GLOBAL DEVELOPMENTS IN TPE’s & THEIR POTENTIAL IMPACT ON CHINA

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Robert Eller Associates is a 15 year-old global plastics consulting company helping companies analyze technical, marketing and economic implications for their business to facilitate management in strategic decision making

- Offices in Akron, Ohio (home office), Paris, Shanghai, New Zealand
- Asia: Active in China, India, Middle East
- 5 Key Focus areas: TPE’s, ETP’s, Automotive, Compounding and Foams
- Multi-client studies:
  - China TPE Market: 2006
  - North America/Europe TPE: 2006
- Single client studies
- Mergers and acquisitions:
  - Complete management service for small acquisitions
  - Due diligence
  - Technical Advisors
GLOBAL ECONOMIC GROWTH: 2 YEAR TROUGH

ANN. % CHANGE (AT PPP)

SOURCE: IMF

b/mydox/rapra 2008/rapra 2008.xls
Price per barrel of crude oil, Nymex-traded futures contract

Record close: $145.29 on July 3

10/10/09
Down 50% from high; further declines likely

Source: Thomson Reuters
DOLLAR VALUE DECLINE

TRADE-WEIGHTED VALUE OF U.S. DOLLAR

March 1973 = 100

SOURCE: FEDERAL RESERVE BOARD
r/mydox/papers/RAPRA TPE.08-Global Ind Vol.xls
EUROPE/U.S. WAGE IMPACTS DIFFER

**Wage Gap**

Wage increases have largely kept pace with inflation in the euro zone, but not in the U.S. Change from a year earlier in consumer prices and wages:

- **Euro zone**
  - Inflation
  - Wages and salaries

- **U.S.**
  - 6%

Note: Wage-growth figures are based on seasonally adjusted labor cost indexes

Sources: Eurostat; European Central Bank; U.S. Labor Department
MACROECONOMIC IMPACTS ON GLOBAL TPE MARKETS

• Shift of a substantial portion of non-automotive manufacturing base served by TPEs to Asia (especially China and India)

• U.S. GDP slowdown spread to other global regions starting in mid-2008, accelerating in 4Q/08

• Impact of high (recently declining) raw material costs on profitability of TPE supply chain

• Dollar deflation effects

• Petrodollar exports

• TPE supply chain structure shifts

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
MACROECONOMIC IMPACTS ON GLOBAL TPE MARKETS (Cont'd.)

- GLOBAL CREDIT LOCKDOWN EFFECTS
  - Erosion of consumer purchasing power
  - TPE demand decline: auto
    construction
    infrastructure

- INFLATIONARY PRESSURES

- WAGE TRENDS
  - U.S.: weak trade unions (7.5% of non-government workers) compared to Europe
  - U.S.: wage deflation/purchase power erosion
  - Europe: potential wage-price spiral?

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
GLOBAL TPE INVESTMENT FLOWS: 
ENLARGING THE FOOTPRINT

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

NOTES:
(a) INDIA IS STARTING 
(b) RECENT START OF JAPANESE
TPE INVESTMENT IN CHINA

STRONG FLOW OF CAPITAL INVESTMENT & TECHNOLOGY

WEAK FLOW OF CAPITAL INVESTMENT & TECHNOLOGY

FLOW OF TPE COMPOUNDS
### SHIFT TO SMALLER, GLOBAL VEHICLES WILL AFFECT AUTO TPEs

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>EFFECT ON AUTO TPO/PP COMPOUND DEMAND OR PROFITABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INCREASE</td>
</tr>
<tr>
<td>Avg. part weight</td>
<td>Lower part wt. decreases TPO demand</td>
</tr>
<tr>
<td>OEM profit/vehicle</td>
<td>Lower OEM profit increases incentive to use TPOs</td>
</tr>
<tr>
<td>PP/TPO penetration</td>
<td>Higher</td>
</tr>
<tr>
<td>r-TPO(b) vs. c-TPO</td>
<td>Incr. OEM pressure to use r-TPO to reduce costs</td>
</tr>
<tr>
<td>Parts integration</td>
<td>Incr. systems designs incr. profit pot'l.</td>
</tr>
<tr>
<td>Rubber substitution</td>
<td>Higher (increases o-TPV use)(a)</td>
</tr>
<tr>
<td>Higher quality req'mts.</td>
<td>Increase demand</td>
</tr>
<tr>
<td>Increased global platforms</td>
<td>Global sales potential</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology proliferation</td>
<td>Better mat'l's./fab. tech. via design imports leads to incr. profit pot'l.</td>
</tr>
</tbody>
</table>

**Notes:**
(a) Incr. o-TPV substitution for TSRs saves wt. & fabrication and systems costs  
(b) Reactor TPOs have yet to satisfy their full potential.

