Robert Eller Associates LLC

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

THE TPE INDUSTRY: GLOBALIZATION, STRUCTURAL CHANGES AND CHALLENGES

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SMITHERS RAPRA TPE 2012
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Bob/papers/tpe berlin 2012

OUTLINE

- TPE life cycle: maturity and commoditization

- Globalization effects/regional market differences

- Role of Asia in global TPE markets

- TPE industry structure shifts

- Growth opportunities:
  - Key forces driving/limiting TPE growth
  - The next TPE growth phase: drivers and barriers
  - Example growth markets: health care, automotive
  - Expanding the performance envelope: s-TPVs, property range

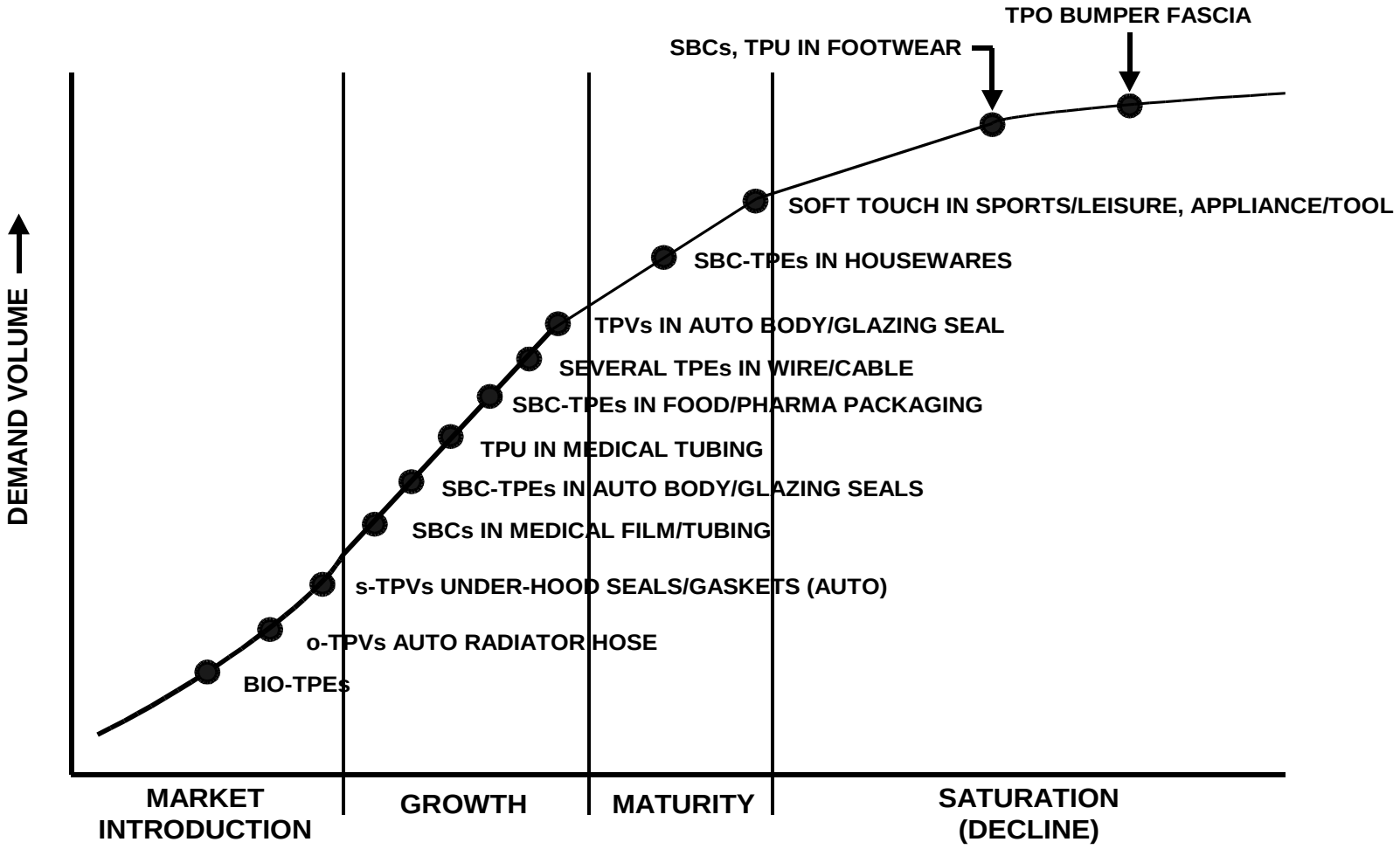
- TPE challenges and value-add strategies

MARKET MATURITY: SOME TPEs EVOLVING TOWARD COMMODITIES

CHARACTERISTIC	COMMODITY	SPECIALTY
Number of grades	- Many standard grades - Compete for same business	- Few grades - Highly targeted
Major TPE suppliers	Continue supply or exit	Enter compounding
Competitive basis	Price. Trend toward global price	Performance (tailored)
Property differentiation	None → minor	Highly differentiated
Sales/marketing approach	- Pursue existing markets - Take orders/Use distributors	"Shape" new markets
Tech support, Applications dev.	Minimal	Substantial
Brand recognition	- Incumbent TPE suppliers (have it) - New entrants without it (e.g. Sinopec, TSRC)	No: must be built
TPE examples	- Standard SEBSs, SBS, TPO - Some o-TPVs, TPUs - Some COPEs	- New SEBS grades - s-TPVs, Bio-TPEs - Health care grades - New acrylic grades

