GLOBAL PERSPECTIVES ON TPE MARKETS, GROWTH TRENDS, AND THE RUBBER INTERFACE

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FEBRUARY 26, 2007
REA BACKGROUND

- ESTABLISHED IN 1991
- ANALYSIS IN SUPPORT OF MANAGEMENT DECISIONS IN: PLASTICS, TPEs, ELASTOMERS, COMPOUNDING
- MULTICLIENT/PRIVATE STUDIES; MERGERS/ACQUISITIONS
- OPERATIONS IN U.S./EUROPE/ASIA
- MOST STUDIES ARE GLOBAL IN SCOPE
- POSITIONING STUDIES: MOST NEW TPEs ENTERING MARKET
- MOST ANALYSES ARE AT ADVANCED R+D/EARLY COMMERCIALIZATION INTERFACE
- OPERATE IN ALL MARKET SECTORS
Specialty Thermoplastic Elastomers . . . Markets, Economics, Technology, Intermaterials Competition

A Europe/U.S./Japan Multiclient Industry Analysis
Completed January 2007
Robert Eller Associates, Inc.
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES
Specialty Thermoplastic Elastomers... Markets, Economics, Intermaterials Competition, and Industry Structure in China

A Multiclient Industry Analysis

2006

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USA • EUROPE • CHINA • JAPAN • SOUTH AMERICA
PRESENTATION OVERVIEW

- TPE DEFINITIONS
- MARKET PERSPECTIVES/GLOBAL SHIFTS
- PATHS TO MARKET/INDUSTRY STRUCTURE SHIFTS
- MATERIALS TECHNOLOGY EFFECTS
- THE RUBBER INTERFACE
- FABRICATION TECHNOLOGY EFFECTS
- MARKET SECTORS
  - AUTO . . . WHY IT'S IMPORTANT
  - NON-AUTO
- CREATING/DESTROYING VALUE
- PROFITABILITY DRIVERS
- CHINA IMPLICATIONS
- FUTURE VIEW
TPE FAMILIES . . . CHANGING STRUCTURE

OLEFINIC (o-TPEs)
- s-TPO
- o-TPV

STYRENIC (SBCs)
- HYDROGENATED (SEBS, SEPS)
- SBC TPVs

ISOPRENE-BASED MIDBLOCKS

SUPER-TPVs
- SILICONE ACRYLATES
- OTHER

OTHER E-TPEs
- COPE
- COPA
- OTHERS

PVC TPEs

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
TYPICAL HARDNESS RANGES OF TPEs AND OTHER PLASTICS

**ELASTOMER**
- SEBS / SBS (SEBS = BLOCK COPOLYMER)
- TPV ALLOYS
- SILICONE
- PLASTICIZED TPU
- NITRILE RUBBER
- EPDM

**RIGID PLASTIC**
- SOFT-PVC
- TPV
- COPE / COPA
- PEBAX (POLYETHER BLOCK AMIDE)
- TPO
- NANO-TPO
- PP
- NYLON 11, 12
- PBT & PET
- ABS
- NYLON 6, 66
- PC
- POM

**DURAMETER A**
- 0 10 20 30 40 50 60 70 80 90

**DURAMETER D**
- 45 55 65 75 85 90 95

**ROCKWELL - R**
- 50 70 90 110 120 130

SOURCE: BAYER, 2007
TPE PRICE/PERFORMANCE RANGES

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
MKT. PERSPECTIVES (EUROPE/N. AMERICA)

- TPE DEMAND GROWTH (ALL SECTORS):
  - OVERALL 5-6%/YR. (EUROPE/N. AMERICA)
  - MAJOR RUBBER BREAKTHROUGH COULD SHARPLY ACCELERATE GROWTH

- AUTOMOTIVE: 7%/YR. GROWTH BETWEEN 2006-2011

- FASTEST TPE GROWTH SECTORS WILL BE:
  - THERMOFORMED SHEET
  - AUTOMOTIVE
  - BUILDING/CONSTRUCTION
  - FOOD/PHARMACEUTICAL PACKAGING

- PROFITABILITY:
  - CONTINUED EROSION?
  - MARKET SEGMENTING INTO COMMODITY/SPECIALTY
ASIA EFFECTS ON EUROPE/N. AMERICA TPE MARKETS

- TPE DEMAND GROWTH IN WEST REDUCED BY CHINA SHIFT OF MARKETS:
  - APPLIANCE/TOOL
  - CONSUMER/HOUSEWARES
  - PERSONAL CARE
  - SPORTS/LEISURE
  - ELECTRICAL-ELECTRONIC/PERSOAL COMMUNICATIONS
- COMPOUNDER SHIFT TO CHINA ACCELERATING (RECENTLY)
- INVESTMENT STARTING TO FLOW FROM CHINA
- AUTO EXPORT: STARTING SLOWLY
- INDIA SHIFT: SLOWER THAN CHINA, CURRENT INTEREST
MANUFACTURING DYNAMICS: THE SHIFT TO LOWER-COST LABOR

