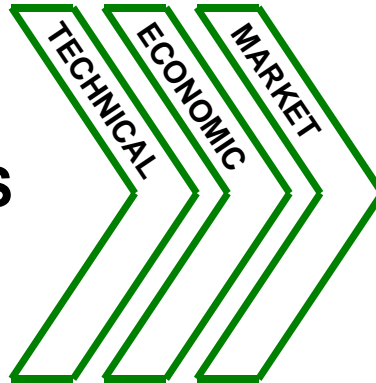

ANALYSIS



**Management
DECISIONS**

Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

TPE APPLICATIONS AND TECHNOLOGIES RESPOND TO RECESSION AND GLOBALIZATION

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PREPARED FOR:

TPE 2009

Frankfurt, Germany

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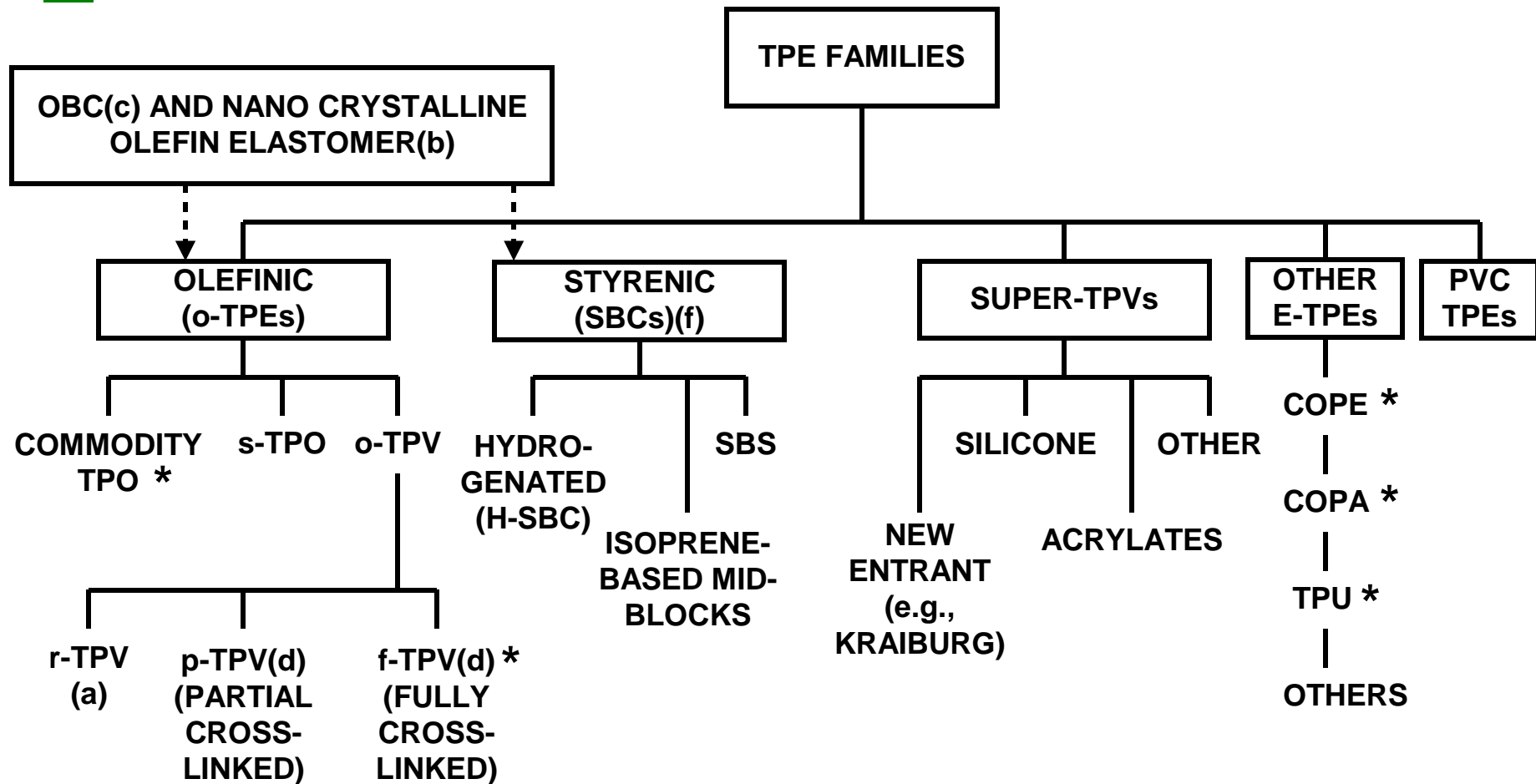
OUTLINE



- **Macroeconomics/Globalization: Effects on TPE Markets and Technologies**
- **Western/Asian Differences**
- **China TPE Market**
- **Global Automotive Market**
- **TPE Growth Applications: Evolving Market Dynamics**
- **Summary**

TPE(d) FAMILIES . . .

CHANGING STRUCTURE, INCREASED INTRA-TPE COMPETITION



Notes: * = Production dominated by resin suppliers
 (a) Recyclate-based TPV
 (b) e.g., Notio™ from Mitsui Chemicals
 (c) e.g., Dow's Infuse™

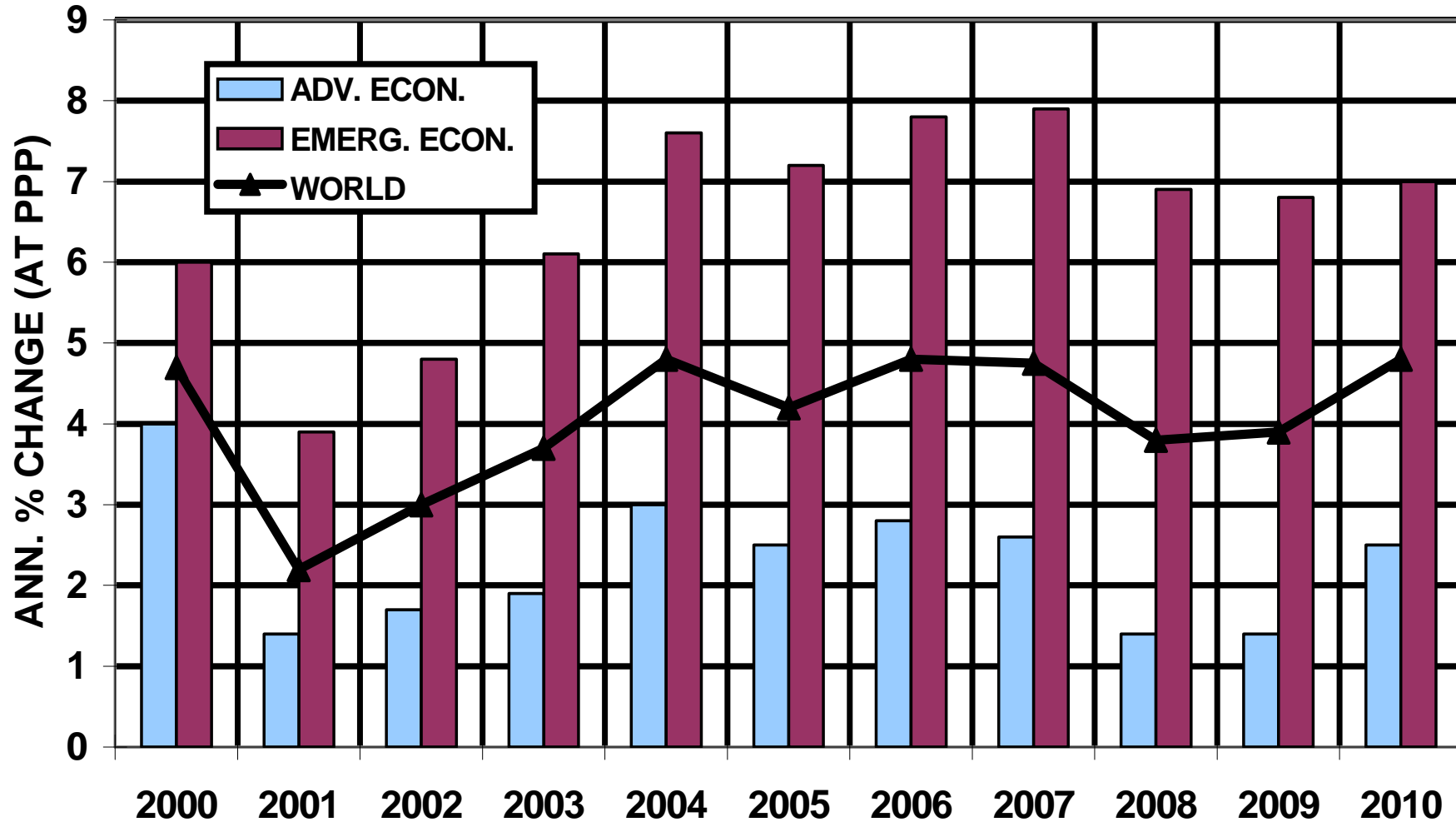
(d) In Asia, the term "TPE" is often used to describe styrenic TPEs
 (e) Sometimes referred to as TPE-V
 (f) Sometimes referred to as TPE-S