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

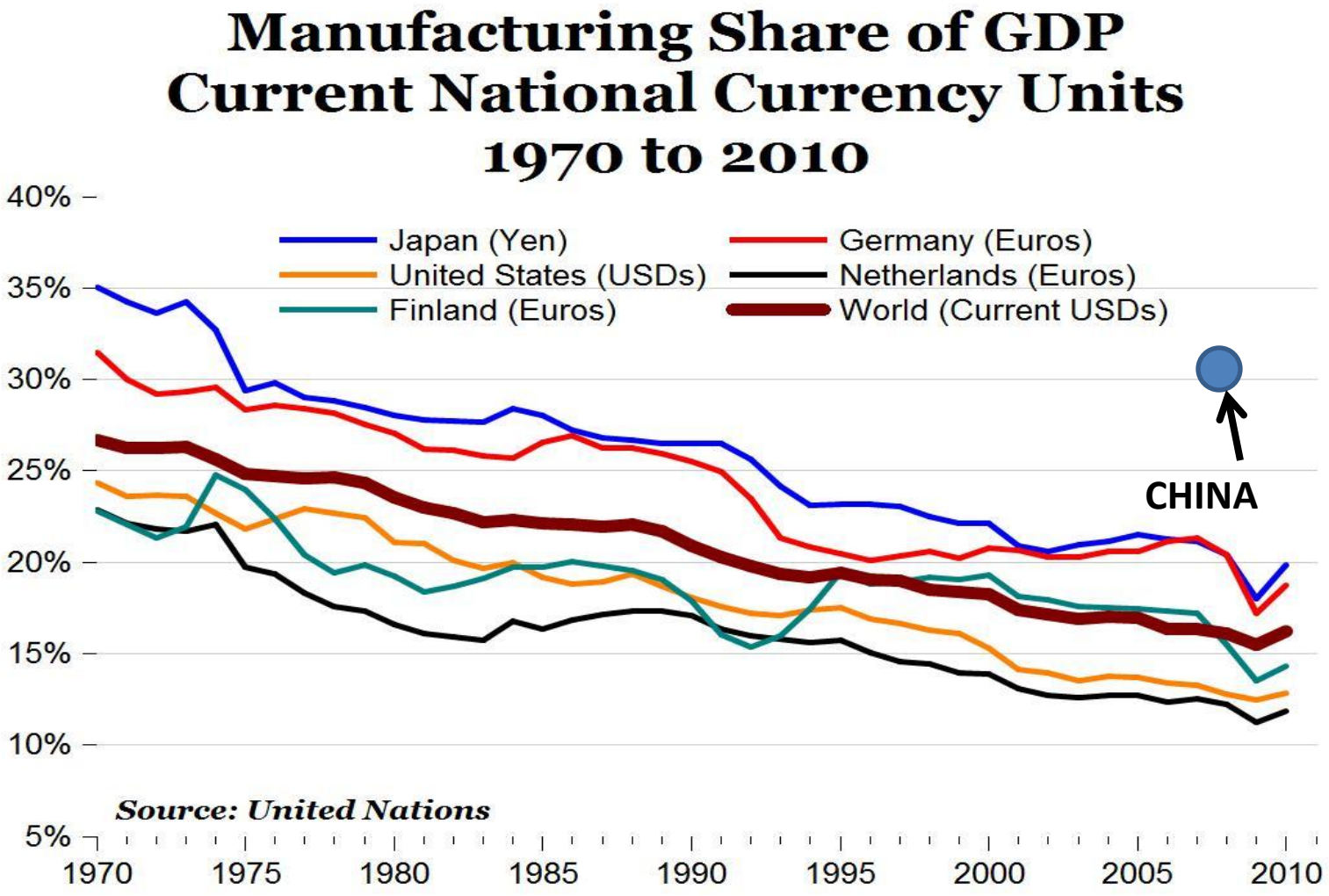
EXAMPLE PRODUCT LIFE CYCLE POSITION OF TPEs



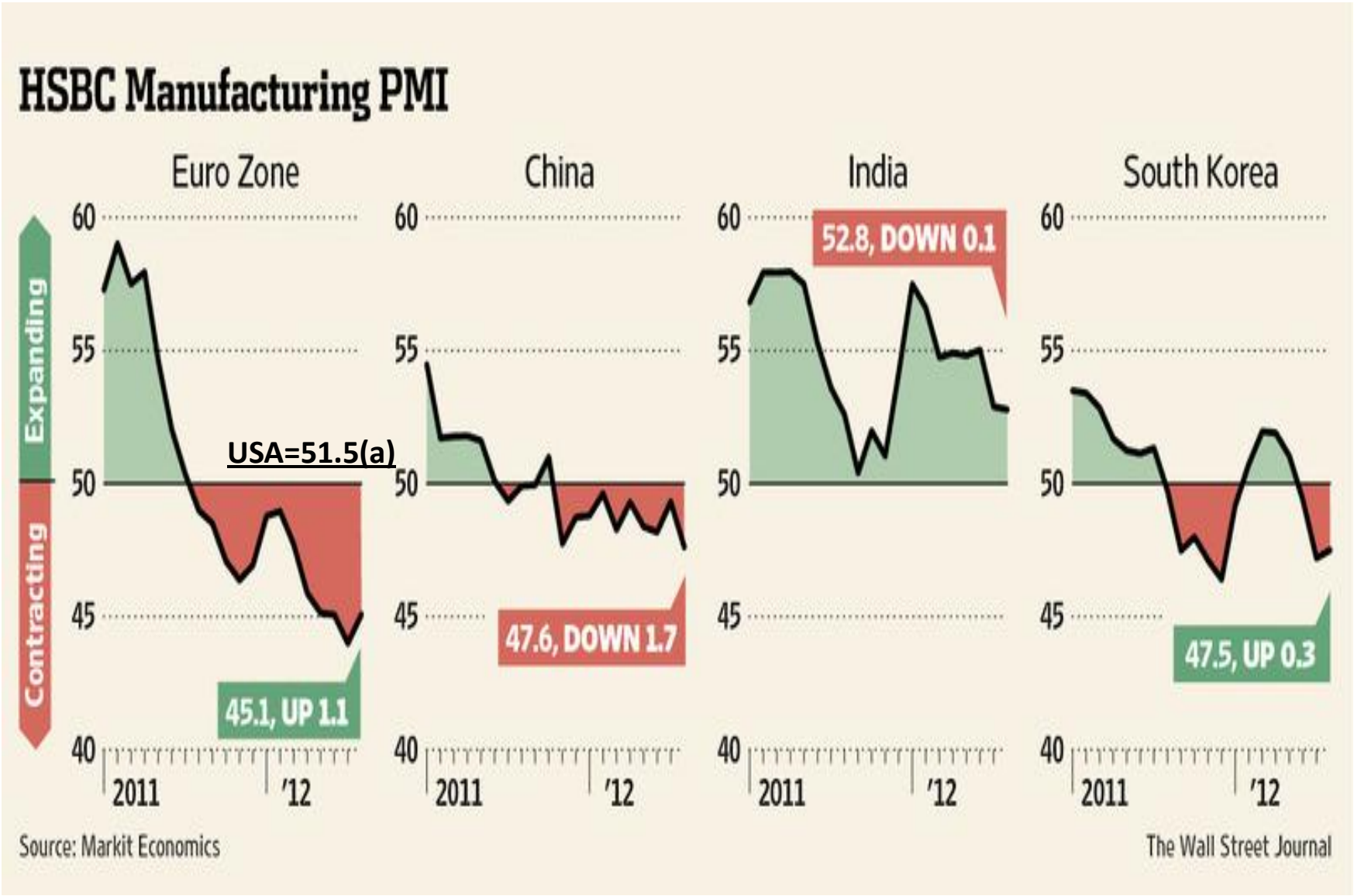
SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/Visio/Prod Life CycleTPEs 081512.vsd