CHINA vs. EAST EUROPE:
- MORE TECHNICAL APPLICATIONS IN EAST EUROPE
- BETTER TOOLING BASE
- IP PROTECTION
- MORE CAPITAL INTENSE AUTOMATION
  (PRODUCTIVITY IMPROVEMENTS vs. LABOR)
TPE INDUSTRY STRUCTURE SHIFTS

• TECHNOLOGY CONVERGENCE: (EUROPE/U.S./ASIA?)

• SHARE SHIFT IN U.S. END USE MARKETS:
  EUROPEANS, JAPANESE, KOREANS

• JAPANESE TPE COMPOUNDERS:
  MAJOR SHARE GAIN IN N. AMERICA (o-TPEs)

• PRIVATE EQUITY GROUPS ENTERING

• REACTOR TPO/METALLO-PLASTOMERS/OBCs:
  CAUSE MARKET SHARE SHIFT BETWEEN TPEs

• COMPOUNDER PRODUCT LINES: BROADENING

• s-TPVs: ATTRACTING NEW SUPPLIERS

• SBC-TPV:
  COULD SHIFT COMPETITIVE POSITIONS
  (STYRENIC vs. o-TPV)

• IN-HOUSE COMPOUNDING:
  WILL CHANGE INDUSTRY STRUCTURE AND PATH TO MARKET
NEW TPE MATERIALS TECHNOLOGIES

- **s-TPVs (SUPER-TPVs):**
  - ACRYLIC, NITRILE, AND SILICONE BASED
  - VERY SMALL CURRENT VOLUMES
    (ZEON AND DuPONT ARE LEADERS)
  - MODERATE GROWTH POTENTIAL
  - AUTO UNDER-HOOD IS MAIN TARGET
  - HIGH PRICE LIMITS APPLICATION POTENTIAL

- **r-TPOs:**
  - BROADENING PROPERTY RANGE, NEW COMPETITORS

- **PLASTOMER/HMS PP:** POOR MAN’S CROSSLINKING

- **OLEFIN BLOCK COPOLYMERS:**
  - RECENT INTRODUCTION BY DOW SHIFTS TPE COMPETITIVE INTERFACE
# TPE/RUBBER SUBSTITUTION STATUS

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>STATUS</th>
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<tbody>
<tr>
<td>BODY/GLAZING SEALS*</td>
<td>- STARTED</td>
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<tr>
<td></td>
<td>- WILL ACCELERATE</td>
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<td>- FOAMING REQUIRED?</td>
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<tr>
<td>HOSE*</td>
<td>- NO SIGNIFICANT PENET. YET</td>
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<td>- REQUIRES PARADIGM SHIFT</td>
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<tr>
<td>BELTS</td>
<td>- UNLIKELY PENETRATION IN AUTO</td>
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<td>- MAJOR TPV, TPU TARGET</td>
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<tr>
<td>BOOTS/ BELLOWS/ DUCTING*</td>
<td>- SUBSTANTIAL PENETRATION.</td>
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<td>- SHIFT TO HIGHER PERF. TPEs?</td>
</tr>
<tr>
<td>GROMMETS, BUMPERS, GASKETS*</td>
<td>- STARTED</td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
FABRICATION TECHNOLOGY SHIFTS

• 2-SHOT MOLDING
• IN-LINE COMPOUNDING?
• NEGATIVE FORMING/IN-MOLD GRAINING
• PROFILE EXTRUSION
• BODY/GLAZING SEAL TPE SUBSTITUTION*
• IN-MOLD DECORATION
• INJECTION MOLDING ADVANCES (LOW GLOSS/FEWER FLOW LINES/FINE GRAIN)
• SHEET THERMOFORMING
• BROADEN BLOW MOLDING POTENTIAL*
• CO-EX*; CO-BLOW*

* = RUBBER CHALLENGE TECHNOLOGIES
THE TPEs -- NEW FAMILY MEMBERS/BROADENED PERFORMANCE ENVELOPE, NEW TECHNOLOGIES

TPE FAMILIES

OLEFINIC
- TPO
- TPV
- NANO-COMPOSITES, COATED FABRICS, SHIFTING GLOBAL AUTO SPECS
- p-TPV (PARTIAL CROSSLINKED)
- BROADENED APPLICATION RANGE FOR p-TPVs