MACROECONOMIC CONDITIONS/GLOBALIZATION



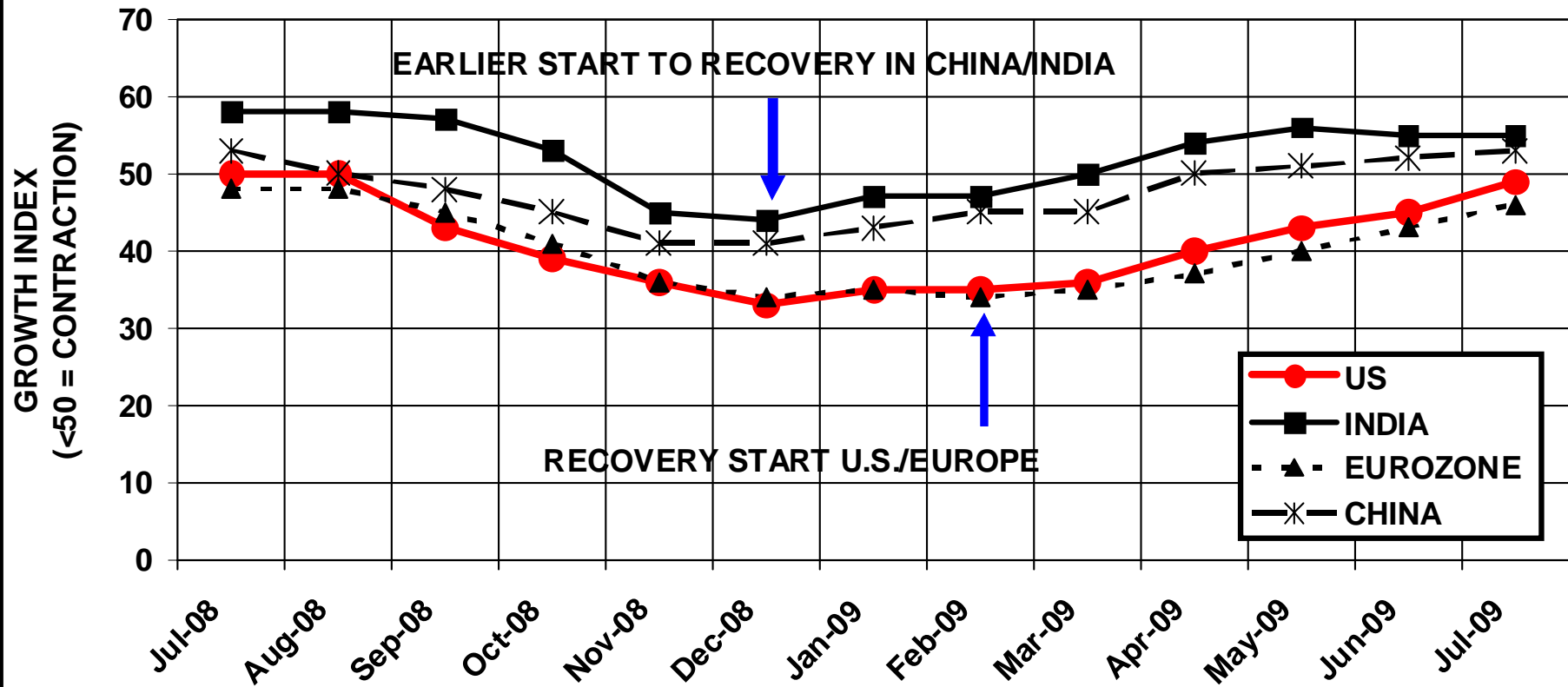
- **At Least 2-year Trough**
- **Global Mfg. Rebound Since April '09:**
 - **Government subsidies**
 - **Auto scrappage programs**
 - **Slowed unemployment claims**
 - **Slowed GDP declines**
- **Manufacturing Shift: West → Asia**

GLOBAL ECONOMIC GROWTH: 2 YEAR TROUGH



SOURCE: IMF

MFG. PURCHASING MANAGERS' INDICES (PMIs)



SOURCES: FINANCIAL TIMES; ROBERT ELLER ASSOCIATES LLC, 2009

b/mydox/papers/TPE sectors 09.xls

WESTERN/ASIAN DIFFERENCES

- **Asia (Esp. China) Rebound:**
 - Faster recovery than Western regions
 - Large, government stimulus programs
 - Western downturn hurting exports
 - Deep interest rate cuts

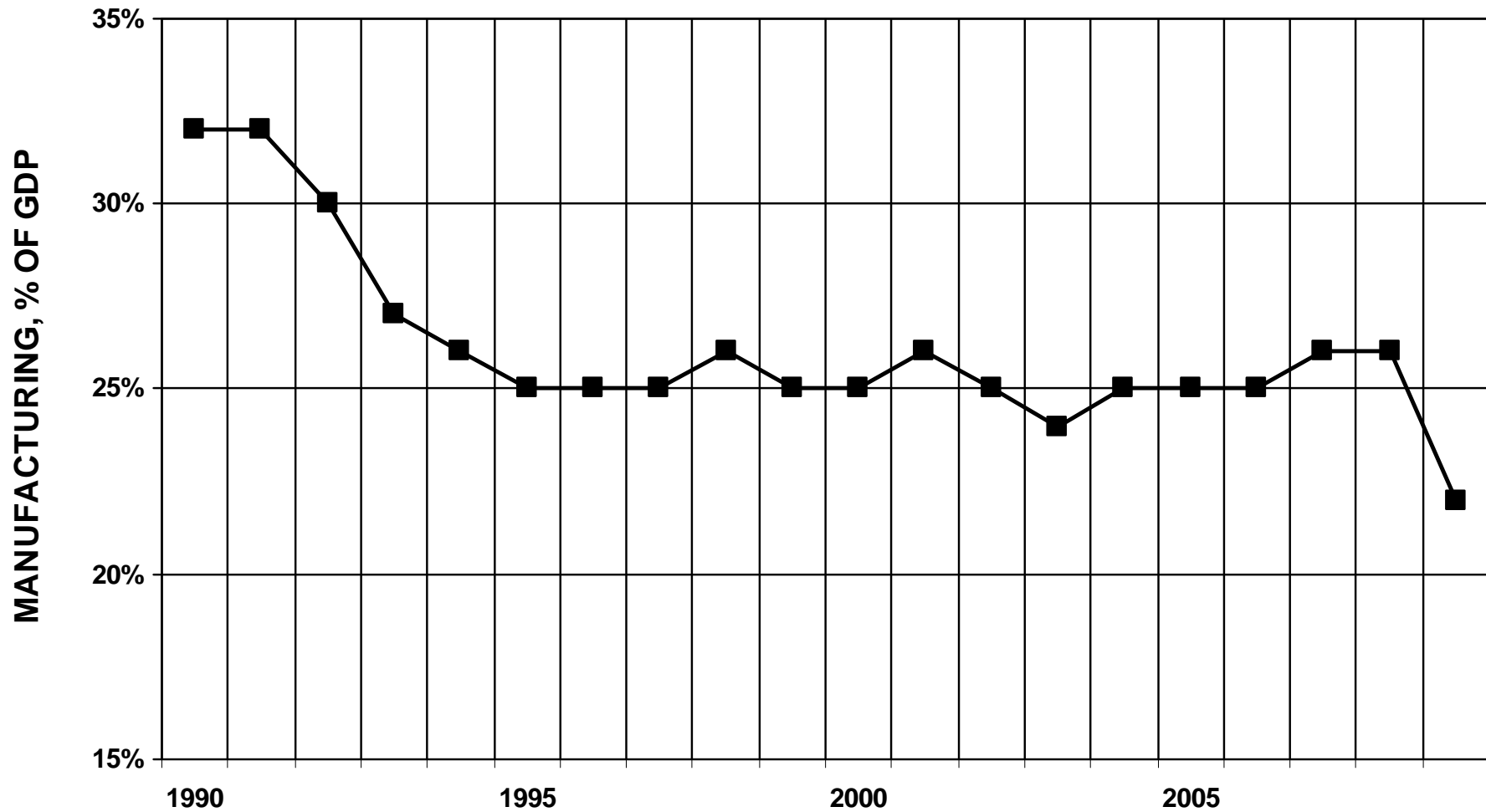
CHINA GROWTH

Year	GDP Growth, %	Note
2007	11.9	
2008	10.0	
2009	7.8	Growth due to gov't. programs and some gain in the domestic economy
2010	9.0	

WESTERN/ASIAN DIFFERENCES (Cont'd.)

