ANALYSIS

TECHNICAL ECONOMIC MARKET

Management
DECISIONS

Robert Eller Associates LLC

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

Automotive Supply Chain Shifts/TPE Opportunities

Prepared by:
Robert Eller Associates LLC
Phone: ++330-670-9566
E-mail: bobeller@robertellerassoc.com
www.robertellerassoc.com

Prepared for:
Polyolefins 2008
Houston, TX
February 25, 2008
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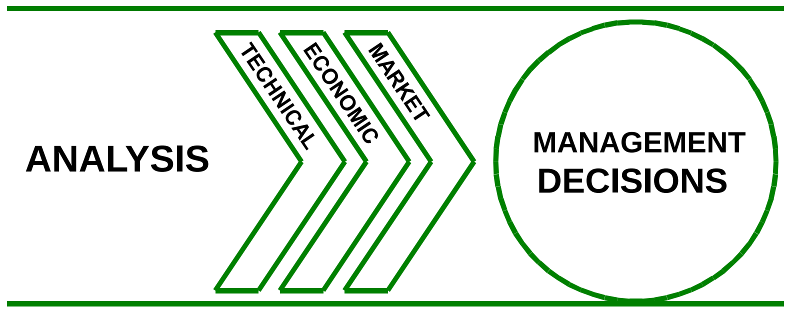
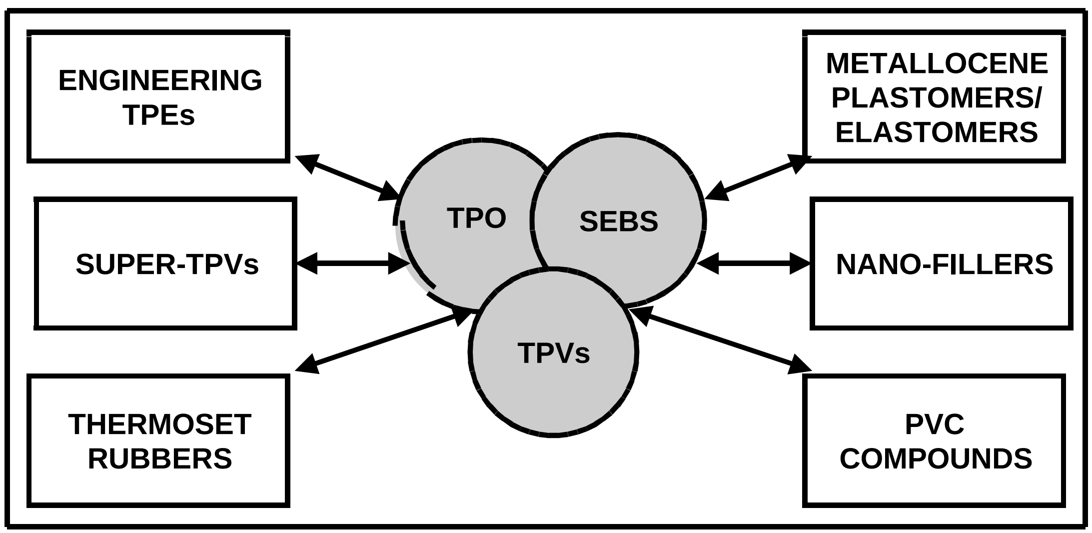
PRESENTATION OUTLINE

- **TPE global automotive industry and auto TPEs**
- **Automotive supply chain shifts and TPE effects**
- **TPE material/process technology couple**
- **Automotive TPE growth targets:**
  - **- Body/glazing seals**
  - **- Role for 2-shot molding**
  - **- The rubber attack**
  - **- Talc effects**



Specialty Thermoplastic Elastomers . . . Markets, Economics, Technology, Intermaterials Competition



A Europe/U.S./Japan Multiclient Industry Analysis

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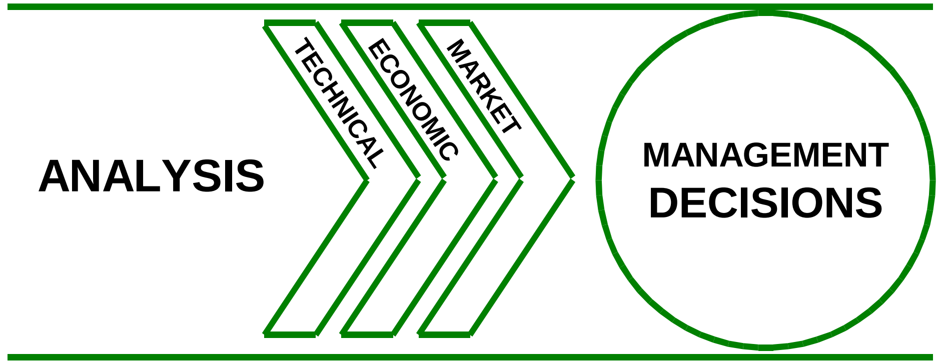
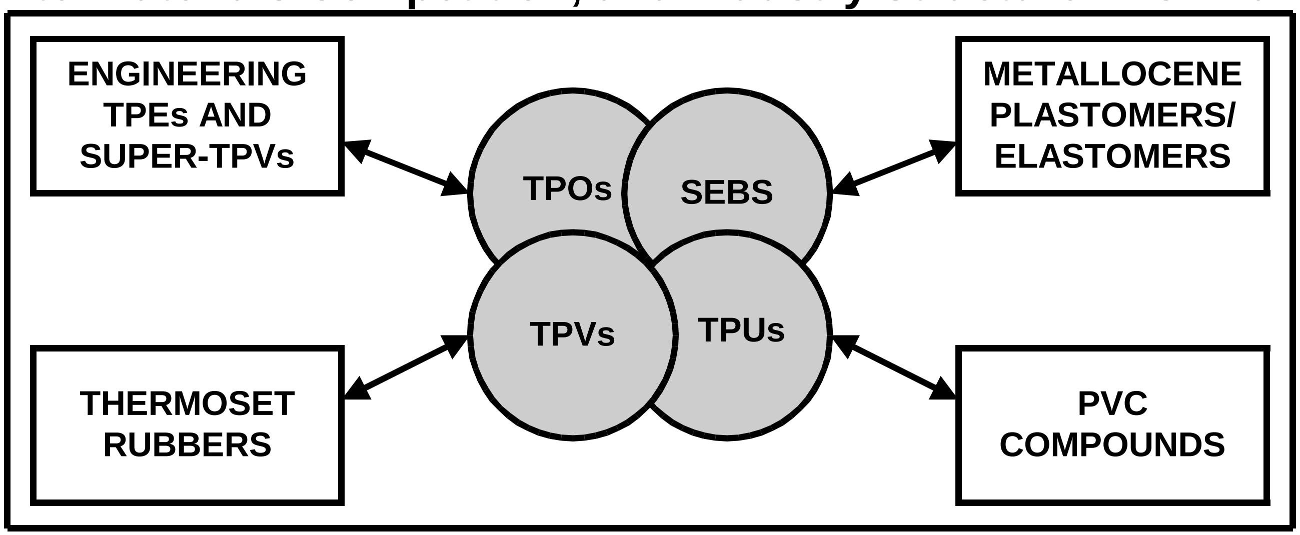


Specialty Thermoplastic Elastomers ... Markets, Economics, Intermaterials Competition, and Industry Structure in China