**SOURCE:** ROBERT ELLER ASSOCIATES LLC, 2008
<table>
<thead>
<tr>
<th>VEHICLE</th>
<th>PP (kg)</th>
<th>PP/PLASTICS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citroen C4</td>
<td>90</td>
<td>56</td>
</tr>
<tr>
<td>Toyota Aygo</td>
<td>47</td>
<td>52</td>
</tr>
<tr>
<td>Toyota Auris</td>
<td>71</td>
<td>51</td>
</tr>
<tr>
<td>Toyota Yaris</td>
<td>64</td>
<td>47</td>
</tr>
<tr>
<td>Opel Corsa</td>
<td>65</td>
<td>44</td>
</tr>
<tr>
<td>Ford Mondeo</td>
<td>72</td>
<td>41</td>
</tr>
<tr>
<td>Fiat 500</td>
<td>60</td>
<td>49</td>
</tr>
<tr>
<td>Mercedes C-Class</td>
<td>72</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: Mavel
• RAW MATERIAL PRICES
  – Rapid 2008 price spike in all auto raw material prices ($600-900/vehicle)
  – TPE raw material cost increases:
    • resin production shift to Middle East ("asset light" strategy)
    • decreased resin supplier, Tier 1, Tier 2 profitability
    • legal disputes between OEMs and Tier 1s unable to meet contractual terms developed under a previous raw material cost scenario
TPE DYNAMICS AND SUPPLY CHAIN RESPONSES (Cont'd.)

• TPE SUPPLY CHAIN RESTRUCTURING DRIVEN BY MFG. INEFFICIENCIES AND MACROECONOMIC PRESSURES WILL:
  – Change path to market for TPEs, TPOs
  – Stimulate TPE substitution (TPOs gain share)
  – Encourage new resin/compound technologies
  – Encourage new fabrication technologies, especially those favoring system cost savings

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
TPE INDUSTRY STRUCTURE SHIFTS

• SHIFT TO ASIAN PRODUCTION (SBCs, PP COMPOUNDS, o-TPVs?)

• MAJOR PP RESIN COMPANIES EXPAND
  – Global PP compound and TPO footprint - Borealis, LyondellBasell, ExxonMobil, SABIC?
  – PP compound/TPO/o-TPV prod. line synergies
  – Japanese PP suppliers expand TPE product range and global footprint (JPP, Sumitomo, Mitsui, JSR)
  – Middle East presence
  – Asset Light: K-Dow (loss of synergy with elastomers?)

• SUPPLY CHAIN CONSOLIDATION CONTINUES
  – DSM spinoff to ?
  – PolyOne/GLS
  – LyondellBasell/SEP
  – Kraton the big “non-event”: no new plant in Asia, no new owner

• PRODUCT LINE CONSOLIDATION/DISCONTINUATION

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
<table>
<thead>
<tr>
<th>TPE Type</th>
<th>2007 “Was”</th>
<th>2008 “Became”</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>o-TPV</td>
<td>SK</td>
<td>Hyundai EP</td>
<td>•Minor, primarily with Korean car manufacturers</td>
</tr>
<tr>
<td>o-TPV TPO</td>
<td>Solvay Engineered Plastics</td>
<td>Lyondell Basell</td>
<td>•Business being managed out of the US/already discontinued 1000 Series •Minor China player who could play a bigger role?</td>
</tr>
<tr>
<td>o-TPV</td>
<td>DSM</td>
<td>Soon to be announced</td>
<td>•Asian buyer? •Emphasis shift?</td>
</tr>
<tr>
<td>SBC</td>
<td>Taiwan PP</td>
<td>LCY</td>
<td>•SBS Plant started in Huizhou •SEBS Technology in Taiwan •SBC Compounds</td>
</tr>
<tr>
<td>SBC’s</td>
<td>Multibase CTS Kraiburg</td>
<td>•Increasing China activity pursuing their western customer base •Intermaterial competition in air bag doors increases</td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
CHINA IMPACTS

• THE “CHINA PRICE”
  – Manufacturing in China remains advantageous but has been weakened by:
    • strengthening of the renminbi (6.5% in 2008)
    • increased labor costs (65-80% in 4 years)
    • higher shipping costs for exports
    • slower ship speeds (conserv e fuel, add 20% to shipping time)
    • China growth slowing (to 9% from 11-12%/yr)
      – Sustained by exports to emerging economies
      – Turn toward domestic demand
      – Not decoupled from global economic conditions

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
GLOBAL RECESSION: TPE EFFECTS IN CHINA

Shift to:
- Domestic TPE end-use markets
- Quality/tiering shift (global → glocal, local)
- Domestic TPE compounders gain share vs. transplant global compounders

NOTE: (a) Europe/US export decline offset by increased exports to emerging economies

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
AUTOPLASTIC SUPPLY CHAIN RESTRUCTURE PRESSURES

PETROCHEM PRICE INCREASES

GLOBAL COMPETITION

OFFSHORE COMPETITION

IMPORTED COMPETITORS/SUPPLIER REDUCTION

STEEP RAW MATERIAL PRICE INCREASES

VEHICLE PRICE DECREASES/PRODUCTION DECLINE

FUEL COSTS INCREASES

Rapid Fleet Mix Shift (U.S.)