- **TPE Market Sectors:**
 - Europe and U.S. similar demand distribution
 - Auto applications dominate (~40% of demand)
 - Broad demand distribution amongst other mkts.
- **TPE Demand in West Impacted By:**
 - Recession conditions
 - Severe auto production downturn
 - Consumer end market production shift to Asia

GERMAN MANUFACTURING AS % OF GDP



SOURCES: UNICREDIT RESEARCH; ROBERT ELLER ASSOCIATES LLC, 2009

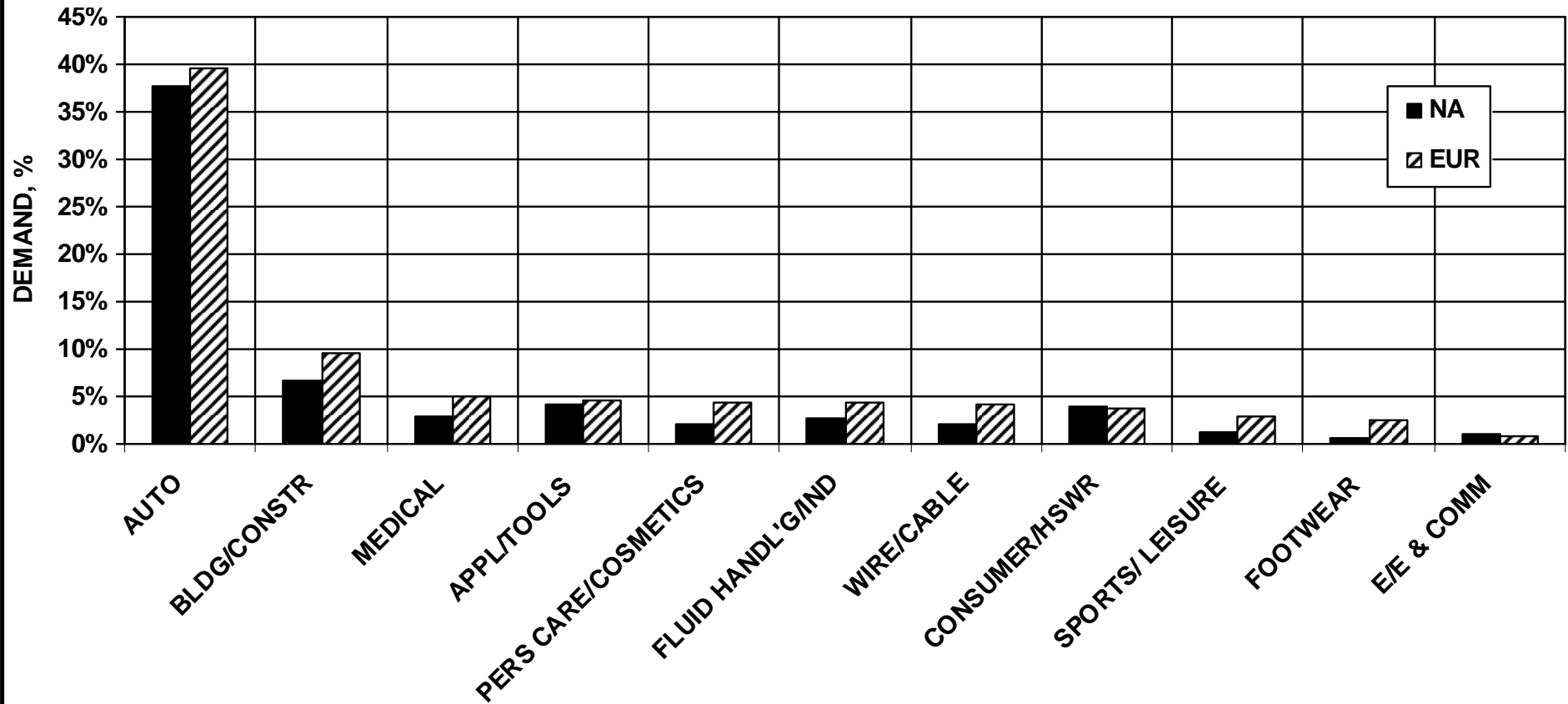
b/mydox/TPE Frankfurt 2009/TPE sectors.xls

GLOBAL AUTOMOTIVE MARKET



- Largest single market for olefinic and styrenic TPEs, even in China
- Global automotive vehicle production fell sharply in 2008/2009
- Global recession/high fuel prices/carbon footprint awareness create new auto TPE paradigm:
 - Fleet composition shift to smaller vehicles
 - Extensive use of government incentives (scrappage/CO₂) → short-term sales stimulus
 - Strong support for electric drive/battery vehicles
 - Moderate fuel economy (CAFE) shift in U.S.