A China Multiclient Industry Analysis

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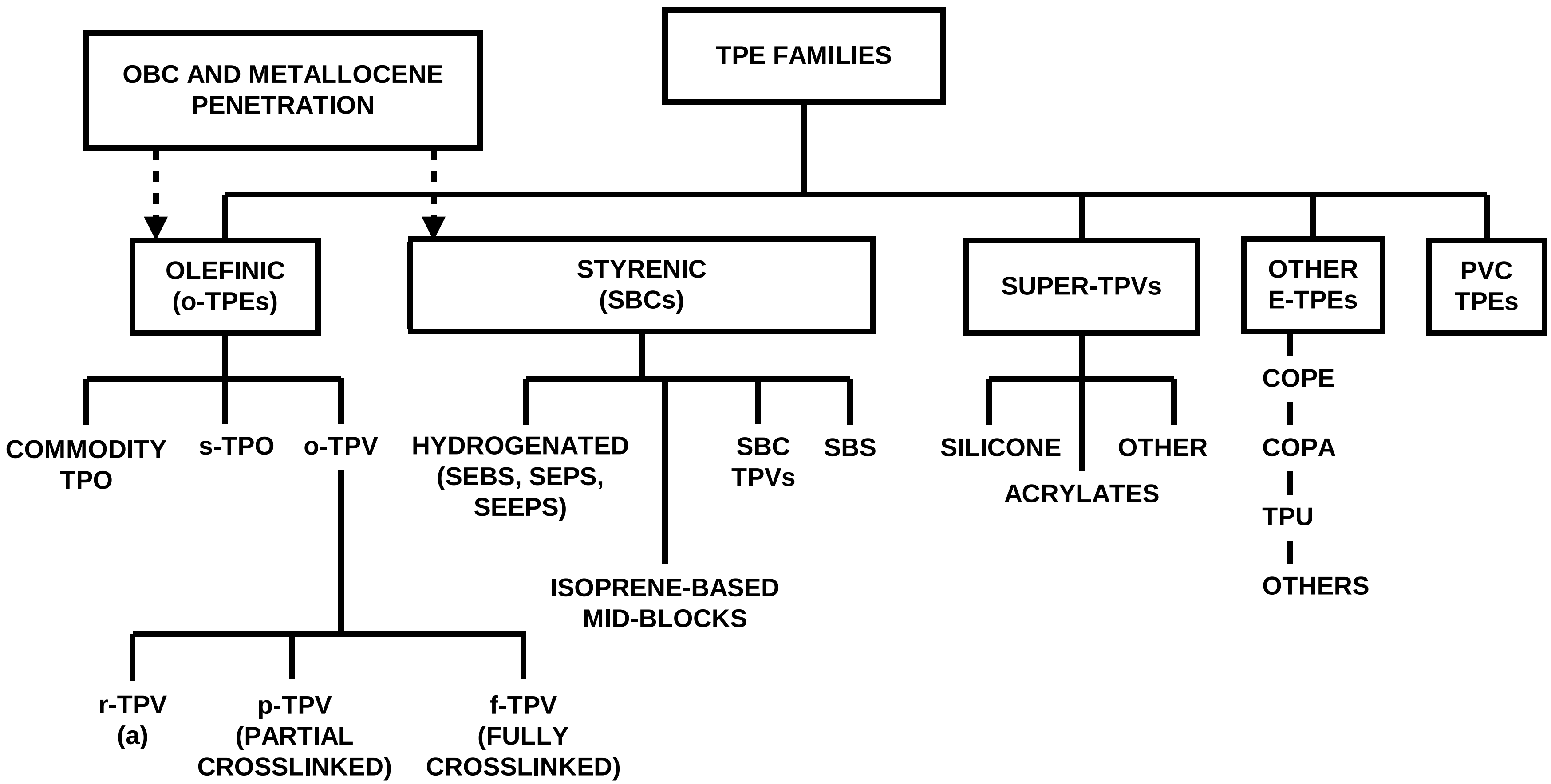
TPE FAMILIES . . .
CHANGING STRUCTURE, INCREASED INTRA-TPE COMPETITION



NOTE: (a) RECYCLATE-BASED TPV

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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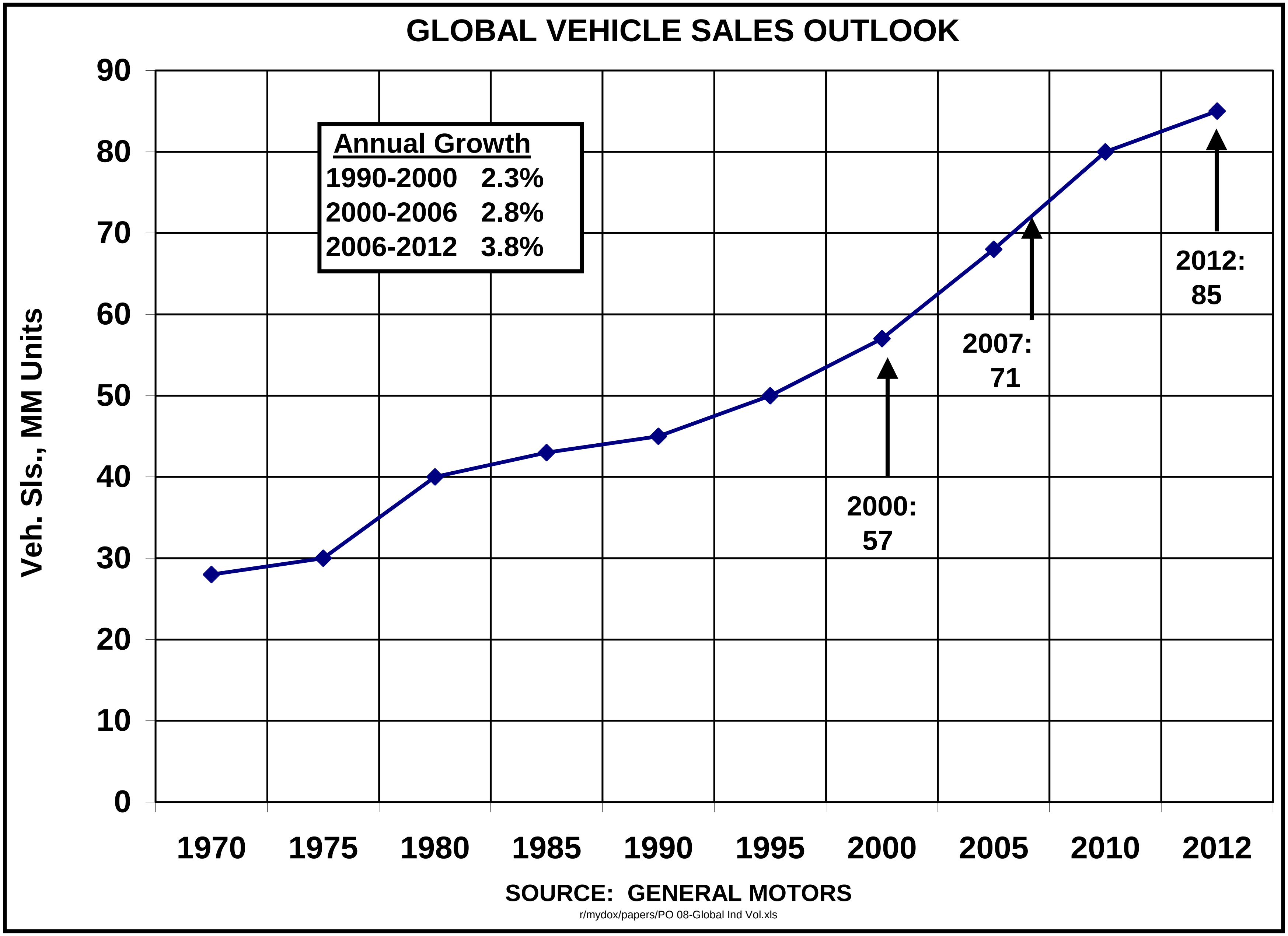
GLOBAL VEHICLE SALES OUTLOOK
Annual Growth
1990-2000 2.3%
2000-2006 2.8%
2006-2012 3.8%
2000: 57
2007: 71
2012: 85
Veh. Sls., MM Units
90
80
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2012
SOURCE: GENERAL MOTORS
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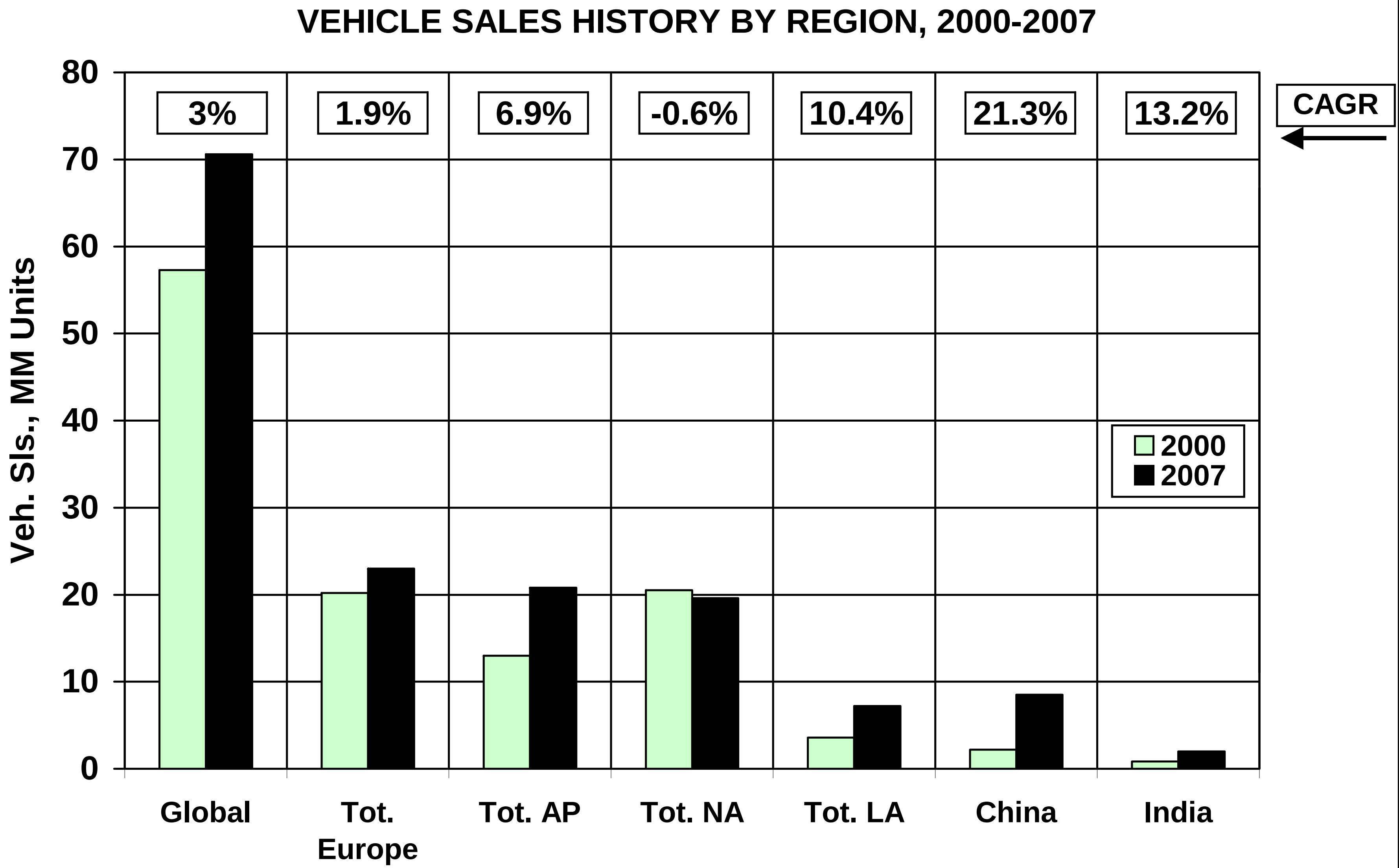
EXT. FACTORS: REGIONAL AUTO MKT. GROWTH