MANUFACTURING DECLINE: SHIFTS TPE REGIONAL DEMAND



GLOBAL MANUFACTURING : EUROPE DECLINE IN 2011 -2012



(a) USA down from PMI = 55 in Jan 2012

THE ASIA SHIFT

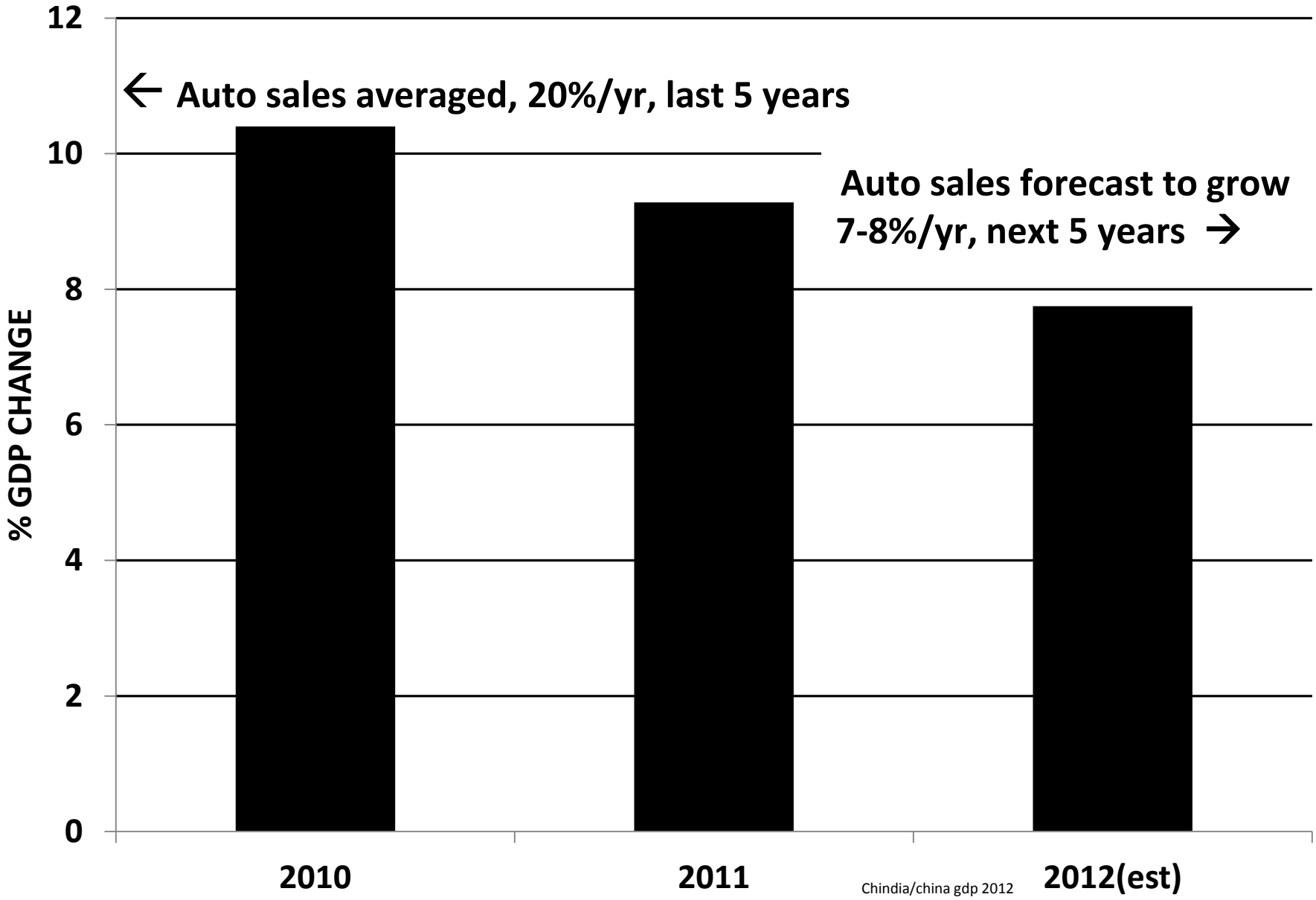
- **TPE demand effects:**
  - **Decreases TPE demand in Europe/N. America**
  - **Especially for consumer product-related TPEs**

- **Supply chain effects as Asia infrastructure matures:**
  - **Western companies dependent on Asian supply chain**
  - **Western investment (resin production, compounding) in Asia**
  - **R/D shift to Asia region**
  - **Asia plant scale →competitive**

- **Investment flow coming out of Asia. Some into TPE sector (e.g. TSRC)**

- **"Re-shoring" starting in U.S. (still a minor driver-shale gas effect)**

CHINA GDP SLOWING → SLOWS TPE GROWTH (AUTO REMAINS GROWTH DRIVER)