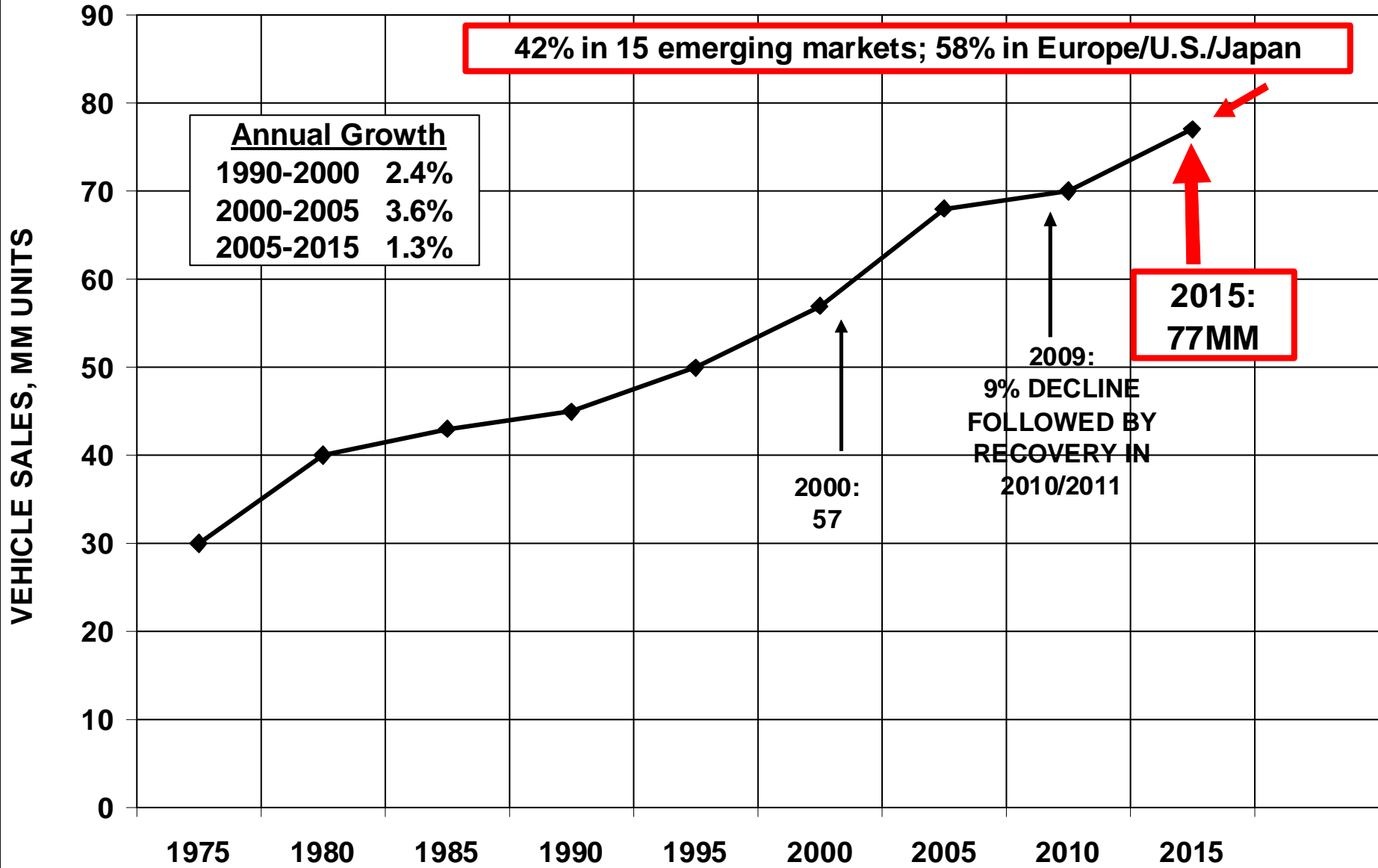
DEMAND SHARES FOR TPE COMPOUNDS BY SECTOR FOR SPECIALTY TPEs



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2009

b/mydox/TPE Frankfurt 2009/TPE sectors/xls

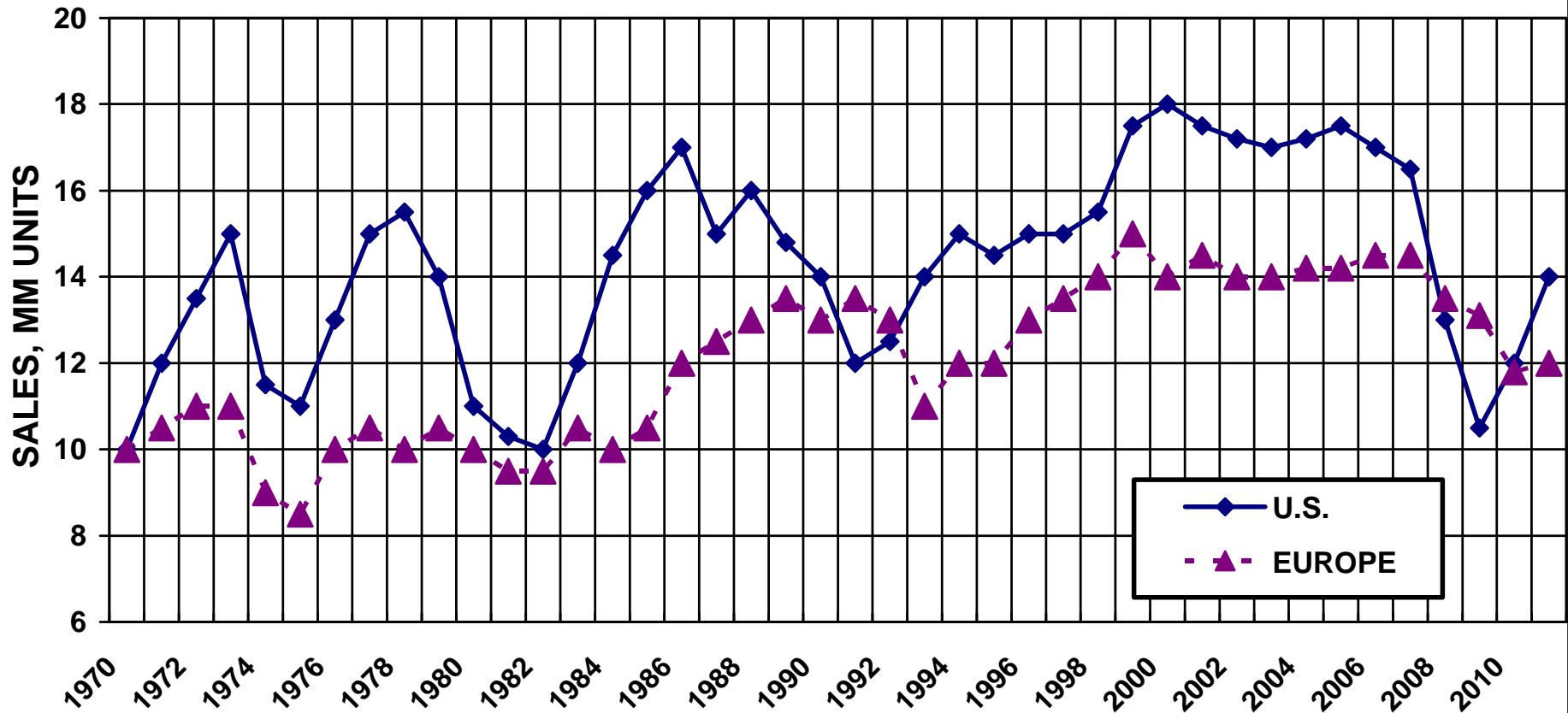
GLOBAL VEHICLE SALES OUTLOOK



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2009

r/mydox/Auto Industry/Global Ind Volume TW 081209.xls

U.S. AND EUROPE LIGHT VEHICLE SALES



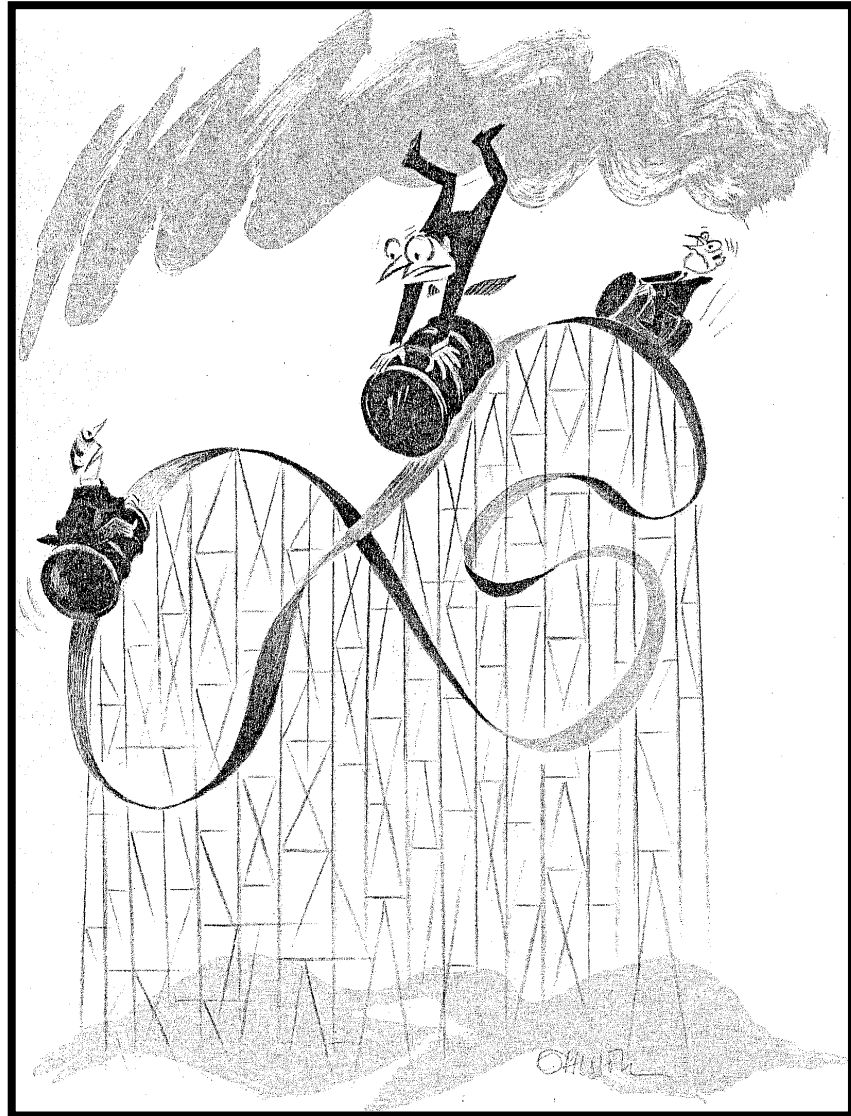
SOURCE: DEUTSCHE BANK, 2009

B/mydox/auto industry/NA and EUR sales.xls

THE OIL PRICE ROLLER COASTER: AUTOMOTIVE TPE DEMAND

Have the 2008 fuel price spike and tipping point permanently shifted:

- fleet composition?
- lightweighting incentives?
- break-even volumes?



REGIONAL DIFFERENCES IN o-TPV USAGE IN AUTOMOTIVE



o-TPV Penetration in Auto Still Low in China/India

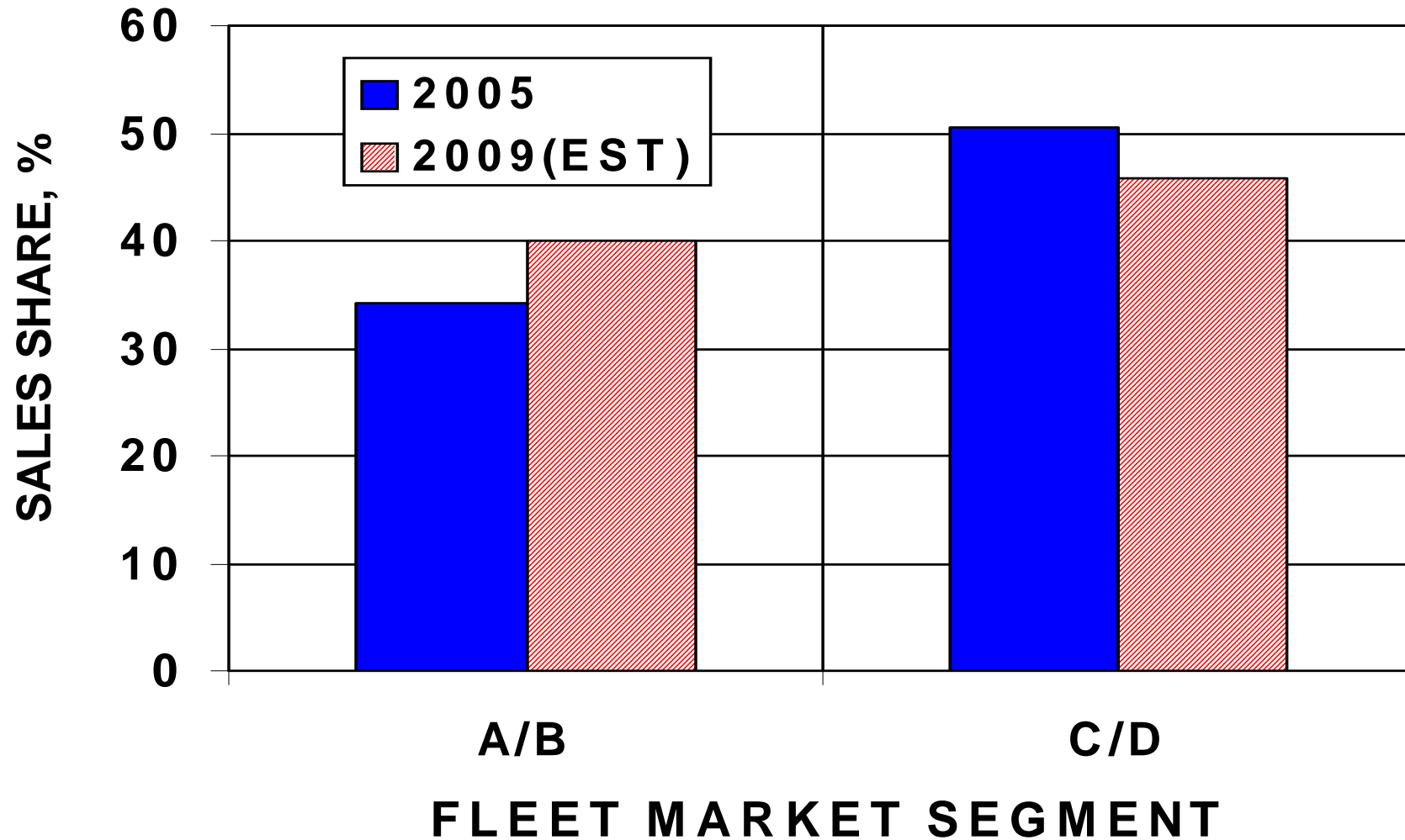
	kg/Vehicle		
	Global	China	India
2005:	2.1	1.4	0.9
2010:	2.6	2.0	1.5