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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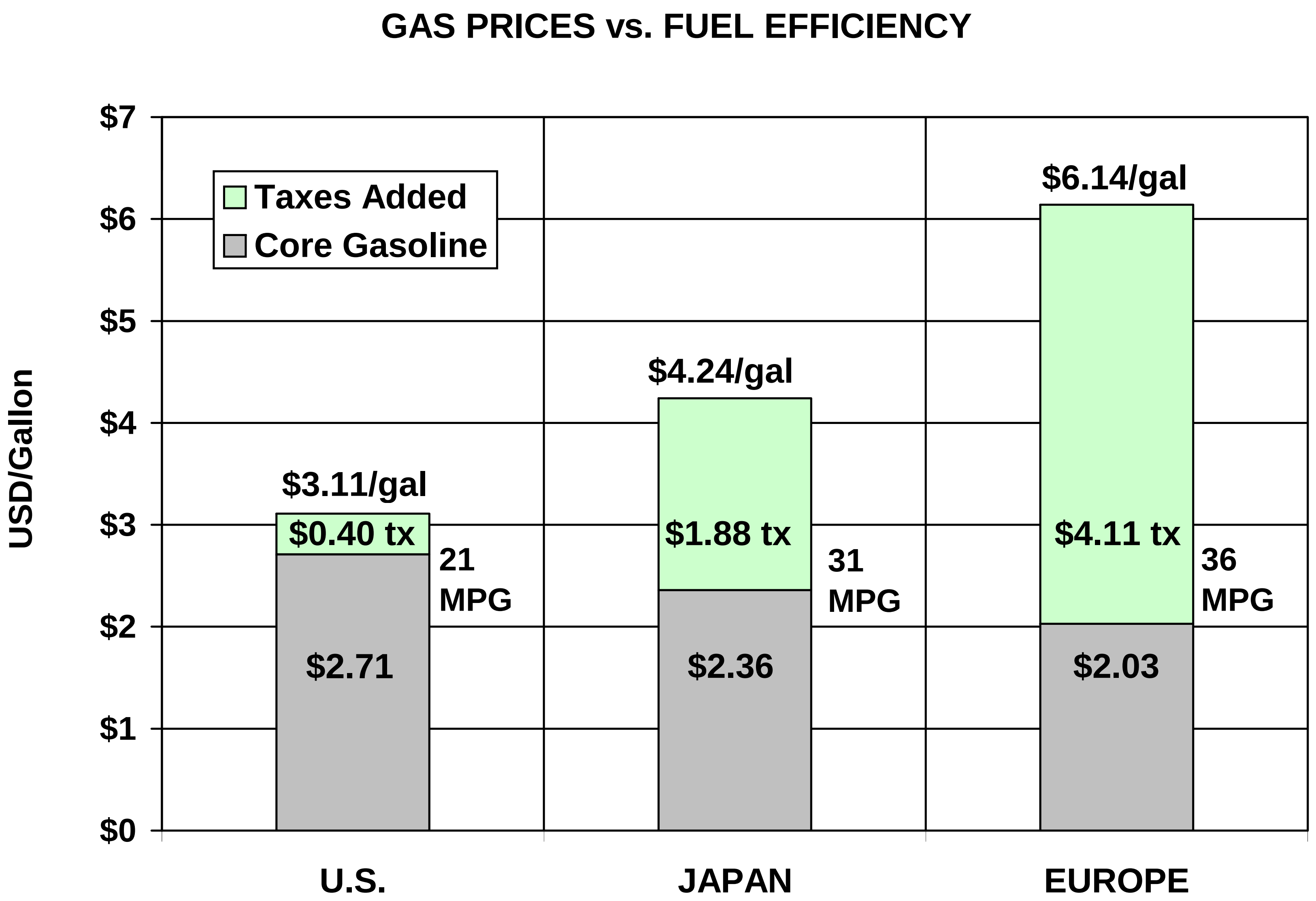
EXTERNAL FACTORS: FUEL EFFICIENCY



