Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

POLYCARBONATE IN ASIA: IMPACT OF GLOBAL DEVELOPMENTS ON MARKETS AND APPLICATIONS

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Centre for Management Technology
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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
- Key Focus areas: TPE’s, ETP’s, Polyolefins, 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
TODAY’S DISCUSSION

• Competing in the Asia PC Market
• A brief look at the major market segments and how they will fare in 2009
• The impact of the automotive downturn on the PC business
• BPA: what is the impact
## POLYCARBONATE RESIN MANUFACTURERS

<table>
<thead>
<tr>
<th>PC Manufacturer</th>
<th>Plant Locations</th>
<th>Capacity KT/yr</th>
<th>Tradename/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabic Innovative Plastics</td>
<td>Spain</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Netherlands</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>520</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Saudi Arabia</strong></td>
<td>260</td>
<td>Saudi Kayan (2009), Licensed Asahi Technology</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Bayer</td>
<td><strong>China</strong></td>
<td>200</td>
<td>Makrolon</td>
</tr>
<tr>
<td></td>
<td><strong>Thailand</strong></td>
<td>220</td>
<td>China plant not yet at capacity (2008)</td>
</tr>
<tr>
<td></td>
<td><strong>Belgium</strong></td>
<td>240</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Germany</strong></td>
<td>330</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>US</strong></td>
<td>260</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Teijin</td>
<td>Japan</td>
<td>120</td>
<td>Panlite/Multilon</td>
</tr>
<tr>
<td></td>
<td><strong>Singapore</strong></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>China</strong></td>
<td>160</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>480</td>
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Source: ROBERT ELLER ASSOCIATES LLC, 2008
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<thead>
<tr>
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<th>Plant Locations</th>
<th>Capacity KT/yr</th>
<th>Tradename/Notes</th>
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<tr>
<td>Dow</td>
<td>Texas</td>
<td>84</td>
<td>Calibre</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>55</td>
<td>JV with Sumitomo</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>150</td>
<td>JV with LG</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>423</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>Japan</td>
<td>110</td>
<td>Mitsubishi Chemical - Iupilon</td>
</tr>
<tr>
<td>Engineering</td>
<td>Japan</td>
<td>40</td>
<td>Mitsubishi Gas Chemical-Novarex</td>
</tr>
<tr>
<td>Plastics</td>
<td>Thailand</td>
<td>160</td>
<td>JV Iupilon/Novarex</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>110</td>
<td>JV Samyang Advanced Material-Trirex</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>80</td>
<td>JC MGC/Sinopec (2009)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>420</td>
<td></td>
</tr>
<tr>
<td>Asahi Kasei</td>
<td>Taiwan</td>
<td>150</td>
<td>JV with Chi Mei- Wonderlite</td>
</tr>
<tr>
<td></td>
<td>Russia</td>
<td>65</td>
<td>Licensed OAO Kazanorgsintez</td>
</tr>
<tr>
<td></td>
<td>Iran</td>
<td>25</td>
<td>Licensed NPC (KZPC)</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>65</td>
<td>Licensed Honam Petrochemical</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>65</td>
<td>Licensed Cheil Industries (Samsung)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>305</td>
<td>Saudi Kayan Plant included in Sabic IP</td>
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SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
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<tr>
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<th>Plant Locations</th>
<th>Capacity Kt/yr</th>
<th>Tradename/Notes</th>
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</thead>
<tbody>
<tr>
<td>Idemitsu</td>
<td>Japan</td>
<td>47</td>
<td>Tarflon</td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td>15</td>
<td>JV with PC Brazil</td>
</tr>
<tr>
<td><strong>Taiwan</strong></td>
<td></td>
<td>175</td>
<td>JV with Formosa</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>237</strong></td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
GLOBAL CAPACITY FOR AND CONSUMPTION OF POLYCARBONATE RESINS (2009)

<table>
<thead>
<tr>
<th>PC Manufacturer</th>
<th>Strategy</th>
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<tbody>
<tr>
<td>Bayer</td>
<td>• Strong manufacturing capabilities/compounding in an integrated complex</td>
</tr>
</tbody>
</table>
| Sabic IP        | • Compounding regionally positioned in East/South China  
|                 | • Saudi Kayan plant to provide lower cost resin compared to Taragona, Spain  
|                 | • Chinese Production? |
| MEP             | • JV with MGC/Sinopec  
|                 | • Korea/Singapore/Japan Position (All Asia manufacturing) |
| Dow             | • K-Dow collapse, who’s next?  
|                 | • Supply from Korea to Asia (other than Japan)  
|                 | • Dow Automotive presence low in China  
|                 | • Strong in blends |
| Teijin          | • Strong in CD’s  
|                 | • First Chinese plant |
| Asahi Kasei     | • Licensing |
| Honan           | • Focus on optical media and film/sheet markets |