STYRENIC
- HYDRO-GENATED (SEBS, SEPS)
- ISOPRENE-BASED MIDBLOCKS
- FOAMS, 2-SHOT CROSSLINKED
- RENEWED INTEREST FOR DAMPING PROPERTIES
- f-TPV (FULLY CROSSLINKED)
- -BROADER USE OF METALLO ELASTOMERS
- -NEW FOAM TECHNOLOGIES
- -IMPROVED ADHESION TO METAL/TEXTILES
- -INCREASED SOFTNESS W/ REDUCED OIL CONTENT

SUPER-TPVs
- NEW SBC TPVs
- SILICONE ACRYLATES
- NEW DISPERSED ELASTOMER PHASES, BROADENED MATRIX RESIN CANDIDATES

PVC
- ALL PVC TPEs
- PVC ALLOYS
- NEW ALLOYS (TPU, ACRYLIC, POs) FOR LOW TEMP. PERF.

ENGINEERING TPEs
- TPU
- COPE
- COPA
- OTHER

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007

r/mydox/papers/RMA-TPEs07.vsd
lg/myfiles/visio/RMA-TPEs07.vsd
• 2011 GLOBAL SALES COULD REACH 75MM UNITS
• GLOBAL AAG = 3%/YR.
• ASIA-PACIFIC GROWTH 7.5-8.5%/YR.?
• WESTERN GROWTH STAGNANT OR DECLINE
• GLOBAL FLEET SHIFT TOWARD SMALLER CARS
• VARIATIONS HAVE BEEN IN +/- 5% BAND SINCE 1970
GLOBAL VEHICLE SALES . . . CHINA SHARE GAIN

AVG. ANNUAL % CHANGE 4.3%

NOTE: VEHICLE SALES INCLUDE HEAVY TRUCKS

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
U.S. MARKET SHARE OF THE FORMER BIG 3

GM
FORD
CHRYSLER

SOURCE: ROBERT ELLER ASSOC., 2007
SALES SHIFT FROM ('05-'06) BY VEHICLE TYPE IN NORTH AMERICA

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
AUTO SUPPLY CHAIN (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

PRICE COMMODITIZATION

COMPOUNDER

MATERIALS TECHNOLOGY LAG IN N. AMERICA

TIER 1 FABRICATOR

PROCESS TECHNOLOGY LAG

LEGACY COSTS

MARKET SHARE LOSS

OVER CAPACITY

STOCKHOLDER PRESSURES

ASSEMBLY

PRESSURES PASSED DOWN THE SUPPLY CHAIN:

PRICING PRESSURES

SUPPLY CHAIN "MANAGEMENT"

DEMAND SLOWDOWN

REVISED SPECIFICATIONS

GLOBALIZATION PRESSURES

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

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
TPV DEMAND BY MARKET SECTOR (EUROPE, 2005-2010)

SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE MULTICLIENT STUDY, 2007
DEMAND FOR TARGET TPE COMPOUNDS BY SECTOR
(EUROPE, 2005)

SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE MULTICLIENT STUDY, 2007
AUTOMOTIVE TPE TARGETS AND THE RUBBER INTERFACE

AUTO TPE SYSTEMS TARGETS

BODY/GLAZING SEALS *

BODY SEALS *

DOORS HOOD* REAR DECK*

PRIMARY* SEC.*

REAR QTR.*

WIND-SHIELD BACK-LIGHT

MECH. ENCAP.

SURFACE EXTR.

FIXED *

MOVEABLE *

FLAPPER DOOR GASKETS* AIR DUCTS OTHER

MOVEABLE SIDE

SLIDER* PIVOT*

BELT LINE MOLDING

GLASS RUN CHANNEL

DROP

MOLDING WINDOW LICKER

OTHER MOVEABLE

SUNROOF*?

EXTERIOR

INTERIOR(A)

AIRBAG SKINS* DOORS* COATED FABRIC* FLOOR SYSTEMS *

ACOUSTIC* CARPET BACKING* MATS*

STEERING POWER TRAIN ELECTRICAL* DOOR*

STEER COLUMN BOOT* CVJ BOOTS* R/P BOOTS*

SPARK PLUG BOOTS* SEALS/ GASKETS * ?