SOURCE: AUTO NATION

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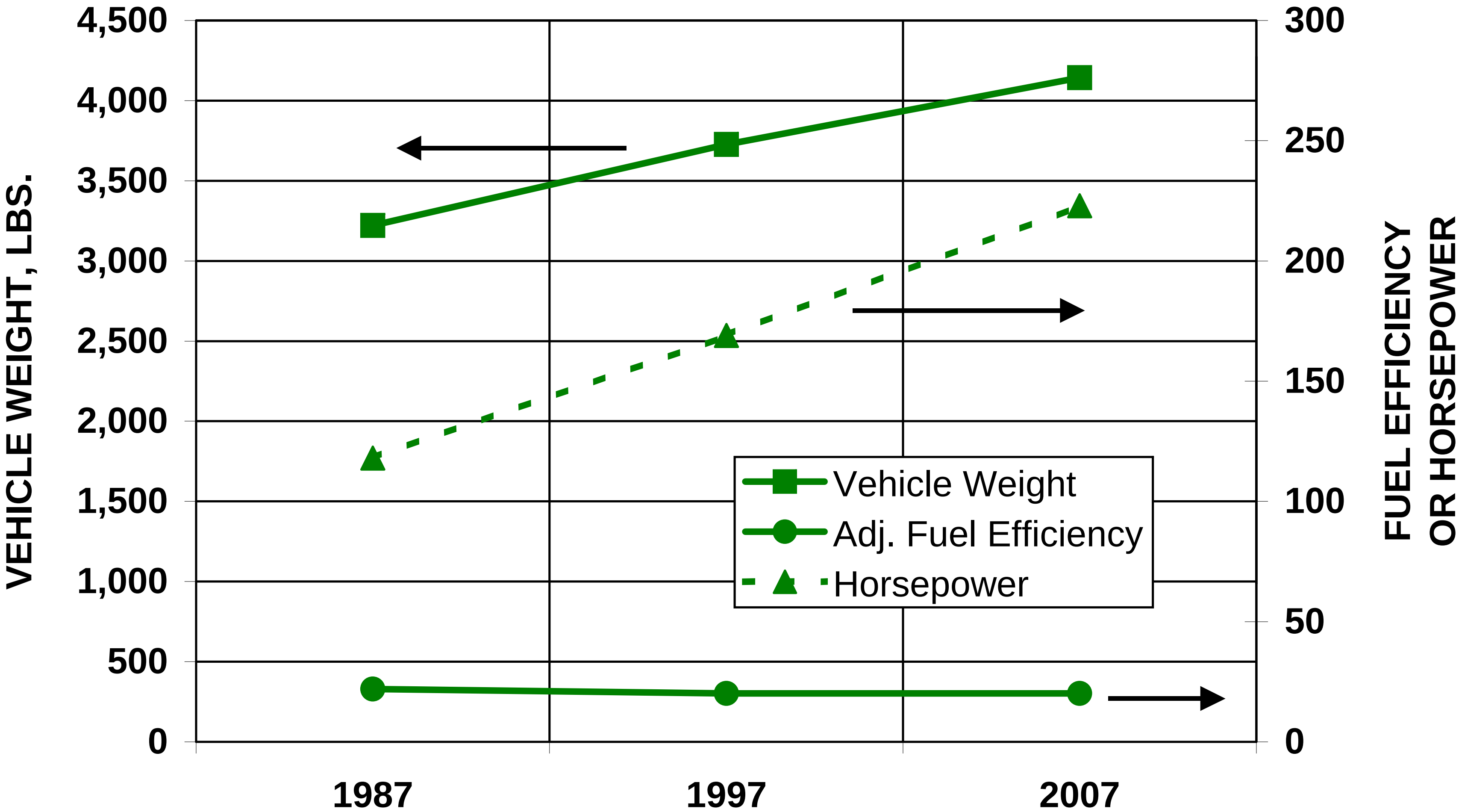
EXTERNAL FACTORS: U.S. VEHICLE POSITION

N. AMERICAN VEHICLES HAVE GAINED WEIGHT, INCREASED HORSEPOWER, AND NOT IMPROVED FUEL EFFICIENCY (MPG) OVER THE LAST 20 YEARS



SOURCE: EPA

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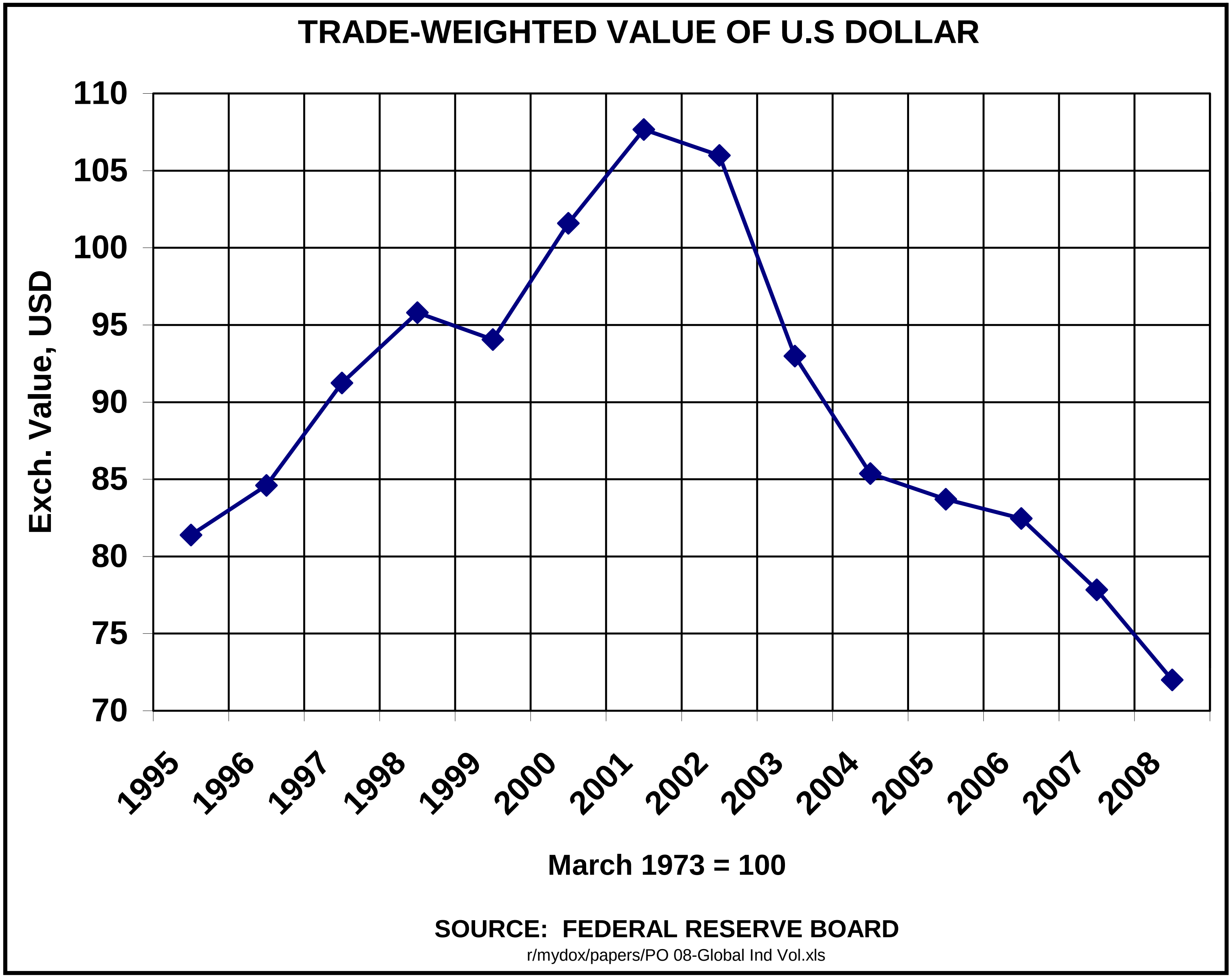
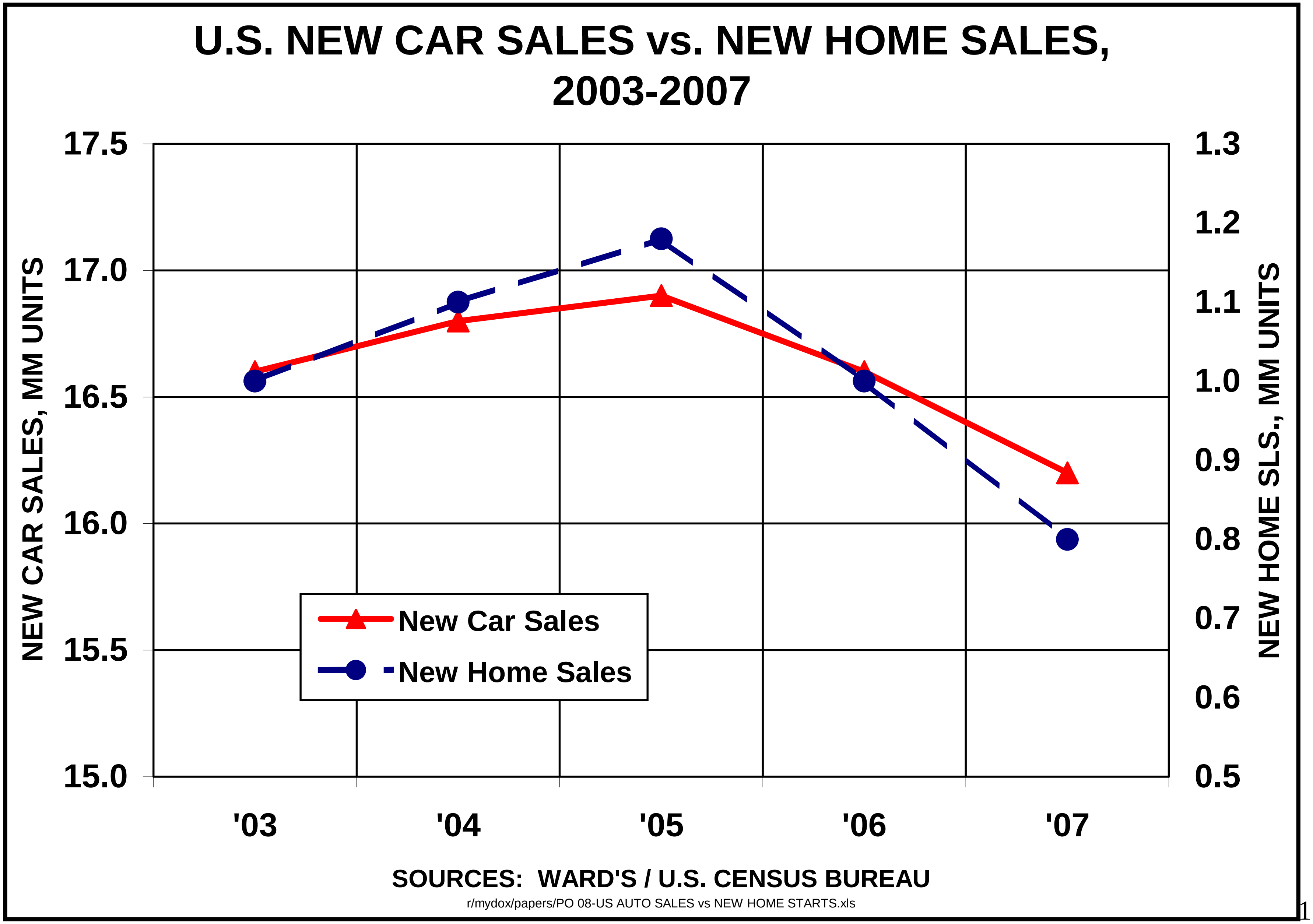
EXTERNAL FACTORS: U.S. DOLLAR DECLINE