LEGACY COSTS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

NOTE: (a) STARTING (VIA MASTERBATCH [FOR TPOs] AND GLASS ROVING [GF-PP COMPOUNDS])

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

r/mydox/papers/RAPRA TPE 08-Implosion0808.vsd // lg/myfiles/Vsio/RAPRA TPE 08-Implosion0808.vsd
EXAMPLES OF TPE AND PP TECHNOLOGY RESPONSES TO MARKETPLACE PARADIGM SHIFTS

• 2-shot molding
• In-line and at-press compounding of TPOs
• Increased use of reactor TPOs
• Interior semi-structural substitutions (e.g., elimination of the instrument panel crosscar beam)
• Wall thickness down-gauging
• Body seal systems substitution using o-TPV accelerates
• Growth of injection molded foams
• Multifunctional masterbatches
• Single compound for multiple interior and exterior components
• Increased use of micro-talc in TPO and PP formulations
• Increased use of molded-in color
• Elimination of coating on molded parts

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
TECHNOLOGY RESPONSES

• 2-SHOT MOLDING
  – Multi-shot molding for small parts is well established to produce a:
    • 3-layer vertical multilayer (e.g., skin/foam/substrate)
    • 2-layer vertical multilayer (e.g., skin/substrate)
    • Side-by-side hard/soft combination (e.g., fan shrouds and cowl vent seals)
  – Current methods for making instrument panels and door trim panels are inefficient:
    • Multiple step process
    • Multi-materials vs. a compatible chemistry structure
    • Difficulty of recycling
    • High scrap rate
    • High labor content
    • Use of coatings

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
• IN-LINE COMPOUNDING FOR HIGH VOLUME PART PRODUCTION
  – Initially started with long-glass fiber reinforced thermoplastics directly at the press
    • 2-stage machine combination
      – Stage 1 for incorporating glass (compounding extruder)
      – Stage 2 for injection molding
  – Shift to in-line TPO compounding (via masterbatch; Dow, ExxonMobil, LyondellBasell)

• INCREASED USE OF REACTOR TPOs
  – Resin polymerization technology to tailor molecular architecture and provide TPO directly from the reactor
  – Reactor TPOs + molded-in color = cost savings
GROWTH OF INJECTION MOLDED FOAMS

The technology for injection molding of TPE foams has advanced slowly but is likely to be stimulated by the:

- Drive for weight savings
- Cost savings associated with process step reduction via 2-shot or other processes
- Development of more sophisticated multifunctional masterbatches
- Improved control of the pressure cycle during injection
• **BODY SEAL/GLAZING SYSTEMS SUBSTITUTION**
  – Manufacturing cost, weight, and energy savings
  – Recycling benefits
  – o-TPV, SEBS substitute for EPDM
  – Ability to co-extrude with rigid PP compounds

• **INCREASED USE OF MICRO-TALC IN TPO AND PP FORMULATIONS**
  – Improved stiffness/impact balance at a lower talc concentration
  – Improved surface quality → exterior panels

• **TRANSPARENCY**
  – Transparent TPEs have recently emerged and are finding applications in a broad range of automotive and non-automotive markets
• “GREEN” PRESSURES
  – Pressures for a reduced carbon footprint have shifted somewhat from materials selection to fuel economy
  – European materials and process selection have generally been more responsive to legislated environmental requirements (ELV)
  – Bio-based TPEs (especially TPUs)
SUMMARY

TPE GROWTH, PROFITABILITY, & REGIONAL POSITION ARE BEING AFFECTED BY:

– The global economic downturn, which has emphasized the globality and interconnected nature of the TPE marketplace
– End markets shift to Asia-Pacific
– Slowing of the China growth engine
– Sharp global automotive downturn
– E. Asian rapid growth/price commoditization of SBCs
– Possible SEBS resin overcapacity risk in Asia
– A shift in the economics of production in and export from China

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
THESE CONDITIONS ARE STIMULATING:
- TPE investment flow into Asia and other low manufacturing cost regions
- “Asset light” strategies stimulating investment in Middle East resin production
- Accelerated shift to lower quality tiers in China
- Systems cost reduction via TPEs
- More direct paths to market from TPE compound to fabricated product
- Further property enhancement to facilitate penetration of rubber markets
- Competition between SBC-type TPEs & o-TPEs
- Improvements in light-weighting techniques (foaming, metal substitution)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
Thank You!

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