BOOT/BELOWS

HOSE/TUBE/DUCT

FLEX MANDREL(B) *

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007

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
EXAMPLE AUTOMOTIVE APPLICATIONS FOR TPEs

HIGH PERFORMANCE BOOTS/BELLOWS(a)

VALVE COVER SEALS(a)

HOSE*

FASCIA*

SEALS (a)

DEFLECTORS, SHIELDS (r-TPV OPPORTUNITY)

FUEL SYSTEMS(a)

HIGH PERFORMANCE BODY PLUGS

NON-CARPET FLOORING

ROCKER PANELS*

BODY SIDE MOLDING*

STEP PADS AND RUNNING BOARDS*(b)

SKINS*

MISC. INTERIOR SOFT TOUCH

COATED FABRICS

EXTERIOR PANELS*

NOTES:
-DOES NOT SHOW BODY/GLAZING SEALS, A CONTINUING GROWTH OPPORTUNITY
* INDICATES NANO-TPE OPPORTUNITY
(a) s-TPV TARGET
(b) NOTE COMPETITION WITH LGF-PP

SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE MULTICLIENT STUDY, 2007
INTERIOR SKIN DEVELOPMENT
(2006 HONDA CIVIC)

- PART: PASSENGER AIRBAG DOOR
- KEY FEATURES:
  - SEAMLESS
  - NO PAINT
  - LOW GLOSS
- MOLDER: VISTEON
- TPO SKIN SUPPLIER: OKAMOTO/O’SULLIVAN
- TPO SUPPLIER: MITSUBISHI CHEMICAL
- MOLDING PROCESS: VISTEON VLIM

SOURCE: VISTEON, 2005
2-SHOT MOLDED DOOR MEDALLION

VEHICLE: DODGE CALIBER ('07)
MOLDER: LEAR
MATERIAL: THERMOPLASTIC ELASTOMER ON PP
BODY/GLAZING SEALS: EPDM SUBSTITUTION ACCELERATES

- 2007 DCX DODGE RAM
- SUPPLIER: JYCO (COMPOUND, PROFILE, DESIGN)
- LITTLE GUY SCOOPS THE BIG GUYS
- MATERIAL: o-TPV
- FIRST o-TPV DYNAMIC BODY SEAL

SOURCE: JYCO
2-SHOT MOLDING: GROWTH DRIVER FOR TPEs

- 2006 DCX CALIBER
- SUPPLIER: LEAR
- DOOR MEDALLION
- 2-SHOT MOLDING: START SMALL, TRANSITION TO LARGE PARTS/CHALLENGE SKIN TECHNOLOGY
- SEBS COMPOUND OPENS THE DOOR FOR TPOs/TPVs
Vehicle: Toyota Tundra (2006), mid-sized pickup truck

REA Note:
  a. Example of New American mfr. entering U.S. auto OEM stronghold
  b. Growth target for exterior compounded TPO
Part: Cargo box side rails
TPE Type: Compounded TPO (Sequel 1514)
TPE Supplier: SEP
Key Features: Scratch/mar resistance (5 finger test), low CLTE
Molder: Plastikon (also have plant in China)
REA Note: Domestic U.S. compounder/new American mfr.
Part: Tailgate cover
TPE Type: Compounded TPO (Sequel 1514)
TPE Supplier: SEP
Key Features: Surface durability, low CLTE
Molder: Plastikon (also have plant in China)
REA Note: Domestic U.S. compounder/new American mfr.
Product Type:
    Jeep rear tailgate seal

Note:  Sponge w/dense EPDM
Manufacturer:  Valeo
TPV Type:  TPV
Mfr. Location:  Europe
Note:  Example of boots/bellows and EPDM replacement
7 MM NEW VEHICLES ARE EXPECTED TO COME FROM CHINA, INDIA, AND THAILAND BY 2012.

SOURCE: CSM; ROBERT ELLER ASSOCIATES, INC., 2007
AUTO BODY/GLAZING SEALS . . .
CHALLENGE TO EPDM

- GLOBAL POTENTIAL IS 600 kt
- A TARGET FOR MAJOR TPE COMPOUNDERS
- GLASS-RUN CHANNEL/BELTLINE MOLDING PENETRATED
- U.S. HAS BEEN SLOWEST TO SHIFT TO TPEs (ACCELERATING)
- o-TPV AND RECENTLY SBC-TPV COMPETE WITH EPDM
- DYNAMIC TPE SEALS STARTING
- EPDM WILL LOSE SHARE
- PVC COULD RETAIN SHARE
- SOME BODY SEAL TIER 1s WILL COMPOUND IN-HOUSE
- START OF GLOBAL JOINT VENTURES (JYCO/INOAC)
- NEW FOAM TECH. COULD ACCELERATE PENETRATION
THE SUPER-TPV CANDIDATES . . .
CHALLENGING HEAT AND OIL RESISTANT RUBBER MARKETS