EXTERNAL FACTORS: U.S. NEW CAR SALES



EXTERNAL FACTORS: KEY TRENDS AND DRIVING FORCES

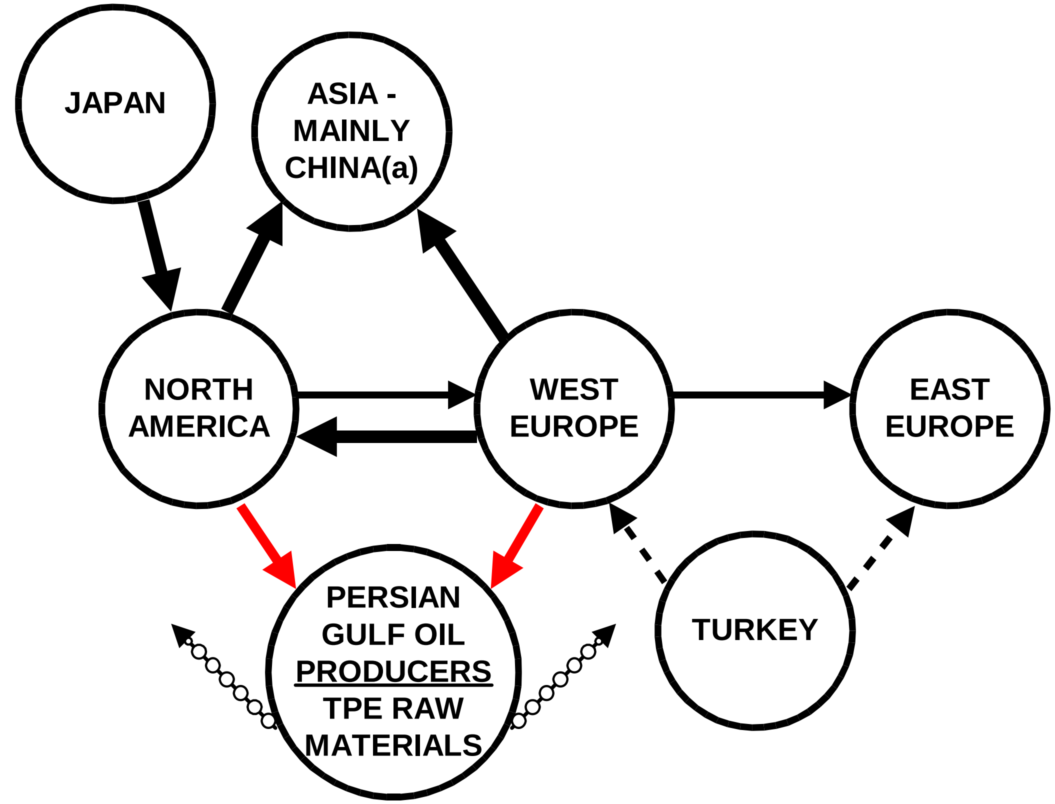
TREND	AUTO TPE IMPACT
Dollar weakness	- Foreign investment in N. America (state wealth, TPE industry players) - Increased U.S. exports
Stagnant Western auto growth/rapid non-Western auto growth	- Investment in non-Western regions by U.S. Tier 1s - Reluctant U.S. capex by U.S. Tier 1s - TPE investment in non-Western regions
Raw material price increase	- Tier 1/TPE compounder profitability squeeze - TPO preference - Optimize material efficient solutions - Fabrication technology optimization trend (reduced unit operations, scrap reduction) - Petrochem investment shift to monomer-rich regions (asset light strategies) - TPE supply chain consolidation
Fuel efficiency pressures	- U.S. fleet composition shift (favors polyolefin solutions) - Favor light-weighting solutions
Continued U.S. domestic OEM share loss	- Japanese/European/Korean Tier 1 and TPE compounder share gain

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

TPE MARKETPLACE GLOBALIZATION

- **TPE investment and technology flows following the globalization of end use markets.**
- **Most major TPE compounders have established Asia (China) operations.**
- **A new class of Asian TPE compounders is emerging (eventually global competitors?/ parallel supply chain).**
- **China: fastest vehicle production growth region.**
- **Petrodollar shifting regional strengths.**

TPE INVESTMENT FOLLOWS MARKETS



PETRODOLLAR OUTFLOW

PETRODOLLAR INFLOW

STRONG FLOW OF CAPITAL INVESTMENT AND TECHNOLOGY

WEAK FLOW OF CAPITAL INVESTMENT AND TECHNOLOGY

FLOW OF TPE COMPOUNDS

NOTE: (a) INDIA IS STARTING

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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AUTO TPE SUPPLY CHAIN SHIFTS