AUTO TPE GROWTH APPLICATIONS



- China/India auto o-TPV growth opportunity
- Auto lightweighting:
 - Driven by fuel price increases
 - TPO growth in exterior panels (e.g., Ford Kuga)
- Rubber challenge continues
 - High heat and oil resistance
 - Body/glazing seal substitution continues
- Reduced cost luxury auto interiors (small car effects)
- TPO solar opportunities (PV roof/wall shingles)
- Halogen-free, flame retardant (mobile electronics)

W. EUROPEAN VEHICLE MARKET SHARE SHIFT



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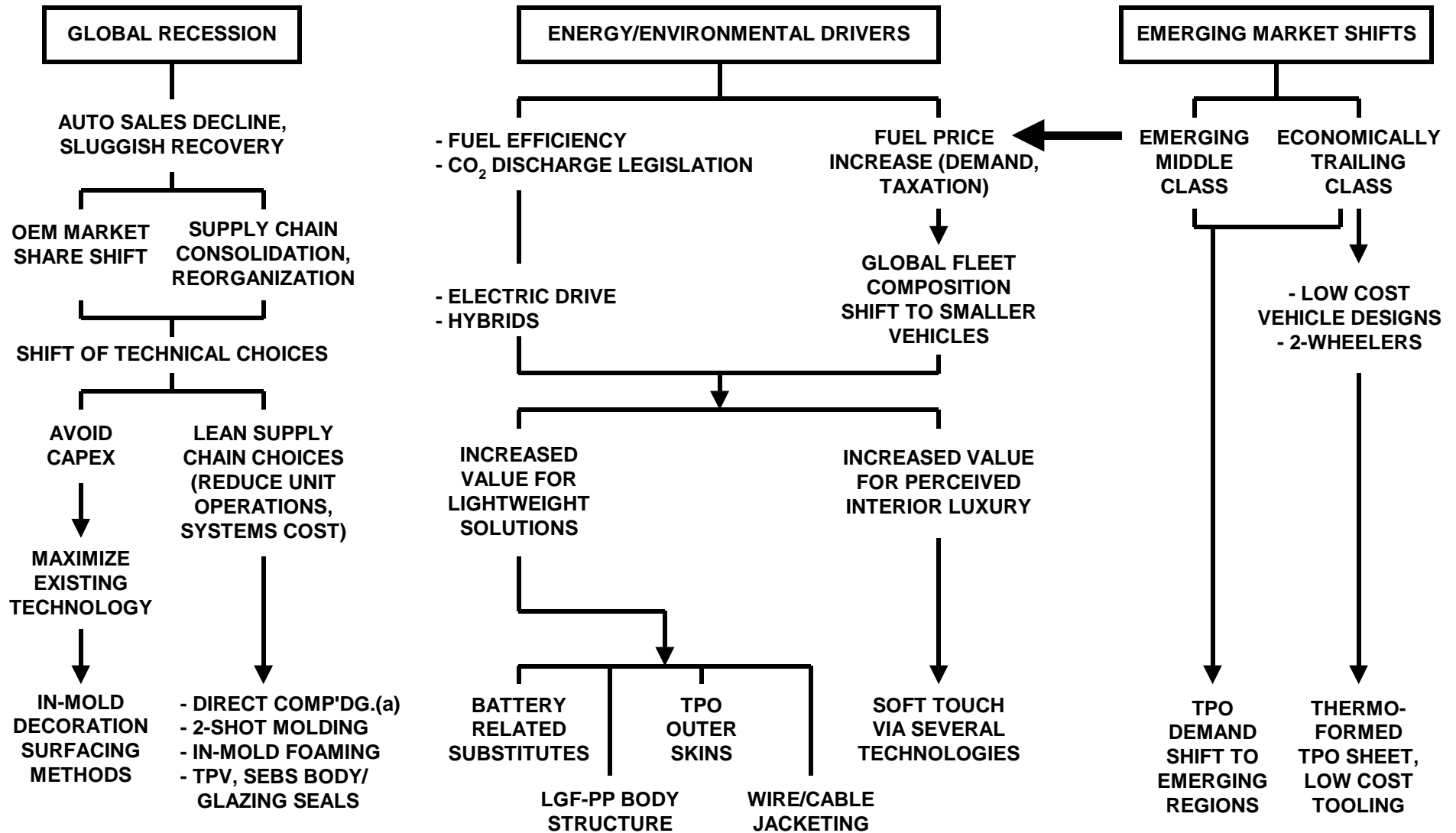
Sources: JD Power; Deutsche Bank; Robert Eller Assoc. LLC, 2009

NEW AUTO PARADIGM: TPE EFFECTS



- Drives up the value of weight savings: 10% wt. reduction → 7% fuel economy improvement
- Further restructuring of auto supply chain
- Encourage parts consolidation
- Encourage PP compound demand (esp. glass fiber/PP) → stimulates use of olefinic TPEs
- Favors TPE systems applications

MACROECONOMIC DRIVERS, NEW PARADIGMS, & AUTO TPE OPPORTUNITIES



Note: (a) DIRECT COMPOUNDING = D-LFT, AT-PRESS FILLER ADDITION, ETC.

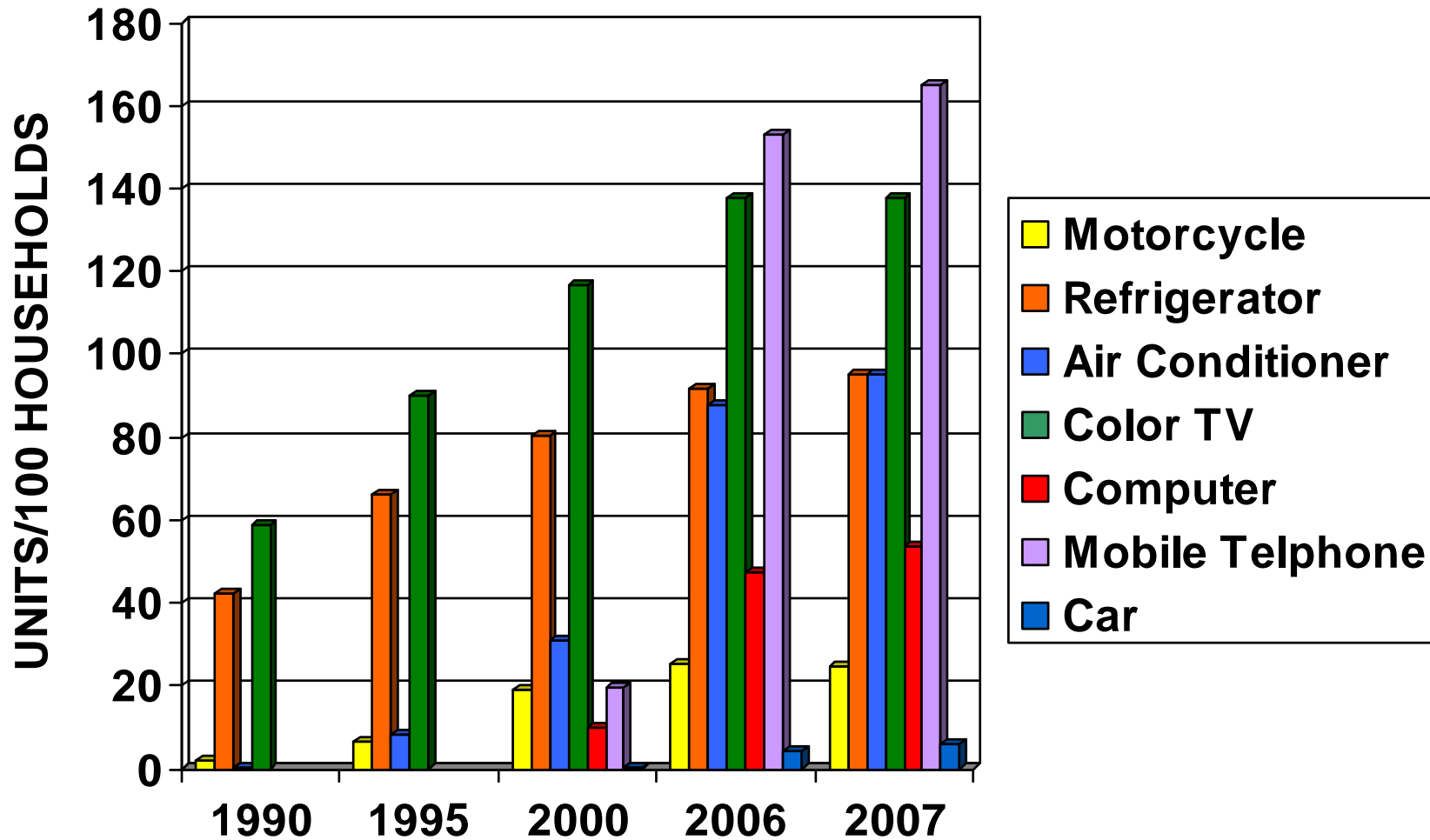
SOURCE: ROBERT ELLER ASSOCIATES LLC, 2009