<table>
<thead>
<tr>
<th>GRADE NAME</th>
<th>ELASTOMER TYPE</th>
<th>MATRIX RESIN(S)</th>
<th>SUPPLIER</th>
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<tbody>
<tr>
<td>TPSiV</td>
<td>SILICONE</td>
<td>PA, TPU</td>
<td>DOW CORNING</td>
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<td>SILICONE</td>
<td>SEVERAL</td>
<td>WACKER</td>
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<td>ZEOTHERM</td>
<td>POLYACRYLATE (ACM)</td>
<td>PP, PA, POLYESTER</td>
<td>ZEON</td>
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<td>E-TPV</td>
<td>ETHYLENE ACRYLATE (AEM)</td>
<td>COPE</td>
<td>DUPONT</td>
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<td>FLUOROPRENE</td>
<td>FLUORO-ELASTOMER</td>
<td>FLUORO-POLYMER</td>
<td>FREUDENBERG-NOK</td>
</tr>
</tbody>
</table>
OIL RESISTANCE/HEAT RESISTANCE OF TPEs AND THERMOSET RUBBERS

HEAT RESISTANCE CLASS

- TYPE C (1)
  - H 250 (482)
  - G 225 (437)
  - F 200 (382)
  - E 175 (347)
  - D 150 (332)
  - C 125 (257)
  - B 100 (212)
  - A 70 (158)

- HEAT RESISTANCE CLASS NO. REQ.
  - A 140
  - B 120
  - C 100
  - D 80
  - E 60
  - F 40
  - G 20
  - H 10
  - K

- OIL RESISTANCE
  - EPDM(P)
  - METALLO PLASTOMERS
  - IIR(S)
  - SEBS
  - NR
  - CR
  - CSM
  - VQM
  - ACM
  - COPE
  - ECO
  - ALCRYN
  - KALREZ(R)
  - FKM

- SOURCE: ROBERT ELLER ASSOCIATES, INC.; TPE MULTICLIENT, 2007

NOTES
- FKM = VITON(R)
- FVQM - FLUOROSILICONES
- CR = CHLOROPRENE
- ACM = POLYACRYLATE
- VQM = SILICONE
- EAM = VAMAC(R)
- IIR = BUTYL
- NR = NATURAL RUBBER
- ECO = EPICHLORHYDRIN
- CSM = CHLOROSULFONATED PE
- H-ACN = HIGH NITRILE
- FA = THIOKOL
- (S) = SULFUR CURE
- (P) = PEROXIDE CURE
- (R) = RESIN CURE
NEW SUPER-TPV TECHNOLOGIES

• ZEON AND DuPONT ARE LEADERS
• AUTO UNDER-HOOD IS KEY TARGET MARKET
• PENETRATION REQUIRES (HEAT, OIL RESIST., UV?)
• HIGH PRICES LIMIT PENETRATION POTENTIAL
• SOME COMPETITION WITH o-TPVs, CHLOROPRENE
• CV JOINTS, OIL FILTER, SOME HOSE APPLIC.
NEW SUPER-TPV TECHNOLOGIES (CONT’D.)

THE DRIVING FORCES FOR TPE SUBSTITUTION INCLUDE:

• INCREASED UNDER-HOOD TEMPERATURES
• INCREASED FUEL EMISSIONS CONTROL REGULATIONS
• INCREASED REQUIREMENTS FOR DYNAMIC SEAL PERFORMANCE AS WARRANTY PERIODS ARE EXTENDED
• POTENTIAL COST SAVINGS VIA INTEGRATION OF THE CONNECTOR FUNCTION WITH THE BODY OF THE PART
TPE SUPPLY CHAIN RECONFIGURATIONS

A. CURRENT:

RESIN SUPPLIER ➔ COMPOUNDER ➔ COMPOUND ➔ TIER 1 ➔ MODULES OR ASSEMBLIES ➔ OEM ASSEMBLY

A-1. CURRENT (ASIAN OEMs):

RESIN SUPPLIER ➔ COMPOUNDER ➔ COMPOUND ➔ TIER 1 ➔ MODULES OR ASSEMBLIES ➔ OEM

B. FUTURE?:

POSSIBLY MEGA-TIER 1s

RESIN SUPPLIER ➔ COMPOUNDER ➔ TIER 1 (SIMPLIFIED PROCESSES) ➔ AGREEMENT ➔ MODULES OR ASSEMBLIES ➔ OEM

C. FUTURE?:

POSSIBLY MEGA-TIER 1s

RESIN SUPPLIER ➔ COMPOUNDING? AS REQUIRED ➔ TIER 1 (SIMPLIFIED PROCESSES) ➔ AGREEMENT ➔ MODULES OR ASSEMBLIES ➔ OEM

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007

r/mydox/papers/RMA-SupplyChainReconf07.vsd
lg/myfiles/visio/RMA-SupplyChainReconf07.vsd
EPDM AND PLASTOMER PATHS TO AUTO OLEFINIC TPE MARKET

COMPETITIVE ATTACK FROM:
- SEBS
- REACTOR TPOs
- PVC FORCING COMPOUND PRICES DOWN

NEAT RUBBER

EPDM OR PLAST. SUPPL.