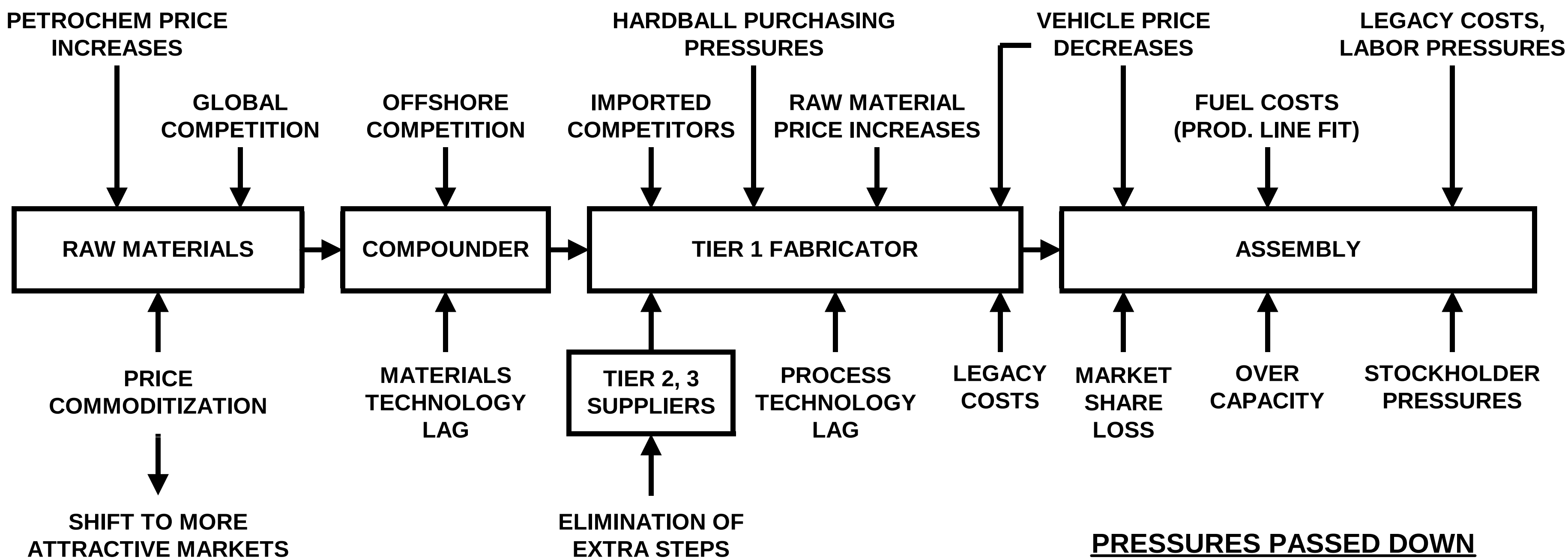
- **Automotive supply chain implosion drives TPE technical innovation**
- **Forward integration of resin suppliers to compounding (TSRC, Kuraray, Basell, others)**
- **Expanding property envelopes: SEBS, o-TPV, TPO, TPU**
- **Metallocene polyolefin and ionomer technologies challenge SEBS and o-TPV**
- **Renewed attack (SEBS and o-TPV) on rubber**
- **Parallel TPE supply chain in China**
- **Commodity vs. specialty TPE sector divergence**
- **Growing role for talc**
- **Resin capacity shift to monomer-rich regions**

AUTO TPE SUPPLY CHAIN SHIFTS (Cont'd.)

- Strengthening of Japanese resin companies in N. America and Europe
- Korean TPE suppliers challenging the incumbents? (e.g., Hyundai EP)
- TPE compounders broadening product lines
- Renewed growth of European compounders in N. America ($ weakness driver?)
- Resin suppliers riding a wave of new reactor technology (direct access to TPE markets)
- Tier 1s shifting to o-TPE compounding in-house?
- Enhanced role for TPE masterbatch

AUTO SUPPLY CHAIN EFFECTS

AUTOPLASTIC SUPPLY CHAIN IMPLOSION (N. AMERICA)



<u>PRESSURES PASSED DOWN THE SUPPLY CHAIN</u>:

← **PRICING PRESSURES**

← **SUPPLY CHAIN "MANAGEMENT"**

← **DEMAND SLOWDOWN**

← **REVISED SPECIFICATIONS**

← **GLOBALIZATION PRESSURES**

<u>ELIMINATE/REDUCE THE INEFFICIENCIES</u>:
- MULTIPLE STEPS
- EXCESSIVE LOGISTICS
- SCRAP GENERATION
- INEFFICIENT PROCESS TECHNOLOGIES
- SALES/MARKETING COSTS
- EXCESS LABOR COSTS
- OVER-GLOBALIZATION?

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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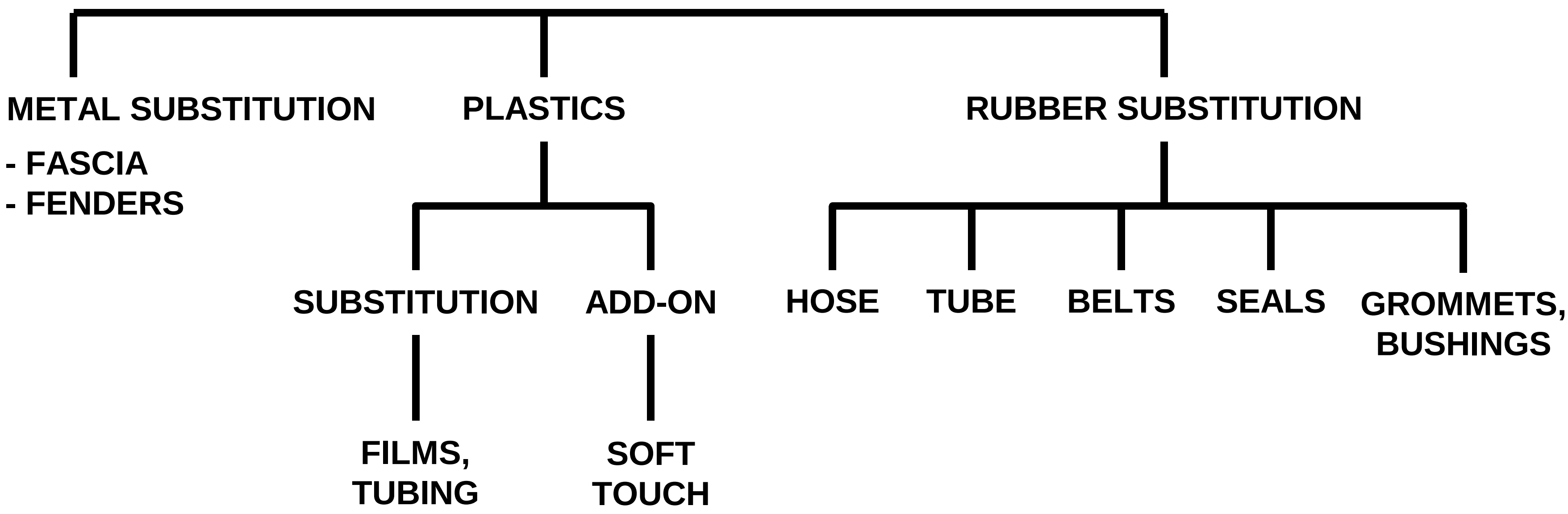
AUTOMOTIVE TARGET MARKETS FOR TPEs



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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AUTOMOTIVE TPE TARGETS AND THE RUBBER INTERFACE

AUTO TPE SYSTEMS TARGETS

- BODY/GLAZING SEALS*
  - BODY SEALS*
    - DOORS
    - HOOD*
    - REAR DECK*
  - GLAZING SEALS*
    - FIXED*
    - MOVEABLE*
- HVAC
  - FLAPPER DOOR GASKETS*
  - AIR DUCTS
  - OTHER
- EXTERIOR
- INTERIOR(a)
  - AIRBAG DOORS*
  - SKINS*
  - COATED FABRIC*
  - FLOOR SYSTEMS*
    - ACOUSTIC*
    - CARPET BACKING*
    - MATS*
- BOOTS/BELLOWS
  - STEERING
    - STEER COLUMN BOOT*
    - CVJ BOOTS*
    - R/P BOOTS*
  - POWER TRAIN
    - SPARK PLUG BOOTS*
    - SEALS/GASKETS*?
  - ELEC-TRICAL*
  - DOOR*
- HOSE/TUBE/DUCT(c)
  - HOSE
    - FLEX MANDREL(b)*
  - AIR MGT. - DUCT*
  - TUBE
    - W. WASHER
    - EGR
    - VAC TUBE (NL)
- ELECTRICAL
  - CABLE JACKET
  - LIGHTING GASKETS*
  - OTHER

NOTES:
* = RUBBER/TPE INTERFACE
(a) DOES NOT INCLUDE RIGID-FILLED TPOs USED IN INTERIORS
(b) RE-USABLE MANDREL TO MFR. HOSE (TPVs COMPETING WITH NYLON)
(c) E.G., FUEL, COOLANT, OILS, OTHER HOSE

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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Crank Case Ventilation Hose