CHINA TPE MARKETS



- China: Key role in global TPE demand/demand growth
- Unique Characteristics:
 - Largest regional TPE market
 - Highest regional growth rate ('09 – '14)
 - Western transplant compounders/resin suppliers must compete with domestic suppliers
 - Significant domestic cost/market access advantage
 - Highly export oriented
 - Rapid domestic market growth (limited focus to date by Western transplant compounders)

DURABLE GOODS OWNED PER 100 URBAN HOUSEHOLDS IN CHINA



SOURCES: CHINA NATIONAL BUREAU OF STATISTICS
ROBERT ELLER ASSOCIATES LLC 2009

r/mydox/China/China Durable Goods 09.ppt

CHINA TPE MARKETS: QUALITY TIERING



- Accommodates Different Target Market Segments
- Domestic Quality Tiers (Global/Local):
Substantially under-served by Western TPE compounders

CHINA TPE MARKETS: GLOBALIZATION AND LOCALIZATION COMPETITION



- Globalization:
 - Meet global specifications and quality standards
 - Serve global OEMs from China
 - Mfg. base starting to shift to other regions
- Localization:
 - Global compounders in China localize raw materials supply chain
 - Target domestic Chinese OEMs and transplant OEMs
 - (Often) using different TPE compounds for domestic customers

CHINA DOMESTIC TPE COMPOUNDER ADVANTAGES vs. TRANSPLANTS

- Utilize local raw materials; broader range of raw material types and sources
- Lower labor costs than Western transplant compounders
- Lower capital depreciation costs (by factor of 4-10X)
- Lower packaging costs
- Lower shipping costs
- Government subsidies
- Government funded R&D institutes

QUALITY/PERFORMANCE TIERING IN THE CHINA TPE MARKET



	QUALITY	PERFORMANCE	SERVICE	PRICE
Global	High	High	High	High
Glocal	Near Global	Near Global	Moderate	Near Global
Local	Local standards	Local requirements	Low	Local
Low End	Low	Low	None	Low

Source: Robert Eller Associates LLC, 2009

QUALITY TIERING OF CHINA MARKETS



MARKET SEGMENT	PRODUCT/QUALITY DEFINITION
Global	Products produced for global market, meeting global quality and performance standards at global pricing
Glocal*	Products produced for domestic and export markets with near global quality and performance standards, with near global pricing
Local*	Products produced for the local market, meeting local performance, quality, and price requirements
Low End*	Products marketed based solely on price, with low concern for quality and performance

Note: * = Will gain share in global recession

EXAMPLES OF TPE QUALITY TIERING



	GLOBAL	GLOCAL	LOCAL	LOW END
Toothbrush Supplier	Colgate Palmolive	San Xiao	San Xiao	1-time use (e.g., hotel amenities)
SEBS Compound Supplier	GLS Thermoplastic Elastomers/ PolyOne	Hotai	TSRC	Not used
Typical Compounding Extruder Supplier/Type	Coperion ZSK: designed & mfd. In Germany	Coperion STS: designed & partially made in Germany, remainder made in China; Cost ~40% of ZSK	Coperion CTE: designed & mfd. In China; Cost ~15% of ZSK	
SEBS Resin Supplier	Kraton	TSRC	Baling	Wide spec
o-TPV Supplier	-ExxonMobil (Santoprene) -DSM (Sarlink)		Shandong Dawn- BH Elastomer Co. (Dawnprene)	

CHINA INVESTMENT BY WESTERN COMPOUNDERS



- Accelerated prior to recent downturn
- Some majors elected not to invest in local manufacturing facilities:
 - Kraton
 - Dynasol
 - ExxonMobil
 - DSM
- Recent lifting of import duties from Singapore into China suggests Singapore will continue to see investment by Western (and Japanese) TPE suppliers

TPE GROWTH APPLICATIONS RESULTING FROM EVOLVING MARKET DYNAMICS



- Automotive Lightweighting
- The Rubber Challenge Continues
- Solar Opportunities
- Halogen-free, Flame Retardant (HFFR)
- Bio-based TPEs
- Breathability

EXAMPLES OF RECENT NEW TPE APPLICATIONS



SECTOR	APPLICATION	TPE TYPE	KEY TPE PROPERTIES	SOURCE/NOTE
Auto	Tailgate spoiler	SEBS	-Injected adhesive to bond engineering plastic layers	- Kraiburg for BMW
	Windshield seal	SEBS	-Glass bonding with single component overmolding -High flow properties	- SEBS TPEs challenging EPDM in this high performance application - o-TPVs also challenging EPDM
	-Triple co-extruded glazing profiles ->3 coextrusions possible	o-TPV	-Compression set -Dimensional stability -Foamability? -Surface quality	-Uses 2-3 co-extruders to produce o-TPV/PP compound, rigid/flexible profiles - Krauss Maffei is equipment supplier - Used on VW Golf VI - DSM TPE is o-TPV supplier
	Fiber reinforced soft touch	TPO	-Soft touch with sufficient stiffness/impact	- From LyondellBasell, Dow, ExxonMobil
	Heat/Oil resistant applications, gaskets, etc.	super TPVs	-Heat and oil resistance	- DuPont, Multibase, Nippon Zeon, - Kraiburg (recently) - COPE challenge?
	Wire/Cable	SEBS, TPO/TPV, TPU	-High temperature, flame retardant requirements	- XLPE, PVC are key incumbents
Mobile Electronics	Wire/Cable	SEBS	-Meet HFFR regulations -Low smoke -Low oxygen index	- f-PPE is key HFFR incumbent - Meet RoHS/WEEE requirements - See REA database
	Earplugs, cell phones	super TPV	-Silky touch	- e.g., TPSiV (Dow Corning)
Solar Modules	Wire/Cable	SEBS, o-TPV	-Meet HFFR regulations	- Solar is growth sector
	Gaskets	o-TPV	-Meet HFFR regulations -Heat resistance	- Solar is growth sector

(Cont'd.)

EXAMPLES OF RECENT NEW TPE APPLIC. (Cont'd.)



SECTOR	APPLICATION	TPE TYPE	KEY TPE PROPERTIES	SOURCE/NOTE
Solar Modules	Shingles	TPO	-PV on TPO substrate	- Example of TPO expanding from auto
Medical	-IV sets -other applic.	SEBS, TPO	-PVC substitution -Kink resistance -Low modulus -Processability -Heat sterilization	- Highly dependent on government regulations
Building/ Construction	Gaskets	SEBS, o-TPV	-Compression set -UV resistance -Processability	- More advanced in Europe than U.S.
Multiple sectors	Bio-based TPEs	TPU, SEBS	-Food contact	- Merquinsa - Kraiburg - GLS/PolyOne
	Improved grades for PP modification	SEBS	-Fine dispersion/ transparency -Impact modification -Avoid oil -Scratch resistance	- Kraton - Film/sheet applications - Notio™ (Mitsui Chemicals) competes
Consumer Disposables	Biodegradable TPEs	SEBS? TPU?	-Biodegradability	
Membrane, Breathable	-Desalination -Breathable fabrics	modified (sulfonated) SBC	-Breathable/impermeable	- Kraton - TPU is major incumbent

Source: Robert Eller Associates LLC, 2009

TPO/o-TPV: MAJOR AUTO GROWTH SECTOR



- New soft touch candidates/fabrication technology
- TPO demand stimulation from reinforced PP compound growth

HATCHBACK DOOR: GROWTH APPLICATION FOR TPOs



Vehicle: Ford Kuga (2010)
Application: Roof spoiler, tailgate outer panel
Grade: LyondellBasell Hifax TRC 280X
Molder: Plastal

REA Notes:

- Inner panel is LGF-PP compound
(Stamax from SABIC)
- Design transfer to U.S. (2010)

Photo: Robert Eller Associates LLC

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HATCHBACK DOOR INNER: GROWTH APPLICATION FOR LGF-PP



Part: Hatchback door inner panel
Material: 40% LGF-PP
Status: Prototype
Molder: Plastal
Process: D-LFT (injection)
Equipment: Krauss Maffei
Note: Competes with LGF-PP compound

Photo: Krauss Maffei

r/mydox/papers/spetpo 2009pix.ppt

AUTO SOFT TOUCH REINFORCED TPO/o-TPV



- Small vehicle share increase:
 - drives towards higher quality interiors without high cost of multi-step processes
 - new generation of glass fiber reinforced, molded-in color TPOs with soft touch surface for interiors:
 - improved scratch and mar
 - low knit line visibility
 - low gloss
 - compete with soft touch paints/thermoformed or slush molded skins

MERCEDES SMART FORTWO TAILGATE: PRECURSOR FOR LGF-PP AND TPO IN BODY STRUCTURES?