COMPOUNDING (OFTEN CAPTIVE TO EPDM SUPPLIER)

ADDITIVES  FILLER

PP  OIL

COMPOUNDING COST

INDEPENDENT COMPOUNDER

TPO, TPV OR EPDM COMPOUND

FABRICATOR WITH CAPTIVE EPDM COMPOUNDING TPV OR EPDM

FABRICATOR

FABRICATOR (TIER 1 OR TIER 2)

SOURCES: ROBERT ELLER ASSOCIATES, INC., 2007
NON-AUTOMOTIVE TPE MARKETS

HIGHLY DIFFUSE/GLOBALIZING/SOME COMMODITIZING:
- APPLIANCE/TOOL
- BUILDING/CONSTRUCTION
- CONSUMER PRODUCTS/HOUSEWARES
- ELECTRICAL/ELECTRONICS - PERSONAL COMM.
- FOOTWEAR (TPU, SBS)
- FOOD PHARMACEUTICAL PACKAGING
- MEDICAL DEVICES
- PERSONAL CARE/COSMETICS
- SPORTS/LEISURE
- WIRE/CABLE
- FILM/SHEET/FIBER (NEW GROWTH SECTOR)
- COATED FABRICS
NON-AUTOMOTIVE TPE MARKETS (CONT’D.)

• ABOUT 50% OF TPE DEMAND

• AFFECTED BY DEMAND SHIFT TO ASIA (CHINA)

• SHIFTS TPE GEOGRAPHIC DEMAND PATTERN

• INTRODUCES NEW COMPOUNDERS TO TPE COMPETITION (ESPECIALLY CHINA)

• TWO TIER QUALITY LEVELS? (CHINA?)

• FRAGMENTED, SMALL ORDER SIZES

• 2-SHOT MOLDING WELL ESTABLISHED (SMALL PARTS)
GLOBAL MARKET SHIFT EXAMPLES . . .
EFFECTS ON TPEs
GLOBAL WET RAZOR PRODUCTION HISTORY

SOURCE: ROBERT ELLER ASSOCIATES, INC., TPE MULTICLIENT STUDY, 2007
THE CHINA FACTOR IN TPEs:
MARKET AND INDUSTRY STRUCTURE
IMPLICATIONS
## CHINA SHARES OF GLOBAL PRODUCTION

<table>
<thead>
<tr>
<th>MARKET SECTOR</th>
<th>GLOBAL MARKET SHARE %</th>
<th>NOTE/TPE IMPORTANCE</th>
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</thead>
<tbody>
<tr>
<td>CAMERAS</td>
<td>50</td>
<td>GRIPS/SOFT TOUCH/BUTTONS</td>
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<tr>
<td>FANS</td>
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<td>MINOR</td>
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<tr>
<td>DVD READERS</td>
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<td>GRIPS/SOFT TOUCH/BUTTONS</td>
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<td>TELEPHONES</td>
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<td>TV SETS</td>
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<td>MOBILE PHONES</td>
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<td>GRIPS/SOFT TOUCH/BUTTONS</td>
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<td>LAPTOP COMPUTERS</td>
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<td>PADS/BUTTONS/SOFT TOUCH</td>
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<tr>
<td>AUTOMOBILE</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
PARALLEL SUPPLY CHAINS IN CHINA TPE MARKETS

NATIONALITY BASED

U.S. COMPOUNDERS

EUROPEAN COMPOUNDERS

JAPANESE COMPOUNDERS

KOREAN COMPOUNDERS

TAIWANESE COMPOUNDERS

CHINESE COMPOUNDERS

TRANSPLANT MULTINATIONAL OEMs AND FABRICATORS

JAPANESE OEMs AND FABRICATORS

KOREAN OEMs AND FABRICATORS

TAIWANESE OEMs AND FABRICATORS

CHINESE OEMs AND FABRICATORS

U.S.

EUROPE

JAPAN

KOREA

TAIWAN

CHINA

HIGH QUALITY PRODUCTS (EXPORT)