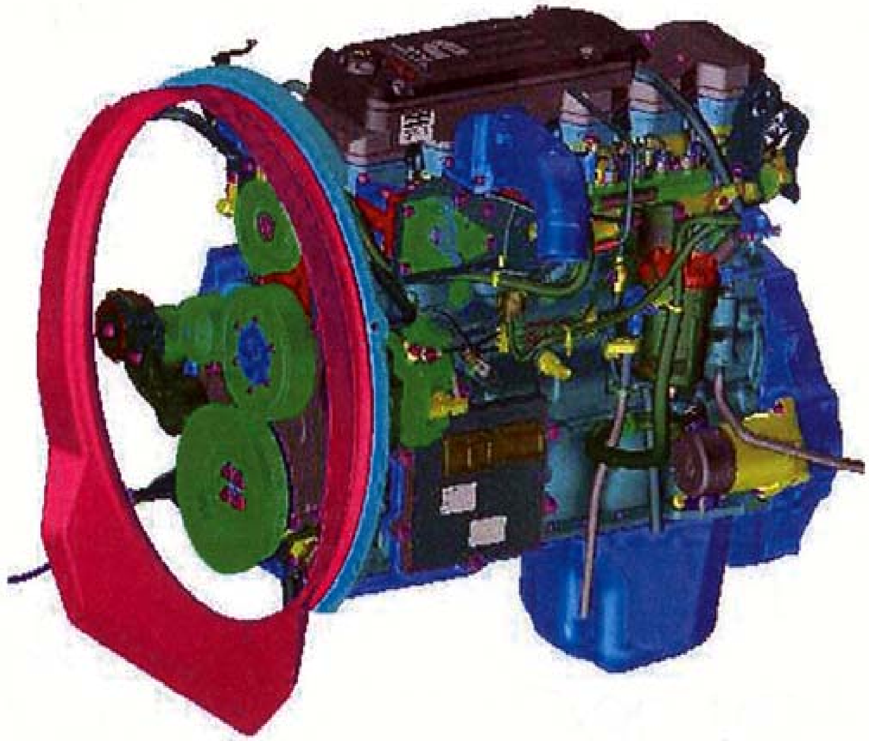
TPE Grade Name: DuPont™ E-TPV

Material Type: s-TPV

Process: Co-extrusion

Status: Concept

Key Features: Blow-by gas resist.



Product: Fan shroud
Manufacturer: Sur-Flo
Material Type: TPV (Nexprene)
TPE Supplier: Solvay Engineering Polymers
Note: Used in Dodge Ram HD pickup

2- color door trim skin on single natural fiber panel substrate
Vehicle: BMW 5 Series
Tier 1: Johnson Controls **Photo: BMW**

BODY/GLAZING SEALS

- Rapid growth
- High volume potential
- In-house compounding vs. merchant supply
- Evolution to in-line compounding?
- Systems will be key to TPE penetration
- o-TPV vs. SEBS vs. EPDM battleground
- Tier 1 consolidation

BODY/GLAZING SEALS: EPDM SUBSTITUTION ACCELERATES

Vehicle: 2007 DCX Dodge Ram
Supplier: JYCO (compound, profile, design)
Material: o-TPV
- Little guy scoops the big guys
- First o-TPV dynamic body seal

SOURCE: JYCO

EXPANDING/SHIFTING PROPERTIES ENVELOPE

- **Inroads into SEBS markets by advanced olefin technologies**
- **Market share shift between TPEs**
  - **- Reactor TPO**
  - **- Improved metallo-plastomers**
  - **- Dow's Infuse™ OBC**
- **POEs with high melt strength, broadened service temperature, low gloss**
- **POE/branched PPs**
  - **- Compete with o-TPVs**
  - **- Profiles/thermoforming**
  - **- Enhanced foam properties**

INTRA-TPE COMPETITION:
ROLE OF IMPROVED POLYOLEFIN TECHNOLOGY

- **Broad range of new PO technologies becoming avail.**
- **SEBS and TPO compound ingredients**
- **POE displacement of EPDM in TPOs almost complete**
- **Will stimulate transparent TPO, elastic fibers, elastic films**
- **Versatile molecular architecture control**
- **Still young technologies with broad growth pot'l., e.g.,:**
  - **- Nano morphology control (clear TPOs, e.g., from Mitsui)**
  - **- Long-chain branching control**
- **Direct sale to fabricators or compounders?:**

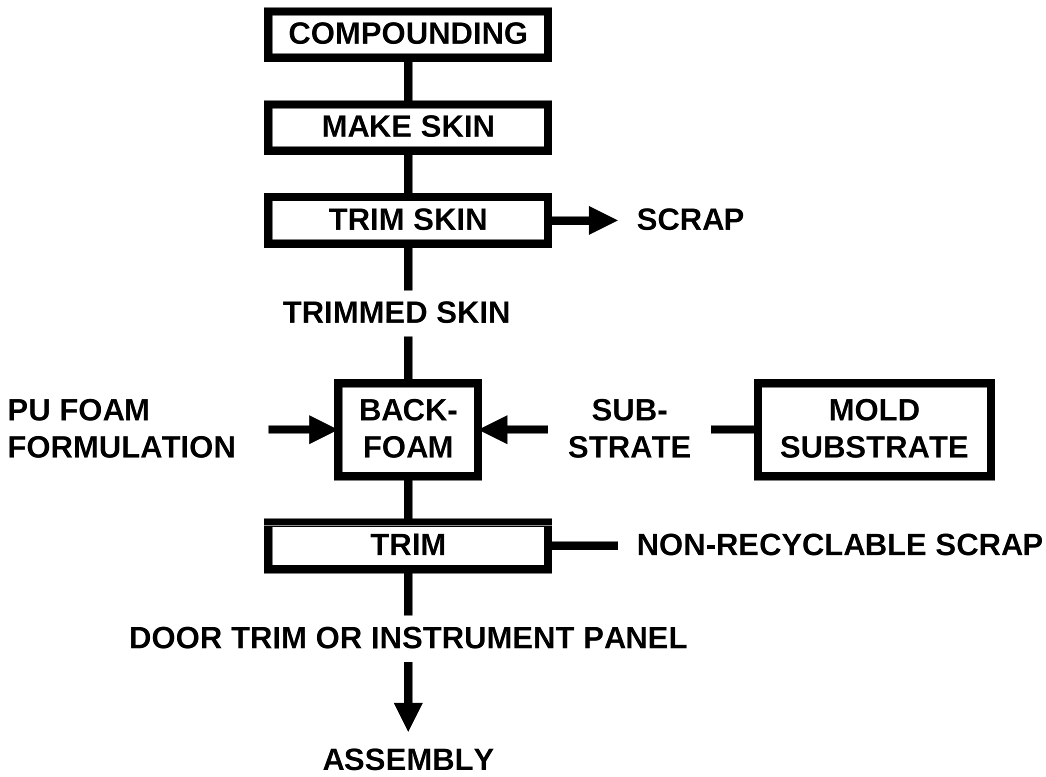
- Dow	**- Mitsui Chemical**
- ExxonMobil	**- Sumitomo**
- Borealis	**- JPP**

NEW MATERIALS/FABRICATION COMBINATIONS

- **Small part, 2-shot molding started**
- **Shift to large part, 2-shot molding**
  - Competition with thermoformed skins
  - Evolving to 3-layer (skin/foam/substrate)
  - Shifts the supply chain
- **Co-fabrication (blow, inject, profile extrude)**
- **Increased role for polyolefin foams**
  - 2-shot injection
  - Acoustics
  - Semi-structural applications
  - Role in all-PO constructions