**SOURCE:** ROBERT ELLER ASSOCIATES LLC, 2008
DEVELOPING A LOW COST MANUFACTURING FOOTPRINT

• ABS Model
  – Major Markets
    • Electronics, consumer electronics, appliances, automotive
  – Entrance of low cost Asian producers
  – Product Market Shift to Asia
  – Lack of Western companies developing local manufacturing in the late 1980’s-1990’s has led to the decline/impact of the western companies
    • Forced structural realignment of industry
      – Borg Warner->GE->Sabic
      – Monsanto->Bayer->Lanxess->Ineos
      – Bayer->Lanxess->Ineos
      – Dow-> closed NA other than auto, will rationalize Europe and NA plant through sale or JV

• Need for low cost manufacturing footprint to survive

ABS Industry Leaders

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>Chi Mei</td>
</tr>
<tr>
<td>Bayer</td>
<td>LG</td>
</tr>
<tr>
<td>Monsanto</td>
<td>Samsung</td>
</tr>
<tr>
<td>BASF</td>
<td>BASF</td>
</tr>
<tr>
<td>Dow</td>
<td>Cheil</td>
</tr>
<tr>
<td></td>
<td>Sinopec</td>
</tr>
<tr>
<td></td>
<td>Ineos</td>
</tr>
<tr>
<td></td>
<td>Ineos</td>
</tr>
<tr>
<td></td>
<td>Toray</td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
THE ABS MODEL: HOW DOES PC COMPARE?

- Similar Markets to ABS:
  - Automotive, Electronics, Recreation, Housings, Power Tools
- Market Shift to Asia in primary markets (all but medical)
- Shift to Asian manufacturers:
  - GE-> Sabic IP/Saudi Kayan
  - Dow-> K Dow successor Asian?
  - Mitsubishi -> Only produce in Asia
  - Teijin -> Only produce in Asia
  - Idemitsu -> Asia only other than small
    - Brazilian operation
    - Asahi Kasei -> Only produce/license in Asia
- Entrance of low cost Korean (Samyang, Cheil, Honan), Taiwanese (Chimei, Formosa) via partnering and licensing and Chinese (Bayer, Mitsubishi and Teijin) producers
- Will PC continue to structurally reorganize? Will Bayer remain the only non-Asian factor in PC like BASF is in ABS?
  - Bayer Shanghai plant does not follow the ABS model
  - When/where/if Sabic IP build a China resin plant?
- Focusing plants onto narrow applications: Honan, Teijin, Idemistsu (Formosa)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
THE EMPOWERED MIDDLE CLASS: TARGETING THE DOMESTIC MARKETS

• The number of urban households with income greater than 40000 RMB/year will triple in the next ten years and by 2025 will represent over 70% of the forecast 400 MM urban households
• This buying boom is just taking off
• Has become the significant driving element of Chinese economy
• Shanghai/Beijing center of this Chinese buying spree, other urban centers are also growing but not as quickly.
• Buying cars, mp3 players, video games, computers, telephones
• Foreign brands popular and extract premiums over domestic products
• Happening all through Asia, not just China
• Intense PC applications

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
DURABLE GOODS OWNED PER 100 URBAN HOUSEHOLDS IN CHINA

SOURCE: CHINA NATIONAL BUREAU OF STATISTICS
ROBERT ELLER ASSOCIATES
### GLOBAL PC MAJOR MARKET SEGMENTS

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Share of PC Market</th>
<th>2009 Growth Rate (%/yr)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/Electronics</td>
<td>27</td>
<td>1</td>
<td>Global recession</td>
</tr>
</tbody>
</table>
| Building & Const.     | 17                 | 2                       | Driven by PC sheet in glazing and demand in Asia
Home construction will be down
Economic stimulus packages help                                |
| Optical Data Storage  | 15                 | 0                       | Demand peaking
Teijin major supplier, lowest price segment                                               |
| Blends/compounds      | 13                 | -5                      | Automotive has a major impact                                                            |
| Automotive            | 12                 | -13                     | Impact of automotive production
Glazing still not a major contributor yet                                                   |
| Medical               | 8                  | 3                       | Aging demographics/BPA issues?
Global recession even impacts medical                                                        |
| Water bottles         | 3                  | -25                     | BPA issues?                                                                              |
| Other                 | 3                  | 3                       |                                                                                           |
| Films                 | 1                  | 8                       | New growing applications                                                                  |