"PREMIUM" DOMESTIC PRODUCTS

LOW QUALITY DOMESTIC PRODUCTS

PRIMARY PATH

SECONDARY PATH

MINOR PATH

SOURCE: ROBERT ELLER ASSOCIATES, INC., 2007
## O-TPVs IN CHINA

<table>
<thead>
<tr>
<th>SUPPLIER</th>
<th>POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXXON MOBIL</td>
<td>-DOMINATES(VIA EXPORT FROM US)</td>
</tr>
<tr>
<td></td>
<td>-50% SHARE</td>
</tr>
<tr>
<td></td>
<td>-NAME RECOGNITION/PREMUIM</td>
</tr>
<tr>
<td>OTHER WESTERN COMPOUNDERS</td>
<td>-HAVE BEEN SLOW TO INVEST(STARTING)</td>
</tr>
<tr>
<td></td>
<td>-STARTING TO SERVE DOMESTIC MARKETS</td>
</tr>
<tr>
<td>TAIWAN/KOREAN COMPOUNDERS</td>
<td>-MINOR ROLE VIA EXPORT</td>
</tr>
<tr>
<td>LOCAL DOMESTIC COMPOUNDERS</td>
<td>-PRIMARILY SMALLER TPV COMPOUNDERS</td>
</tr>
<tr>
<td></td>
<td>-STRONG PRESENCE IN p-TPVS</td>
</tr>
<tr>
<td></td>
<td>-PARALLEL SUPPLY CHAIN</td>
</tr>
<tr>
<td></td>
<td>-COST ADVANTAGES( 30%)</td>
</tr>
<tr>
<td></td>
<td>- RECYCLATE USE?</td>
</tr>
<tr>
<td>JAPANESE</td>
<td>-PRIMARILY SERVE JAPANESE AUTO OEMs</td>
</tr>
<tr>
<td></td>
<td>-MORE FOCUS ON INDIA</td>
</tr>
<tr>
<td></td>
<td>-MITSUI IS LEADER</td>
</tr>
<tr>
<td></td>
<td>-SHIFT POSSIBLE IN FUTURE?</td>
</tr>
</tbody>
</table>
# CHINA vs. INDIA

<table>
<thead>
<tr>
<th>POT’L DOMESTIC MARKETS</th>
<th>CHINA</th>
<th>INDIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFRASTRUCTURE</td>
<td>• 1.3 BILLION PEOPLE</td>
<td>• 1.0 BILLION PEOPLE</td>
</tr>
<tr>
<td></td>
<td>• AGGRESSIVELY BUILDING INFRASTRUCTURE AROUND ECONOMIC DEV’MENT ZONES, FACILITIES OFTEN IN PLACE WAITING FOR NEW PLANTS</td>
<td>• ROADS/PORTS/LOGISTICS POOR</td>
</tr>
<tr>
<td></td>
<td>• CONTINUITY TO A PLAN, A SENSE OF CONSTANCY</td>
<td>• GOLDEN QUADRANGLE A HELP, BUT ONLY A START</td>
</tr>
<tr>
<td></td>
<td>• EXCELLENT CENTRAL PLANNING = STRENGTH</td>
<td>• DEMOCRATIC GOV’T CHANGED FREQ. (ELECTIONS EVERY 4 YEARS)</td>
</tr>
<tr>
<td></td>
<td>• BECOMING VERY BUSINESS FRIENDLY</td>
<td>• NEW GOV’TS MEANS A STOP-START</td>
</tr>
<tr>
<td></td>
<td>– CONTINUALLY OPENING UP FOR MORE FOREIGN INVESTMT</td>
<td>• BUREAUCRACY THAT IS NOT HIGHLY BUSINESS FRIENDLY</td>
</tr>
<tr>
<td></td>
<td>– FLOATING OF THE YUAN</td>
<td>• CORRUPTION EXISTS BROADLY</td>
</tr>
<tr>
<td></td>
<td>– BONDED WAREHOUSING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CORRUPTION EXISTS, BUT FOCUSED ON A FEW PEOPLE</td>
<td></td>
</tr>
</tbody>
</table>

| GOVERNMENT              | CHINA                          | INDIA |

| BUSINESS                | • WILL DOMINATE GLOBAL MANUF. PARTICULARLY MANUF. FOR EXPORT FOR THE NEXT 10 YRS. | • WILL DOMINATE SERVICE CENTER AND SOFTWARE COMPANIES THAT CAN TAKE ADVANTAGE OF QUICKLY BUILT ELECTRONIC HWYS |
THE ECONOMIC WAR IS OVER?

• MANUFACTURING FOR MANY TPE END PRODUCT SECTORS HAS ALREADY SHIFTED FROM WEST TO EAST

• YUAN REVALUATION:
  - TOKEN GESTURE?
  - AGAINST A MARKET BASKET (U.S. DOLLAR EQUALLY WEIGHTED WITH OTHER CHINESE TRADING PARTNER CURRENCIES)
  - U.S. DOLLAR POWER WEAKENED/LIKELY TO CONTINUE
  - SUBSTANTIAL ASIAN COST ADVANTAGE CONTINUES

• CHINESE U.S. BOND INVESTMENT SLOWS U.S. RETALIATION POT’L.