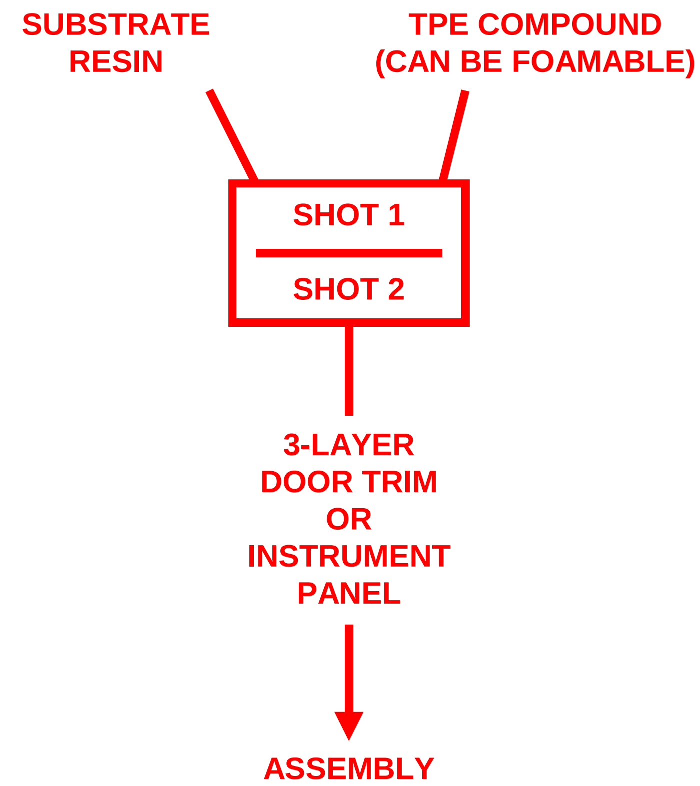
NEW TPE FABRICATION TECHNOLOGY:
LARGE-PART, 2-SHOT MOLDING CHALLENGES SKINS

CURRENT PROCESS



- LABOR INTENSIVE
- HIGH SCRAP
- MULTI STEP
- MULTI MATERIAL
- NON-RECYCLABLE
- DIFFICULT CRAFTSMANSHIP

2-SHOT



- LOW LABOR
- LOW SCRAP
- SINGLE STEP
- 1-2 CLOSELY RELATED MATERIAL FAMILIES
- EASILY RECYCLED
- HIGH CRAFTSMANSHIP

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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2-Shot Molded Door Medallion

Vehicle: Dodge Caliber ('07)

Molder: Lear

Material: Thermoplastic Elastomer On PP

LARGE-PART, 2-SHOT, SOFT TOUCH DEVELOPMENT

Part: Instrument Panel Upper
Skin Compound: COPE (Foamed Pibiflex from P Group)
Substrate: PBT/ASA (Ultradur^{R} S4090IGX from BASF)
Injection Machine: Engel
Foam Technology: Trexel

SOURCE: ROBERT ELLER ASSOCIATES LLC

LARGE-PART, 2-SHOT, SOFT TOUCH: TRUCK IP UPPER

Part:	**Truck IP Upper**
Status:	**Prototype**
Skin Compound:	**COPE (foamed Pibiflex from P Group)**
Substrate:	**PBT/ASA (Ultradur^{R} S4090IGX from BASF)**
Molding Machine:	**Engel Duo Series (for Dolphin process)**
Tier 1:	**IAC**

SOURCES: *POLYMOTIVE*; ROBERT ELLER ASSOCIATES LLC

TALC EFFECTS

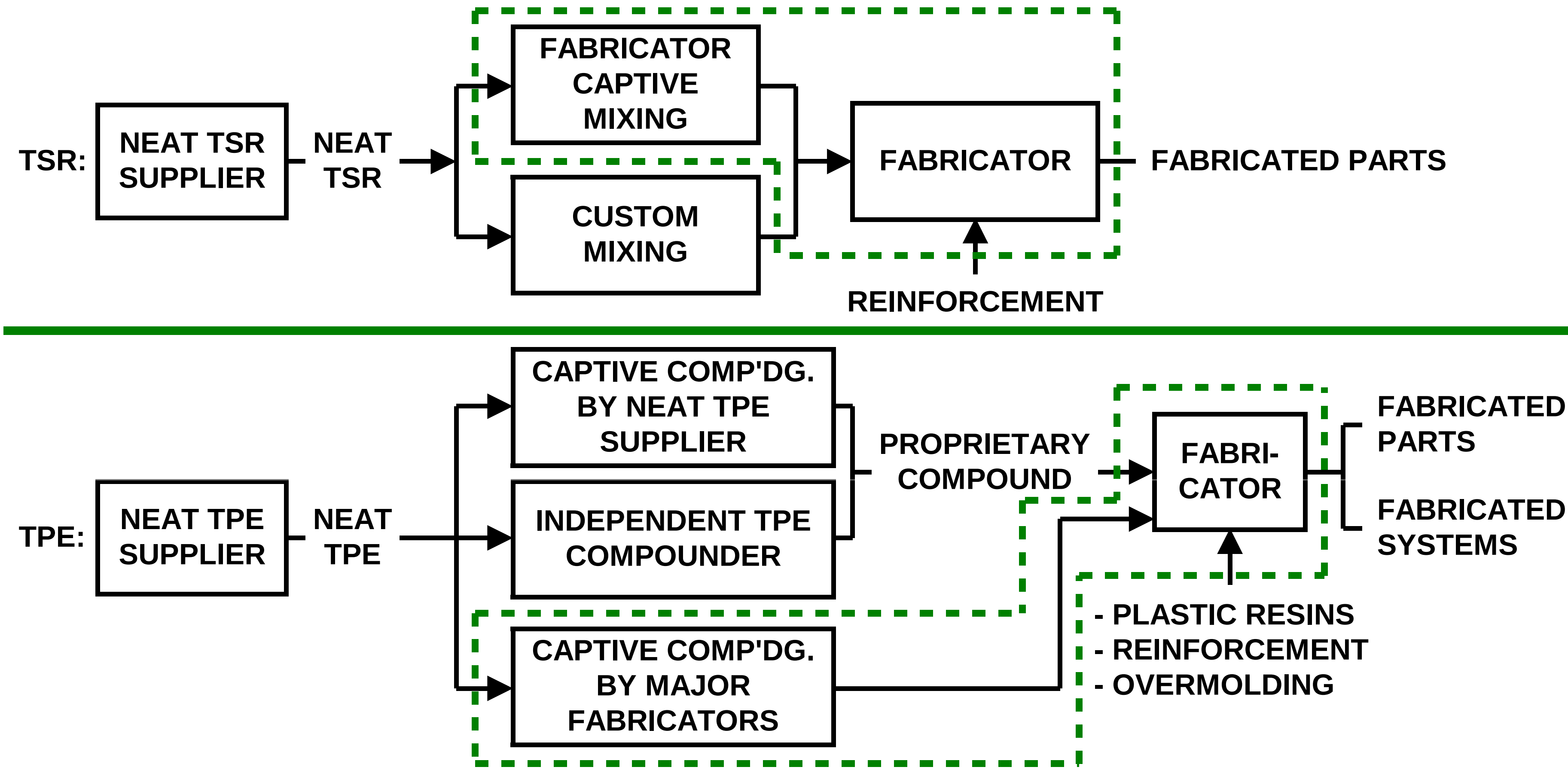
- **New micro-talcs broaden the properties envelope**
- **Exterior and interior applications**
- **For exterior applications:**
  - Europe ahead (front-end modules, e.g., BMW X5; hatchback, e.g., Renault Modus)
  - Could accelerate exterior panel penetration
- **Role for masterbatch?**

BMW X5 Front-end Module

Compound: 30% talc-filled TPO
Molder: Plastic Omnium
Filler Type: Jetfine® 3CA (Rio Tinto Minerals)
Key Features: Class A finish, zero gap, low temp. (-40ºC) impact, weight save, high scratch resistance, meets European pedestrian safety requirements

SOURCES: PLASTIC OMNIUM; ROBERT ELLER ASSOCIATES LLC, 2007

TPE vs. TSR PATH TO MARKET



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

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SUMMARY

- **Rapidly shifting global automotive TPE marketplace and TPE industry structure:**
  - **Regional automotive growth differences**
  - **Strong global investment flows**
  - **Internationalization of the N. American TPE market**
  - **Petrodollar effects**
  - **China/India TPE compound imports to N. America and Europe?**

- **Commoditization of low end TPE compound markets (shifting supplier rankings and target markets)**

SUMMARY (Cont'd.)

- New technologies driving TPEs deeper into TSR markets:
  - Body/Glazing Seals - Boots/Bellows
  - Hose - Coated Fabrics

- Continued profitability pressure from:
  - Consolidated customer base
  - Raw material price increases
  - Global pricing structures
  - Direct paths to market by resin suppliers
  - Increased in-house compounding
  - Masterbatch use by fabricators

SUMMARY (Cont'd.)

- **Expanding properties envelope**
- **Interface blurring between SEBS and o-TPV:**
  - **- Compound formulations**
  - **- Market sector dominance**
  - **- Product lines**
- **Forward and backward integration changing the TPE supply chain**
- **Many opportunities for capturing value (via systems approach)**
- **Global sourcing accelerating**
- **Olefin-based TPEs gaining share**