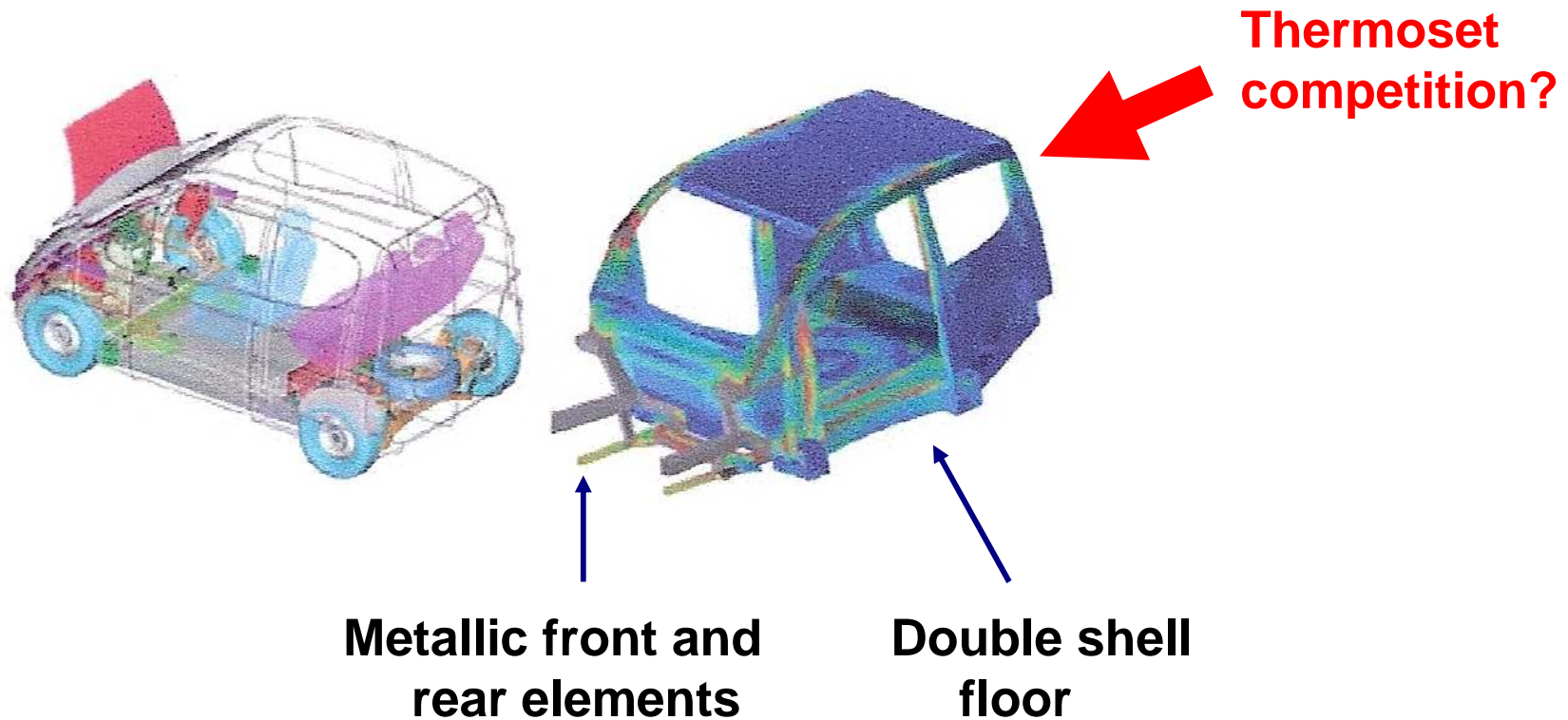


- 20% stiffness increase vs. earlier version
- LGF-PP move into body structures
- Early use of E-LF-PP (endless long fiber polypropylene)
- Mineral-filled TPO exterior skin

- E-LF-PP gives high load bearing and impact absorbency
- Translation potential for rear seat backrest

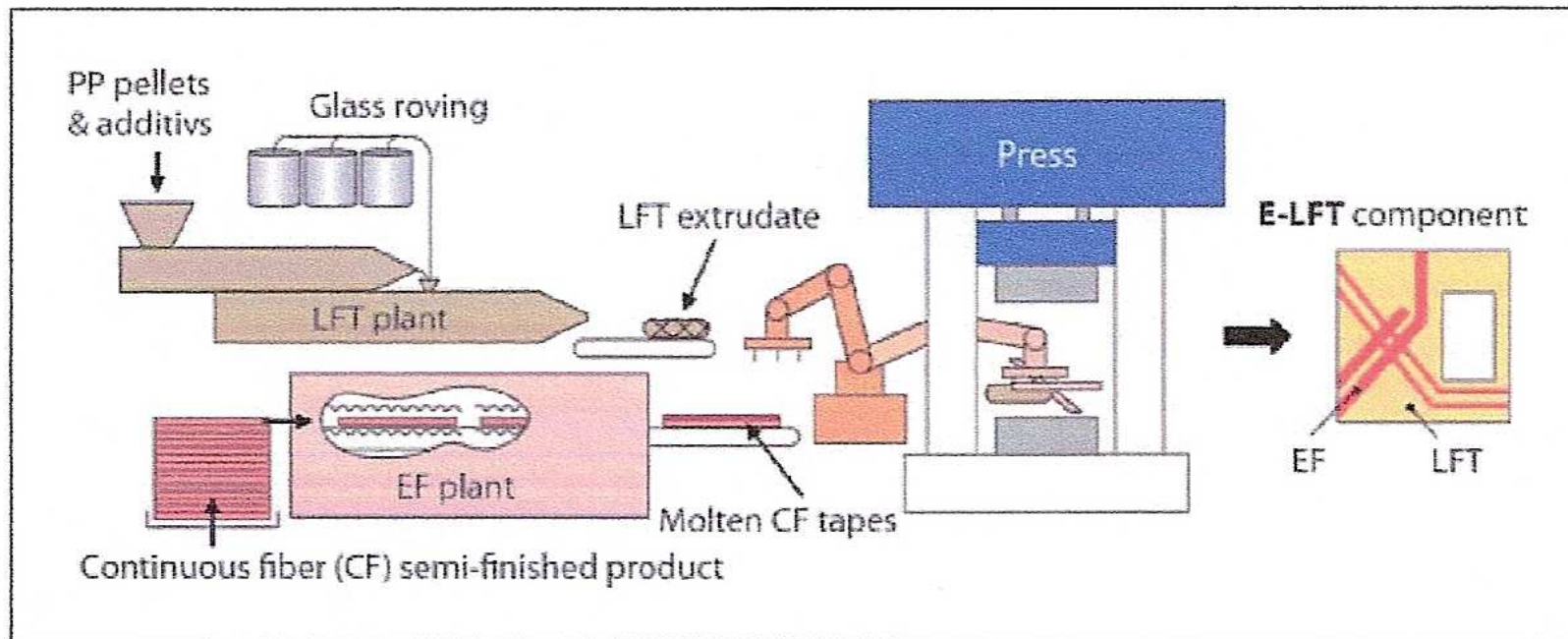
Source: Weber Automotive; ESORO AG

DESIGN CONCEPT FOR E-LGF-PP BASED COMPACT CAR BODY STRUCTURE



Source: Weber Automotive; ESORO AG

EXAMPLE OF LGF-PP & E-LF-PP DIRECT PROCESS



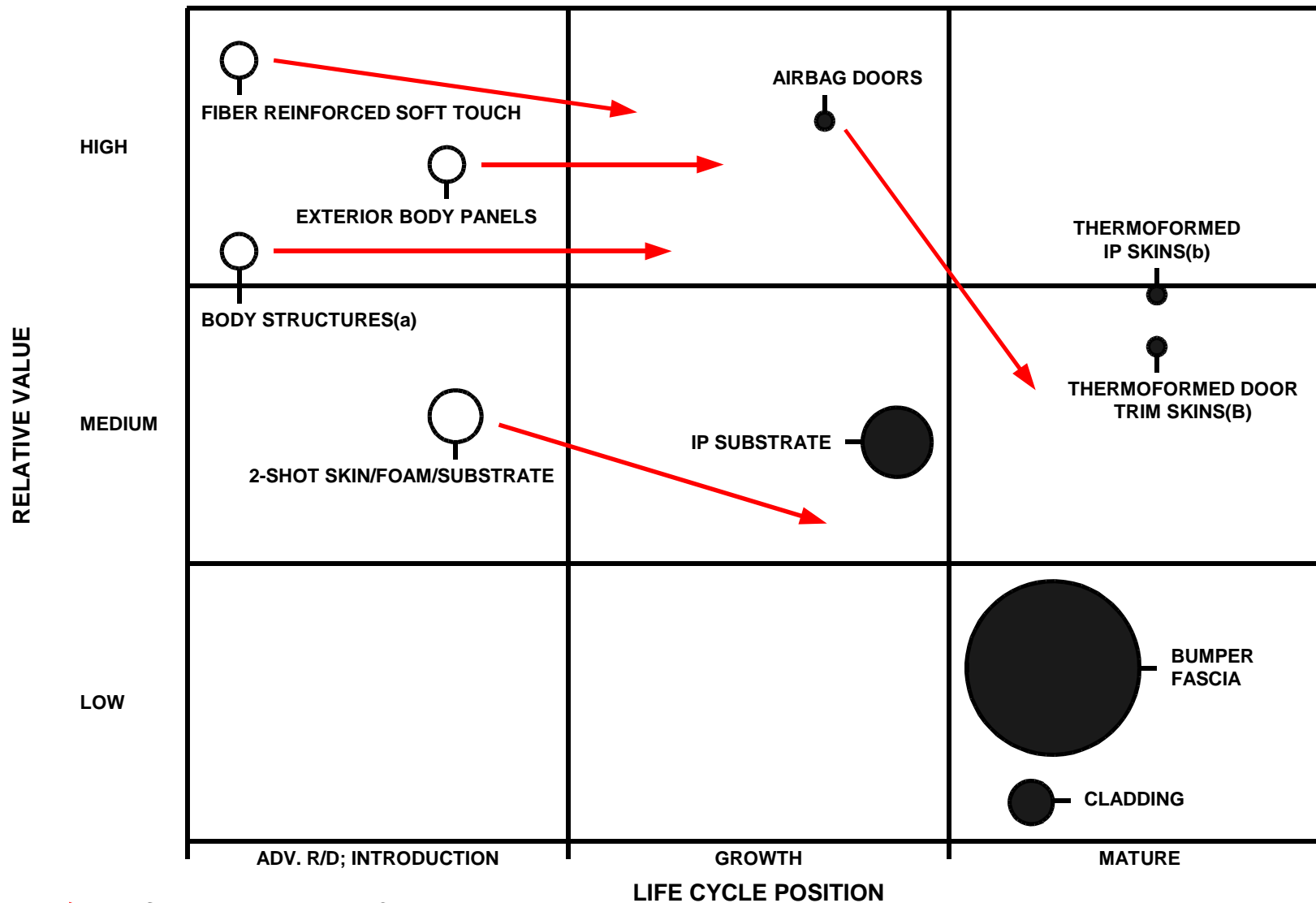
Source: Robert Eller Associates LLC, 2009

