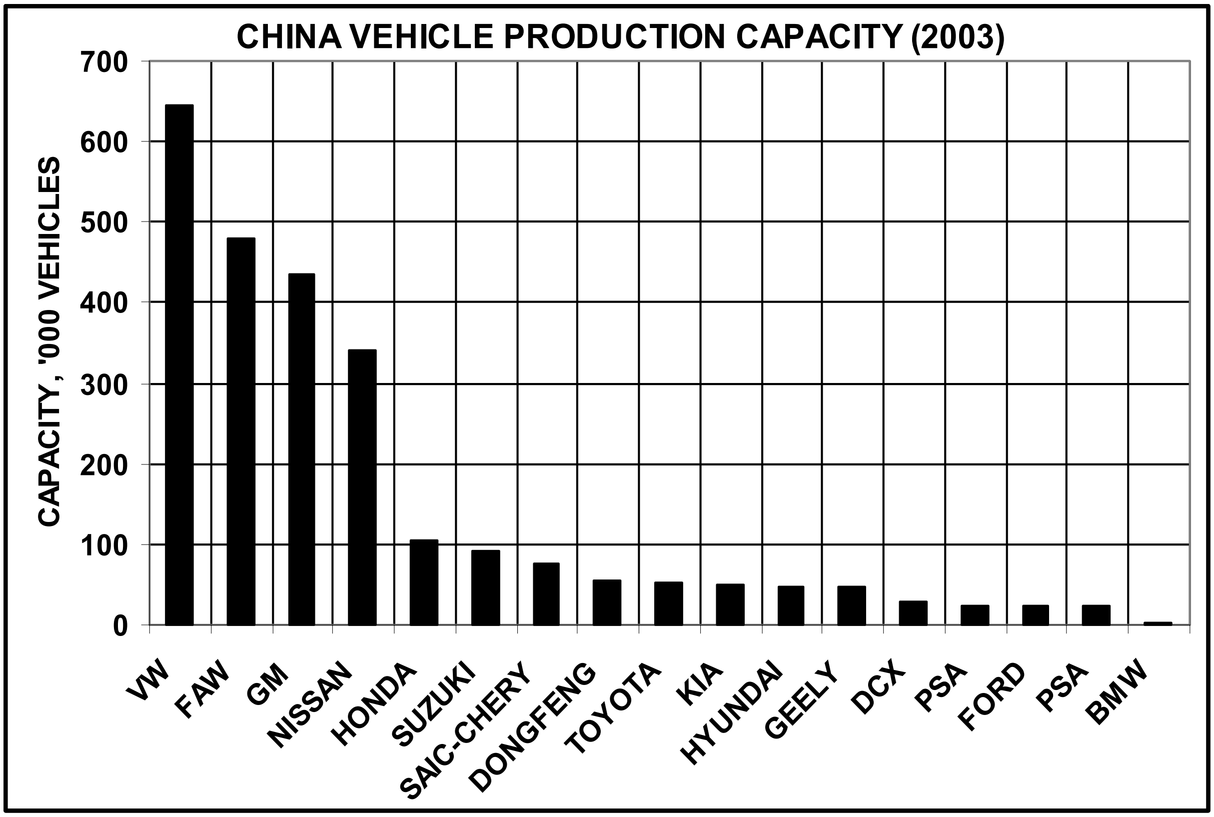
AUTOMOTIVE CAPACITY TREND IN CHINA



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003

EXHIBIT 8

CHINA VEHICLE PRODUCTION CAPACITY (2003)



SOURCE: ROBERT ELLER ASSOCIATES, INC., 2003