Chindia/china gdp 2012

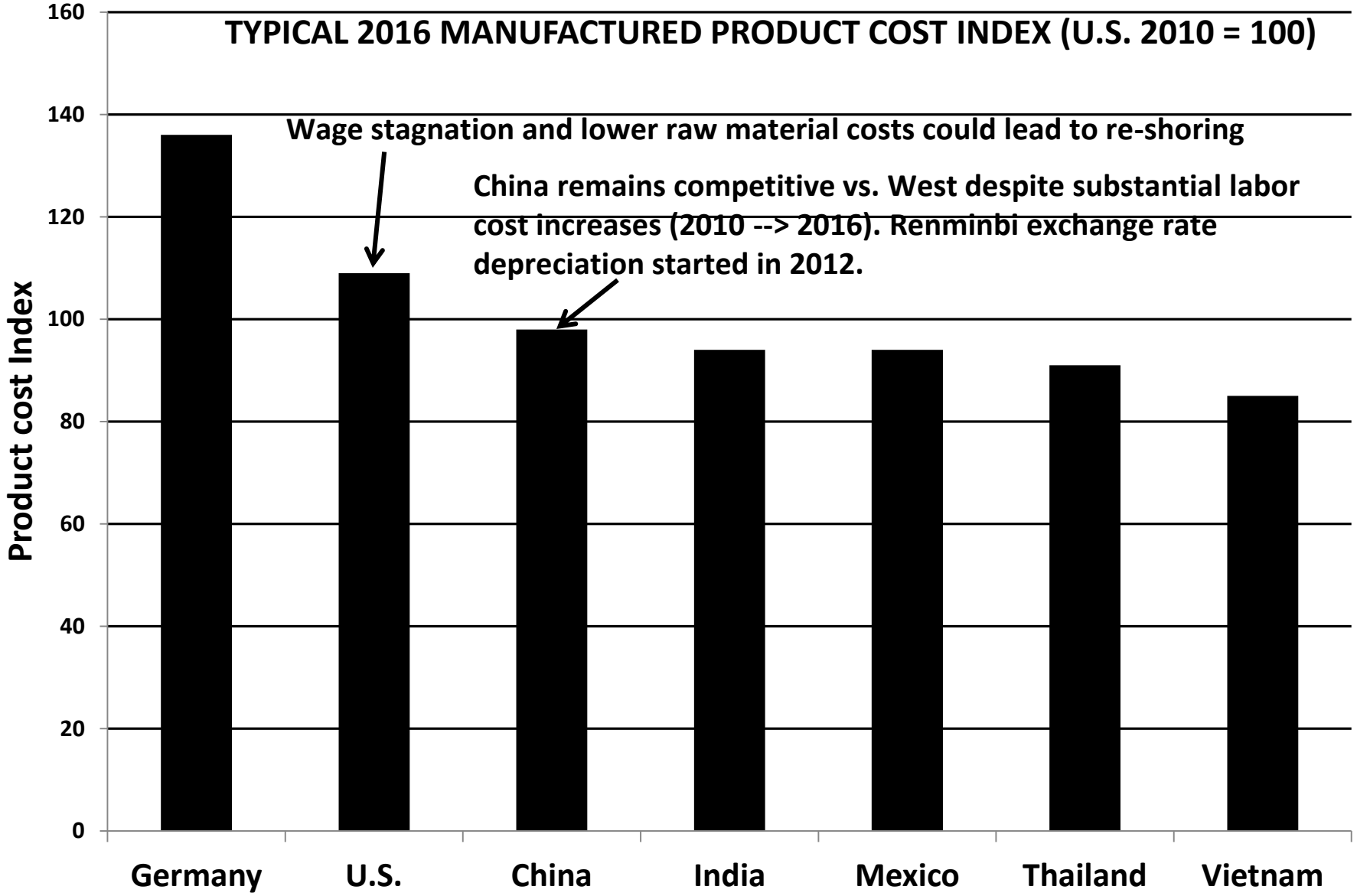
THE ASIA SHIFT AFFECTS WESTERN TPE MARKETS DIFFERENTLY

TPE SECTOR	HIGH ASIA GROWTH INDEPENDENT OF WESTERN CONDITIONS	ASIA GROWTH DECREASES WESTERN TPE MARKETS	ASIA GROWTH NO EFFECT ON WESTERN TPE	NOTE
Auto	X			High Asia TPE growth market
Footwear		X (a)		Shifted long ago
Bldg/Const.			X	A classical stay at home market
Consumer		X (a)		Shifted long ago
Wire/Cable		X		
Food/Pharma			X	Packaging
Health care	X		X	High growth West/Asia TPE market
Appliance/Tool		X (a)		Re-shoring candidate
Personal Care/ Cosmetics			X	
Fluid Handling /Industrial			X	-Rubber hose is a recent o-TPV target - Re-shoring candidate
Sports/Leisure		X (a)		
Coated Fabrics		X		Asia very dominant in textiles
Elec/Electronic		X (a)		Major shifts already occurred

Note: (a) market shift to Asia has already affected Western markets

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

MANUFACTURING COSTS (2016): CHINA REMAINS COMPETITIVE



SOURCE: EIU, WORLD BANK, L.E.K., ROBERT ELLER ASSOCIATES LLC, 2012

RE-SHORING EFFECTS ON TPE REGIONAL DEMAND

- **Starting in U.S.: still very minor, could shift regional TPE structure**

- **European conditions currently less favorable for re-shoring**

- **Manufacturing cost drivers narrowing the landed cost gap:**
  - **shale gas/energy cost and TPE raw materials cost decline potential**
  - **U.S. labor cost stagnant or declining/China wage rate inflation**
  - **market proximity**
  - **rapid response time**
  - **logistics cost save**
  - **currency exchange rate shift favors re-shoring**
  - **automation/product quality control**

- **Speed to market**

- **Anti-dumping laws and duties(U.S. and Europe)**

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

EXAMPLE RE-SHORING BY CURRENT/POTENTIAL TPE CUSTOMERS

- **Sports/leisure:** Buck knives (U.S. - formerly outsourced 30% to Chinese suppliers)
- **Footwear:** Picolino Shoes (Spain), several footwear companies (Italy)
- **Auto:** U.S.: European overcapacity = ~ 30%)
- **Audiovisual mounting products/accessories:** Peerless Industries; Sleek Audio
- **Industrial equipment:** Caterpillar, GE
- **Mobile electronics:** Google(Nexus Q music/video player)
- **Plastics molding:** Intertech Plastics (U.S.)
- Note: 34% of U.S. companies surveyed in M.I.T. study indicated plans to re-shore

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

TPE INDUSTRY STRUCTURE AND DYNAMICS

- **Region:** shifted to global 4-5 years ago, key China role, re-shoring effects
- **Concentration:** bipolar, 10-12 large suppliers, many small compounders
- **Entry barriers:** easy to enter, IP not critical (formulation driven)
- **Entry paths:** multiple: captive resin suppliers, distributors, compounders, back integrated fabricators
- **Target markets:** auto (dominates), broad range of low volume markets
- **Growth dynamics:**
  - EPDM, PVC substitution, automotive systems cost/weight save
  - Strong intra-TPE competition, cascade to lower cost TPEs
  - Broadening property envelope
  - Bio-TPEs entering
  - Applications development shifted to tier 1s, end users
  - Growth: tied to unit volume growth (e.g. auto) and substitution