SOME TPE LIFE CYCLE POSITIONS



- Early Growth Auto TPOs:
 - Soft touch
 - Exterior body panels
 - Body structures?
- Early Growth SBCs:
 - Bio-based (also TPUs)
 - Body/glazing seals
(competes with EPDM and o-TPV)
 - HFFR/PVC replacement
(mobile electronic wire and cable growth)

AUTO TPO LIFE CYCLE POSITIONS

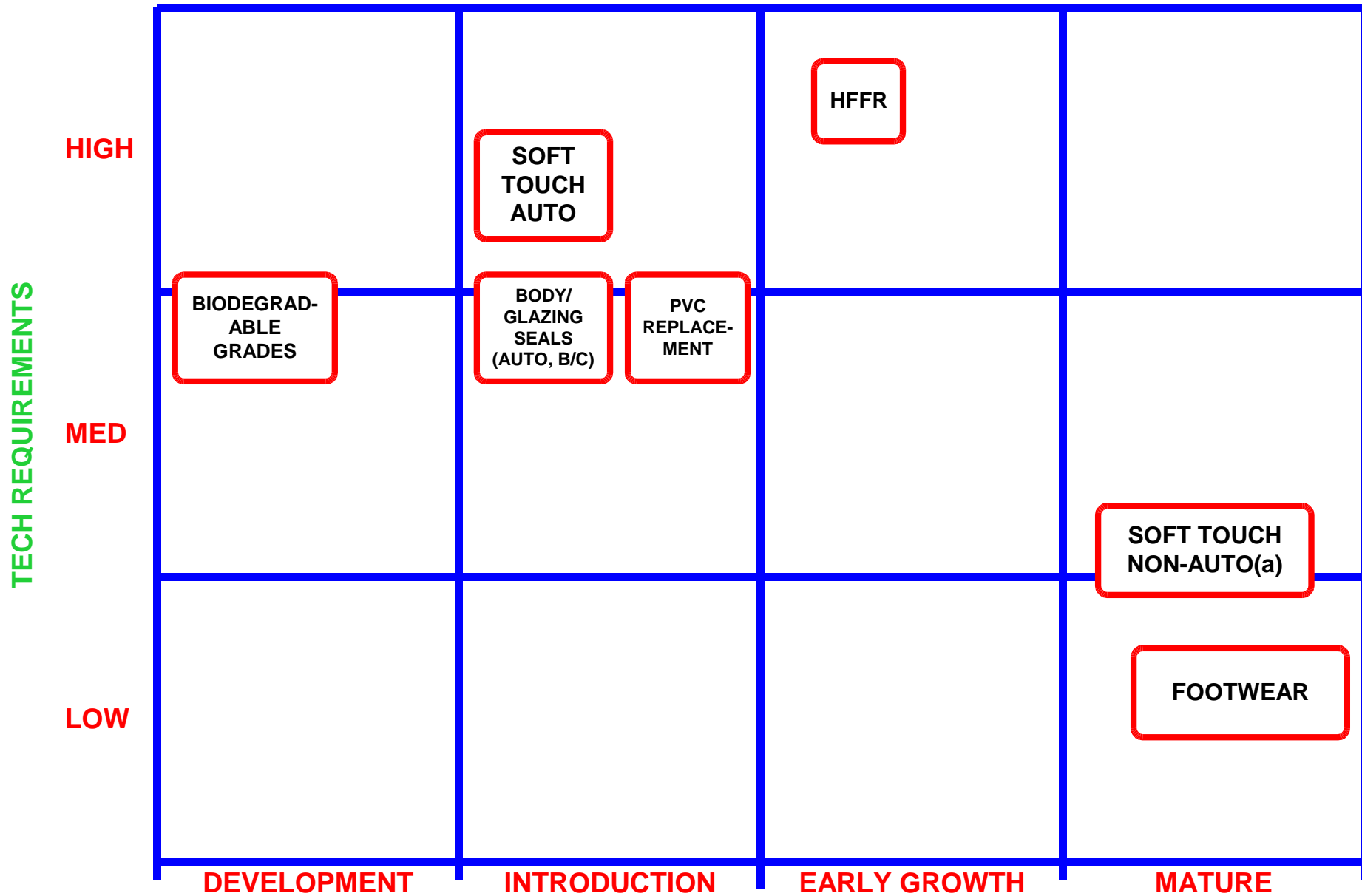


NOTES: (a) LGF-PP = LONG GLASS FIBER PP; E-LF-PP = ENDLESS (E.G., TAPE REINFORCED) LONG FIBER PP

(b) INCLUDES THIN PP (TPO) FILM TECHNOLOGY INTRODUCED IN EUROPE (BY JCI, OTHERS)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2009

SBC TPE LIFE CYCLE EXAMPLES



NOTE: (a) SOFT TOUCH GROWING IN AUTOMOTIVE

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2009

SUMMARY



- Global TPE Demand: affected by end use market shift to Asia
- Auto:
 - High share of demand and growth
 - Severe recession demand effects
 - China auto growth will stimulate demand
 - New auto paradigm
 - New applications will stimulate TPO, o-TPV, SBC

SUMMARY (Cont'd.)



- China TPE Market:
 - Export/slowdown impacts
 - High growth domestic (glocal/local markets)
 - Western vs. domestic compounder competition
- High Heat/Oil Resistance: stimulated by new entrant?
- HFFR/Low Smoke: wire and cable stimulates several TPEs
- TPE Profitability in the New Paradigm – REA's client focus

ABBREVIATIONS



c-TPO	– compounded TPO
CAFE	– Corporate Average Fuel Economy (U.S.)
COPE	– copolyester-type TPE
GDP	– gross domestic product
HFFR	– halogen-free, flame retardant
LGF-PP	– long-glass fiber reinforced polypropylene
LGF-TP	– long-glass fiber reinforced thermoplastic
MNC	– multinational company or compounder
o-TPV	– olefinic TPV
PP	– polypropylene
r-TPO	– reactor TPO
SBC	– styrene block copolymer type TPE (may be SEBS or SBS)
TPE	– thermoplastic elastomer (all classes of thermoplastic elastomer; SBC, TPO, o-TPV, TPU, etc.); note in some regions (e.g., Asia), “TPE” is used to refer to SBC-type TPEs
TPO	– thermoplastic polyolefin
TPU	– thermoplastic polyurethane

CHINA: STRATEGIC RIVAL OF WEST?

- Global Power Position: Emerging power, comparable to U.S. at start of 20th century
- Economic Expansion: Outpaces West
 - 8.9% in 3Q/09 vs. 3.5% in U.S.
 - Provides economic leverage
 - Will soon overtake Japan as global #2 economy
 - Larger than U.S. economy by 2040-2050
- Largest Global Exporter
 - 1 year trade surplus = US\$250BN
 - U.S. largest export target
(trade deficit = US\$575BN [12% Wal-Mart])
 - Flood of cheap, Chinese-manufactured goods swamping global economies (job implications)

CHINA: STRATEGIC RIVAL OF WEST? (Cont'd.)

- Largest Creditor Nation (holding \$2 trillion in USD assets)
 - Provides huge trade leverage over U.S.
 - Could threaten dollar exchange rate
- Voracious Raw Material Demand (political implications)
- Dominant Economic Player in SE and NE Asia
- Key Global Power (influence on global disputes, e.g., N. Korea and Iran)
- Massive Military Modernization Program
- Building Port Facilities in Pakistan, Sri Lanka, Myanmar → ? major global naval power