Automotive Supply Chain Shifts/TPE Opportunities
• 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

Robert Eller Associates, Inc.
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES
Specialty Thermoplastic Elastomers ... Markets, Economics, Intermaterials Competition, and Industry Structure in China

A China Multiclient Industry Analysis

Robert Eller Associates, Inc.
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES
TPE FAMILIES . . .
CHANGING STRUCTURE, INCREASED INTRA-TPE COMPETITION

NOTE:  (a) RECYCLATE-BASED TPV

SOURCE:  ROBERT ELLER ASSOCIATES LLC, 2008
GLOBAL VEHICLE SALES OUTLOOK

Annual Growth
1990-2000 2.3%
2000-2006 2.8%
2006-2012 3.8%

SOURCE: GENERAL MOTORS

r/mydox/papers/PO.08-Global Ind Vol.xls
EXT. FACTORS: REGIONAL AUTO MKT. GROWTH

VEHICLE SALES HISTORY BY REGION, 2000-2007

- Global: 3% Growth
- Europe (Tot.): 1.9% Growth
- Asia-Pacific (Tot.): 6.9% Growth
- North America (Tot.): -0.6% Growth
- Latin America (Tot.): 10.4% Growth
- China: 21.3% Growth
- India: 13.2% Growth

CAGR:

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
b/mydox/papers/PO 08-Global Ind Vol.xls
EXTERNAL FACTORS: FUEL EFFICIENCY

GAS PRICES vs. FUEL EFFICIENCY

SOURCE: AUTO NATION

r/mydox/papers/PO 08-FUEL.xls
EXTERIOR 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
r/mydox/papers/PO 08-FUEL.xls
EXTERNAL FACTORS: U.S. DOLLAR DECLINE

TRADE-WEIGHTED VALUE OF U.S DOLLAR

March 1973 = 100

SOURCE: FEDERAL RESERVE BOARD
r/mydox/papers/PO 08-Global Ind Vol.xls
EXTERNAL FACTORS: U.S. NEW CAR SALES

U.S. NEW CAR SALES vs. NEW HOME SALES, 2003-2007

SOURCES: WARD'S / U.S. CENSUS BUREAU

r/mydox/papers/PO 08-US AUTO SALES vs NEW HOME STARTS.xls
## EXTERNAL FACTORS: KEY TRENDS AND DRIVING FORCES

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

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

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
r/mydox/papers/PO 08-InvTechTPE08.vsd // lg/myfiles/visio/PO 08-InvTechTPE08.vsd
• 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)

PETROCHEM PRICE INCREASES

GLOBAL COMPETITION

OFFSHORE COMPETITION

IMPORTED COMPETITORS

RAW MATERIAL PRICE INCREASES

VEHICLE PRICE DECREASES

FUEL COSTS (PROD. LINE FIT)

LEGACY COSTS, LABOR PRESSURES

RAW MATERIALS

COMPOUNDER

TIER 1 FABRICATOR

ASSEMBLY

PRICE COMMODITIZATION

MATERIALS TECHNOLOGY LAG

TIER 2, 3 SUPPLIERS

PROCESS TECHNOLOGY LAG

MARKET SHARE LOSS

OVER CAPACITY

STOCKHOLDER PRESSURES

SHIFT TO MORE ATTRACTIVE MARKETS

ELIMINATION OF EXTRA STEPS

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

PRESSURES PASSED DOWN THE SUPPLY CHAIN:

PRICING PRESSURES

SUPPLY CHAIN "MANAGEMENT"

DEMAND SLOWDOWN

REVISED SPECIFICATIONS

GLOBALIZATION PRESSURES

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

re/mydox/papers/PO 08-implosion08.vsd // lg/myfiles/visio/PO 08-implosion08.vsd
AUTOMOTIVE TARGET MARKETS FOR TPEs

METAL SUBSTITUTION
- FASCIA
- FENDERS

PLASTICS

RUBBER SUBSTITUTION

SUBSTITUTION                   ADD-ON
SUBSTITUTION                  ADD-ON
 FILMS, TUBING                SOFT TOUCH
HOSE                          TUBE
BELTS                         SEALS
GROMMETS, BUSHINGS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
AUTOMOTIVE TPE TARGETS AND THE RUBBER INTERFACE

AUTO TPE SYSTEMS TARGETS

BODY/GLAZING SEALS*

- BODY SEALS*
- GLAZING SEALS*
- DOORS
- HOOD*
- REAR DECK*
- FIXED*
- MOVEABLE*

HVAC

- FLAPPER DOOR GASKETS*
- AIR DUCTS
- OTHER

EXTERIOR

BODY SEALS*

- GLAZING SEALS*
- HVAC
- OTHER

INTERIOR(a)

- AIRBAG DOORS*
- COATED FABRIC*
- FLOOR SYSTEMS*
- SKINS*
- ACOUSTIC*
- MATS*
- CARPET BACKING *

- STEERING
- POWER TRAIN
- DOOR*

- BOOTS/BELLOWS

- STEER COLUMN BOOT*
- CVJ BOOTS*
- SPARK PLUG BOOTS*
- SEALS/GASKETS*?

ELECTRICAL

- ELECTRICAL
- LIGHTING GASKETS*
- HOSE/TUBE/DUCT(c)
- FLEX
- MANDREL(b)*
- AIR MGT. - DUCT*
- HOSE
- TUBE
- W. WASHER
- EGR
- VAC TUBE (NL)

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
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
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

COMPOUNDING

MAKE SKIN

TRIM SKIN

TRIMMED SKIN

BACK-FOAM

SUBSTRATE

MOLD SUBSTRATE

TRIM

NON-RECYCLABLE SCRAP

DOOR TRIM OR INSTRUMENT PANEL

ASSEMBLY

- LABOR INTENSIVE
- HIGH SCRAP
- MULTI STEP

- MULTI MATERIAL
- NON-RECYCLABLE
- DIFFICULT CRAFTSMANSHIP

2-SHOT

SUBSTRATE RESIN

TPE COMPOUND (CAN BE FOAMABLE)

SHOT 1

SHOT 2

3-LAYER DOOR TRIM OR INSTRUMENT PANEL

ASSEMBLY

- LOW LABOR
- LOW SCRAP
- SINGLE STEP

- 1-2 CLOSELY RELATED MATERIAL FAMILIES
- EASILY RECYCLED
- HIGH CRAFTSMANSHIP

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
2-Shot Molded Door Medallion

Vehicle: Dodge Caliber ('07)
Molder: Lear
Material: Thermoplastic Elastomer On PP
Part: Instrument Panel Upper
Skin Compound: COPE (Foamed Pibiflex from P Group)
Substrate: PBT/ASA (Ultradur® 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® 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. (-40°C) impact, weight save, high scratch resistance, meets European pedestrian safety requirements

SOURCES: PLASTIC OMNIUM; ROBERT ELLER ASSOCIATES LLC, 2007
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)
• New technologies driving TPEs deeper into TSR markets:
  - Body/Glazing Seals
  - Hose
  - Boots/Bellows
  - 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