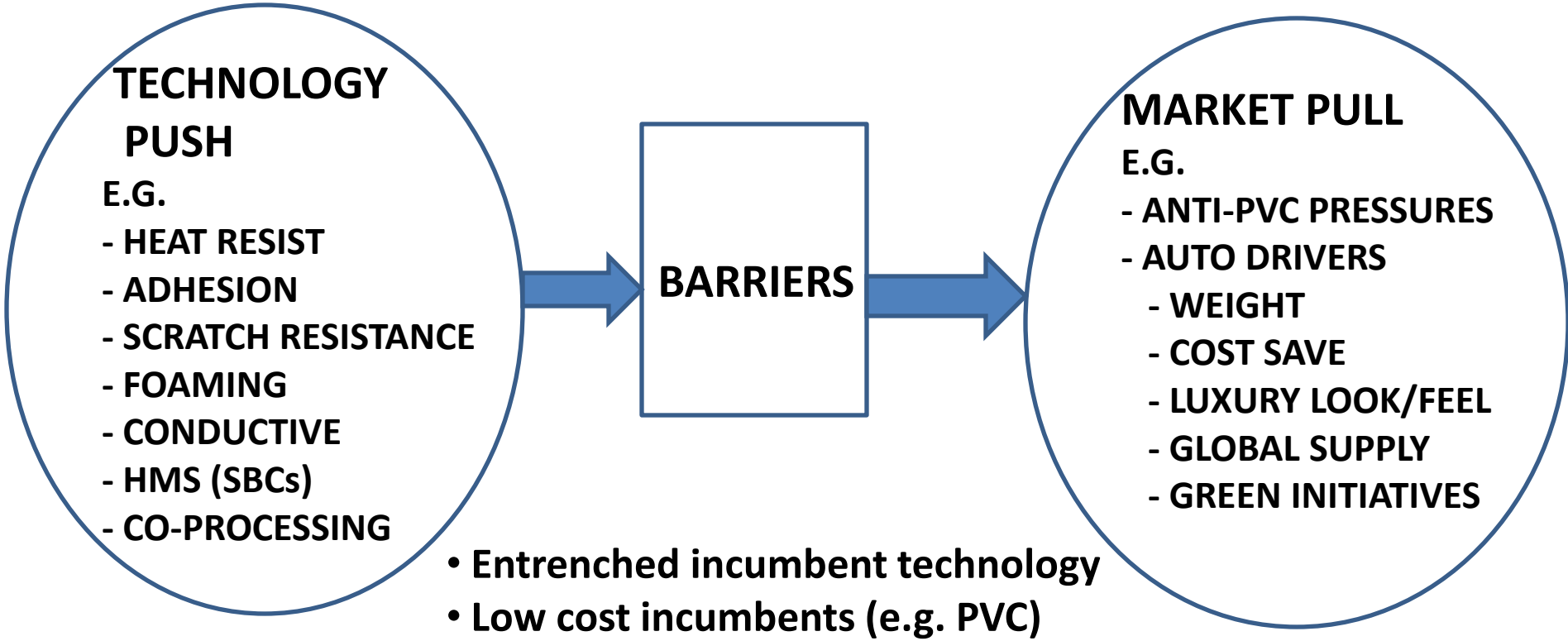
SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

TPE INDUSTRY STRUCTURE SHIFT EXAMPLES

SHIFT TYPE	EXAMPLES
Acquisition by major TPE supplier	Merquinsa acquisition by Lubrizol
Distributor entry into TPEs	-Albis →TPV entry. Ravago acquisitions
Resin supplier → compounding	TSRC, PP resin suppliers , others
Target U.S. markets	TSRC, Ravago, Albis, CTS, Polymax, Hexpol
Investment and imports: Asia to West	- Nantong Polymax (TPE compound supply), LCY - TSRC acquisition of Dexco*
Product line diversification	- Teknor Apex acquisition of DSM's Sarlink®* - Kraiburg : high temp TPV (Hipex®); silky touch
Major TPE supplier emphasizing specialty vs commodity grades	- Kraton entry into higher performance grades - Kuraray entry into di-block/tri-block acrylic TPEs
Shifts to Asian production and market development	Many TPE suppliers , recently: CTS, Hexpol, Dow Corning/Multibase
TPE entry from other sectors	-Hexpol acquisitions: Elasto, Horst Mueller

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

NEXT TPE GROWTH PHASE: TECHNOLOGY PUSH/MARKET PULL



- Entrenched incumbent technology
- Low cost incumbents (e.g. PVC)
- In-house compounding by fabricators (e.g. rubber)
- Shift to commodity strategy by major TPE suppliers

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

NEW PROPERTY/MARKET DIRECTION EXAMPLES

PROPERTY	TPE TYPES	EXAMPLE MARKET SECTORS	NOTE
Wet grip	SBS → SEBS?	- Health care - Tools, sports/leisure	With/without tackifiers
Foam	SBC, TPV COPE	- Auto: steering wheels - Body seals, skins	- 2 shot molding, extrusion - Challenge EPDM, PVC, PU
High flow	TPV, SEBS,	- Auto: glazing seals, - Skins (soft touch) - Pkg., housewares	Auto interior soft touch is high growth application
High flow	TPO	- Auto bumper fascia	Target →<3.2 mm
- Hi temp, - Oil resist	s-TPV	Auto under-hood	Challenges specialty rubbers
- "Sustain " - "Green"	SBC, TPU COPE	- Auto - Consumer	Achieved via: monomer, filler, oils
Transparency/ translucency	TPU, TPVs, SBCs	Med., consumer, pkg., fluid delivery	Translucent TPU with long glass reinforcement
Slush moldable	SEBS	Auto interior skins	
High melt strength (HMS)	SEBS	Auto, Health care	HMS allows foaming, blow molding, film extrusion
Silky touch	SEBSs-TPV	Electronics, auto	Kraiburg, Multibase

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

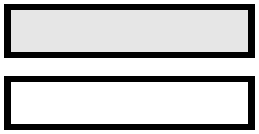
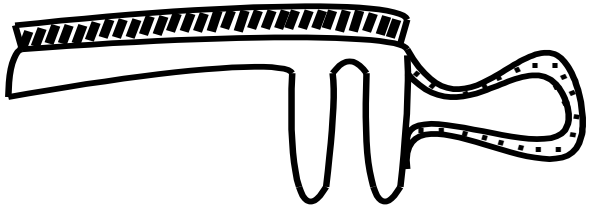
EXTENDING THE SBC PROPERTY RANGE