• ASIAN TPE MARKET SIZES DWARF U.S. AND EUROPE MARKETS
  - MARKET POWER OF 3BN NEW CONSUMERS
  - 1.5BN NEW WORKERS

• ASIA PULLING AHEAD IN TECHNICAL EDUCATION LEVEL AND NUMBERS
Manufacturer: Gillette
Product Name: Mach 3, Grip
TPE Type: SEBS
Bond Type: Physical
Manufacturer Location: China
Note: Grip and head with different TPEs

Manufacturer: Gillette
Product Name: Venus 3
TPE Type: SEBS
Bond Type: Chemical
Manufacturer Location: Poland
Manufacturer: Black and Decker
TPE Type: SEBS
Bond Type: Chemical
Mfr. Location: China
Manufacturer: P&G
Product Name: Pantene
Notes:
- TPEs expensive vs. incumbents
- Plastomers entering competition with EVA cap liners
Manufacturer: Moen
Product: Faucet Mounting Plate
TPE Type: TPV
Bond Type: Physical
Mfr. Location: USA
Note: 2-shot nylon-bonding TPV, replaces EPDM
Manufacturer: Stanley
TPE Type: SEBS
Bond Type: Chemical
Mfr. Location: China
Note: 2-color
Manufacturer: Tupperware
Product Type: 
TPE Type: SEBS
Note: Sold in Europe
TPE COMPOUND VALUE KILLERS

- ANY COMMODITY APPLICATION VIA EXTENDED SUPPLY CHAIN
- COMPETITION WITH PVC
- DIRECT 1:1 COMPETITION WITH EPDM
- CASCADE TO LOWER VALUE TPEs
- MOST AUTO APPLICATIONS (NOT ALL)
- COMPETITION WITH CHINESE COMPOUNDERS
- FABRICATOR IN-HOUSE COMPOUNDING
- MULTIMATERIALS CONSTRUCTION
- MULTI-STEP FABRICATION
TPE RESIN/COMPOUND VALUE CREATORS

- SYSTEMS COST SAVINGS POTENTIAL
- MONOMATERIALS CONSTRUCTION POTENTIAL
- IMPROVED ADHESION
- 2-SHOT MOLDING (ESPECIALLY LARGE PARTS)
- FOAMING
- CO-PROCESSING
- GLOBAL SPECIFICATIONS
- ELIMINATION OF CROSSLINKING
- MASTERBATCHES
- CONTROLLED RHEOLOGY
- SPECIALTY NICHES (IN-MOLD DECORATION)
- IMPROVED ACOUSTIC PROPERTIES
o-TPV PROFITABILITY DRIVERS

**INCREASE**
- IMPROVED PROPERTIES
  -- FOAMING
  -- ADHESION
  -- COLOR CONTROL
- MOMENTUM FROM PREVIOUS MARKETING
- CHINA MARKET PENETRATION (FOR EARLY ENTRANTS)

**DECREASE**
- AUTOMOTIVE DEPENDENCE
- TECHNOLOGY PROLIFERATION
- INCREASED COMPETITION
- PRICE PRESSURES
- CASCADE TO LOWER PRICED TPEs

**RUBBER PENETRATION**
- HOSE
- BELTING
- SYSTEMS COST SAVE

**CHINA MARKET PENETRATION**
- DIRECT COMPOUNDING OF TPVs?
- COMPETITION FROM IMPROVED STYRENIC TPEs?

**SHORT TERM**
**TIMING**
**LONG TERM**

**SOURCE:** ROBERT ELLER ASSOCIATES, INC., 2007
SUMMARY

- SUPPLY CHAIN SHIFTING (AUTO, NON-AUTO)
- TPE MARKET IS GLOBALIZING
- TPE PROPERTY ENVELOPE BROADENING
- MORE RAPID MATERIALS/FABRICATION TECHNOLOGY SHIFTS THAN FOR RUBBER:
  - CREATES VALUE
  - CREATES GROWTH
  - CASCADE TO LOWER VALUE TPEs
- IN CHINA:
  - ECONOMIC WAR IS OVER
  - DOMESTIC COMPETITION STARTING
- EUROPE/N. AMERICA: STAGNANT MARKETS
- RUBBER SUBSTITUTION IS POTENTIAL BREAKTHROUGH
• U.S. AUTO MARKET:
  - BIG 3 → BIG 6
  - SEVERE SUPPLY CHAIN RESTRUCTURING
  - TPE SUPPLY BASE SHIFT
  - EUROPEAN/JAPANESE TECHNOLOGY TRANSFER
  - CONSOLIDATED CUSTOMER BASE WITH INCREASED PURCHASE POWER
  - SALES DOWNTURN IN 2007
  - FLEET SHIFT TO SMALLER VEHICLES