**SOURCE:** ROBERT ELLER ASSOCIATES LLC, 2008
PC IN AUTOMOTIVE: APPLICATIONS

- Major Applications
  - Interiors:
    - Trim and instrument panels
      - Mature market
      - PP substitution/Small Vehicle trend (particularly in Asia)
  - Exterior
    - Headlights
      - Still growing
      - Aerodynamic, styling freedom
    - Glazing
      - Still developing/growth opportunity
- Blends:
  - PC/ABS:
    - interior trim, instrument panels, wheel covers, mirror housings
      - Mature business threatened with continued competition from lower cost PP compounds
  - PC/PBT:
    - body panels, bumper systems
      - Potential opportunity for weight savings
      - Will the drive to save weight open the door finally for wide use of plastic body panels
GLOBAL VEHICLE PRODUCTION DECLINE?

GLOBAL VEHICLE SALES OUTLOOK

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

FIRST EVER DECLINE? (2008/9)

2000: 57
2007: 71
2012: 80?
2012: 85?

VEHICLE SALES, MM UNITS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
r/mydox/papers/RAPRA TPE 08-Global Ind Vol.xls

VEHICLE SALES, MM UNITS

ASIA VEHICLE PRODUCTION: SLOWED BUT GROWING

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
AUTO: PRODUCTION/SALES BY REGION

VEHICLE PRODUCTION AND SALES

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
aerodynamic styling ......and lightweight
......and lowers the center of gravity

Photo courtesy Exatec
and allows for parts/system integration…….

Photo courtesy Exatec
Renault Megane R26

Rear and side windows

SOURCE: PLASTICS NEWS, 2008
Smart Minicar Panoramic Roof

SOURCE: BAYER MATERIAL SCIENCE, 2008
X-Bow from KTM

Wind Deflector

SOURCE: BAYER MATERIAL SCIENCE, 2009
AUTO GLAZING STATUS

• Getting lots of attention from the car companies, particularly with the pressure for higher mileage vehicles
• Still not a high sense of confidence from vehicle engineers
  – Concept Cars, but the production vehicles are traditional glass
  – Sunroofs
  – Proof of concept is slow because of the time aging factor
• Webasto (Germany) has doubled its production capacity with the purchase of an additional Kraus Maffei 2-shot molding machine and Eisenmann coating line
• Smart Minicar panoramic roof
• Renault Megane R26 Sports Vehicle rear and side windows
• Honda Civic European version lower portion rear window
• Chevrolet Corvette panoramic roof
• Two companies driving the concept
  – instead of the JV Exatec, Bayer (BayVision) and Sabic Innovative (Exatec) have separate efforts
  – Will this be more effective?
• Real potential is >8 years away
  – Patient dollars for a long term payout?
BPA IMPACT

• Last year we said the battle was lost and 2008 confirmed the loss: how far will it spread?
• Emotive vs technical logic
• Issue US/Canada driven
• Vulnerable Applications
  – Baby bottles
  – “Sport” Reusable Water bottles
  – Large 20+ liter water bottles
  – Medical Market
    • applications where heat is involved, not total market
    • Less impact on older people
• Alternative solutions:
  – Eastman’s Triton Copolyester
  – Transparent/Clarified PP
  – Acrylic, SAN and other clear amorphous material have either impact or heat distortion limitations

<table>
<thead>
<tr>
<th>MARKET</th>
<th>STATUS</th>
<th>GLOBAL VULNERABLE VOLUME (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby Bottles</td>
<td>Lost</td>
<td>10</td>
</tr>
<tr>
<td>Sport Reusable Bottles</td>
<td>Losing</td>
<td>20</td>
</tr>
<tr>
<td>Large Water Bottles</td>
<td>Competing</td>
<td>60</td>
</tr>
<tr>
<td>Medical Market</td>
<td>Questions being asked</td>
<td>150</td>
</tr>
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</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
POLYCARBONATE: A 2009 SUMMARY

• 2009 will be a tough year for Polycarbonate
  – Automotive off in North America, globally slow
  – Global economy impacting appliances, electronics, building and construction (houses), optical disks
  – Medical and Water Container market under attack from BPA migration

• Strengthening of Asia: slower growth

• Unanswered questions:
  – Dow ???
  – Sabic IP resin plant in China?
  – How far will BPA issue into medical market?
Thank You!

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