- **The challenges:**
  - **Steep melt viscosity decline with temperature(+ for high filler applications, high flow applications) limits processing /properties)**
  - **High compression set, especially at elevated temperatures**

- **High melt strength (HMS) grades allow:**
  - **Blow moldability**
  - **Foamability**
  - **Film extrusion/calendaring (for PVC film substitution)**
  - **Profile/tubing extrusion**
  - **Thermoformability**

- **Reduced compression set allows :**
  - **Competition with o-TPV rubber substitution (e.g. body/glazing seals)**
  - **Non-auto sealing applications (e.g. packaging, industrial)**

CO-PROCESSING DRIVES TPE GROWTH IN RIGID/FLEXIBLE SYSTEMS

TYPE	STRUCTURE	NOTE/EXAMPLE APPLICATION
Overmold, Film coex, 2-shot mold	 TPE Substrate (rigid segment)	- Soft touch phones - Some 2-tone applications - Vibration damping - Coex films(medical)
Side by Side	 TPE Rigid Segment	- 2-tone - Door trim, console, IP - Bumper fascia
Edging		- Body/glazing seals (profiles) - Cowl vent seals - Co-extrusion or 2-shot
Co-blow Mold	 TPE (flexible) Rigid	- Auto: Boots/bellows,hose - Medical
Co-extrusion Blow Mold or Co-extrusion	 o-TPV s-TPV or ETP inner	Under-hood: - Hose(e.g. fuel) - Duct

Source: Robert Eller Associates LLC,, 2012

r/mydox/Visio/Two Shot OM approaches 2012.vsd

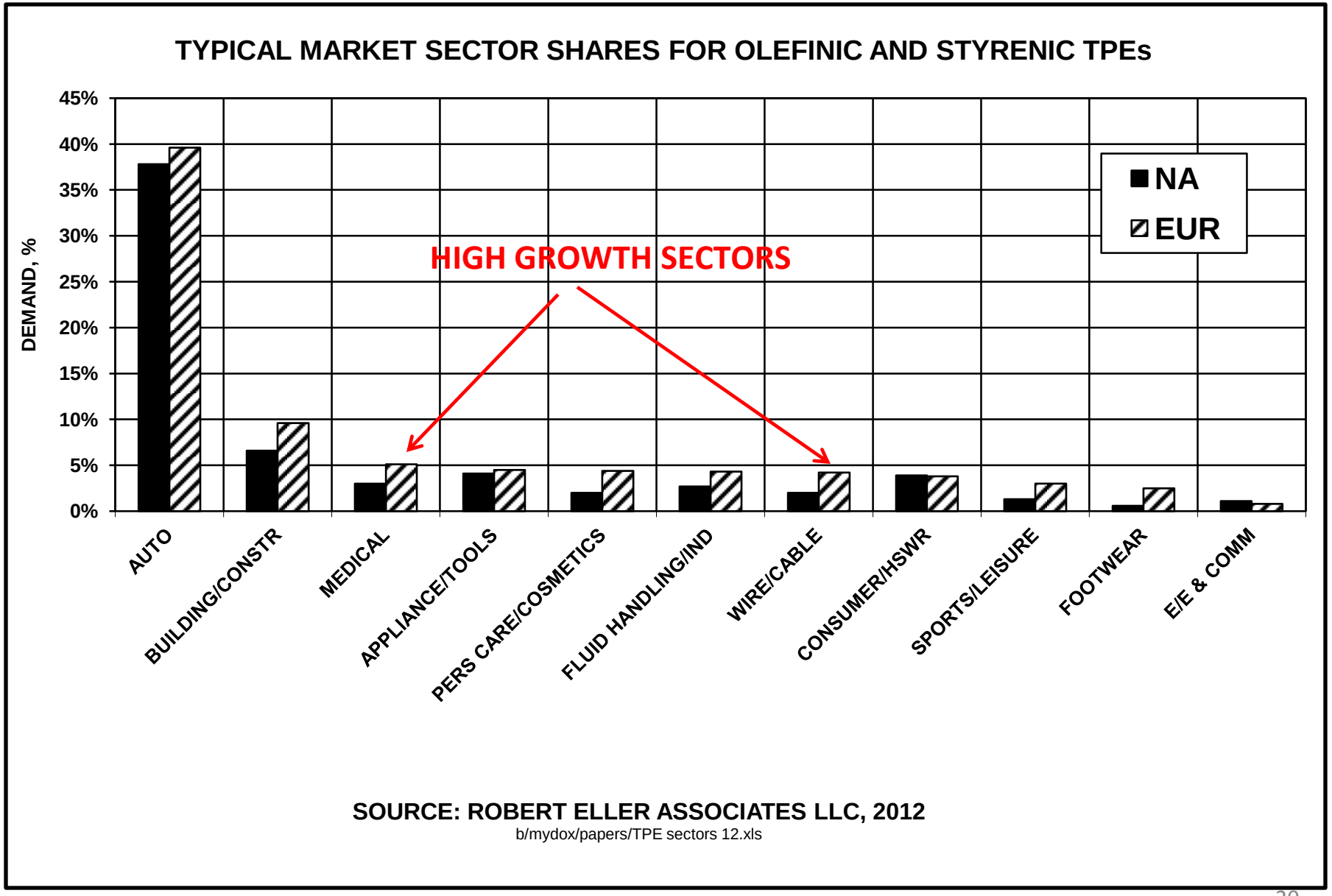
BROADENING THE TPE APPLICATIONS ENVELOPE (EXAMPLE)

PHOTO : AKRO-PLASTIC GmbH

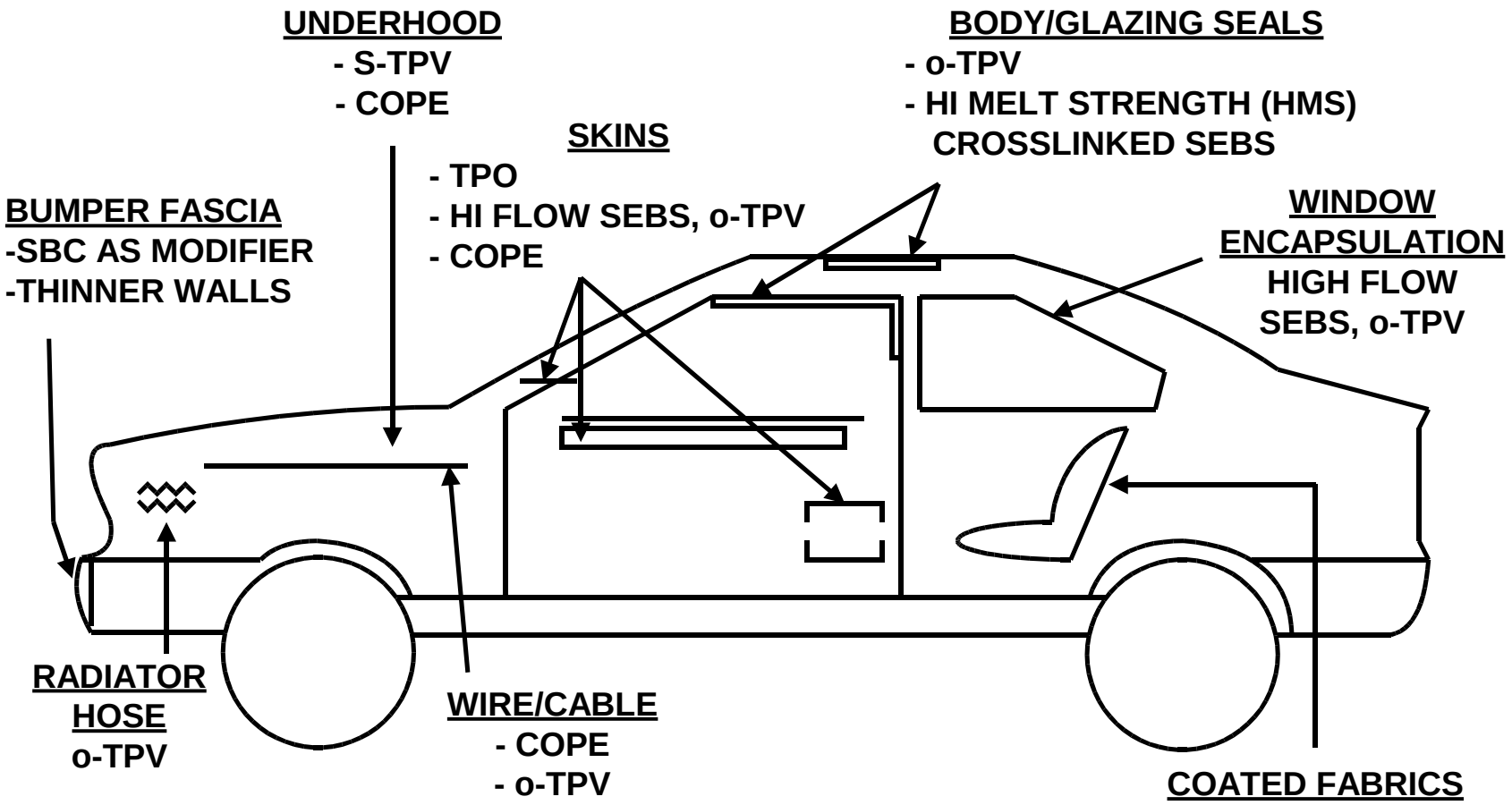
- **Application:** high temp hose
- **Target markets:** auto under hood, industrial hose
- **TPE type (candidates):** several depending on heat resistance level (COPE, TPEE, s-TPV)
- **Key properties:** temp resistance, low stiffness
- **Process:** water Injection molding technology (WIT)
- **TPE enabling technology:** temp resist (s-TPVs)
- **Note:**

- example of fabrication/TPE couple
- woven mesh inserted during molding process
- mesh insertion developed at IKV

AUTO: HIGH SHARE, GROWTH DRIVER (CHINA, N. AMERICA)



AUTOMOTIVE: KEY TARGET MARKET FOR NEW TPEs



THE AUTO MARKET

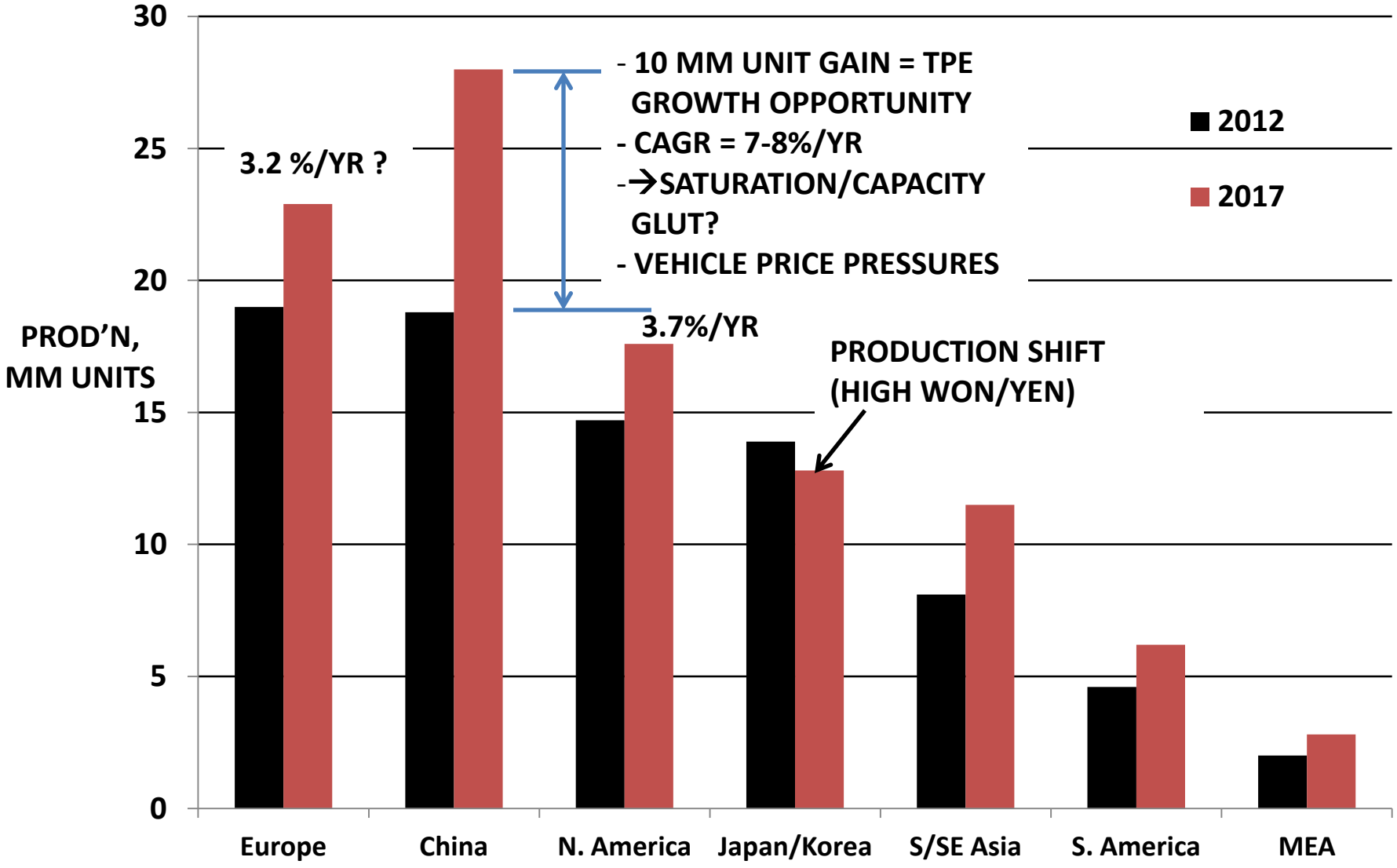
- 40-50% of current TPE demand
- Key incumbents: EPDM, PVC, TPO
- Global footprint

- Role for lightweighting, systems cost-save
- Key target properties: low V.O.C., thin wall, low odor, oil/ fuel resistance, heat resistance, sustainable
- Role for process technology, co-processing innovations

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/Visio./Auto Key Tgt for New TPEs 2012.vsd

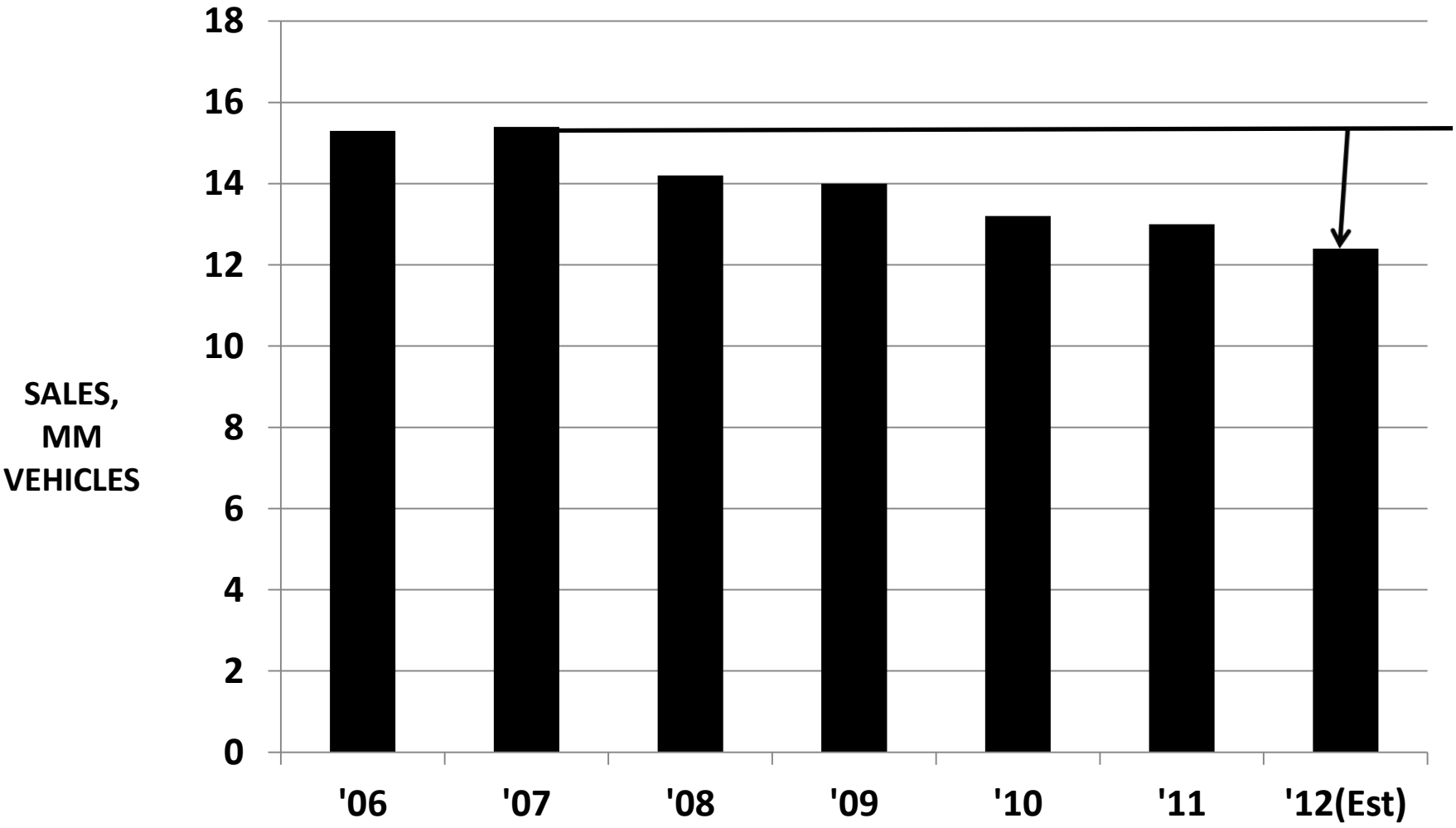
VEHICLE PRODUCTION GROWTH IN CHINA → MAJOR TPE OPPORTUNITY



DATA SOURCE: IHS

auto/global prod volumes 2012-2017

E.U. CAR SALES: 20% DECLINE SINCE 2007. OVERCAPACITY (~ 30%)



SOURCE: EAMA/EUROPEAN COMMISSION

VW: PRIORITY TARGET FOR AUTOMOTIVE TPE SUPPLIERS

- Rollout of MQB (modular architecture) platform:
  - Cost savings (plant flexibility, reduced production time)
  - 6MM units/40 models by 2020
  - More integrated systems/modular constructions

- Global positions
  - On course toward retaining global #1 position
  - Very strong current position in developing markets (Brazil and China)
  - China expansion (300K capacity plant in Changsha), others→ 4MM vehicles/yr by2018
  - Benefit from structural changes in European auto sector (currently 25% share)
  - N. American turnaround (currently 5% share)

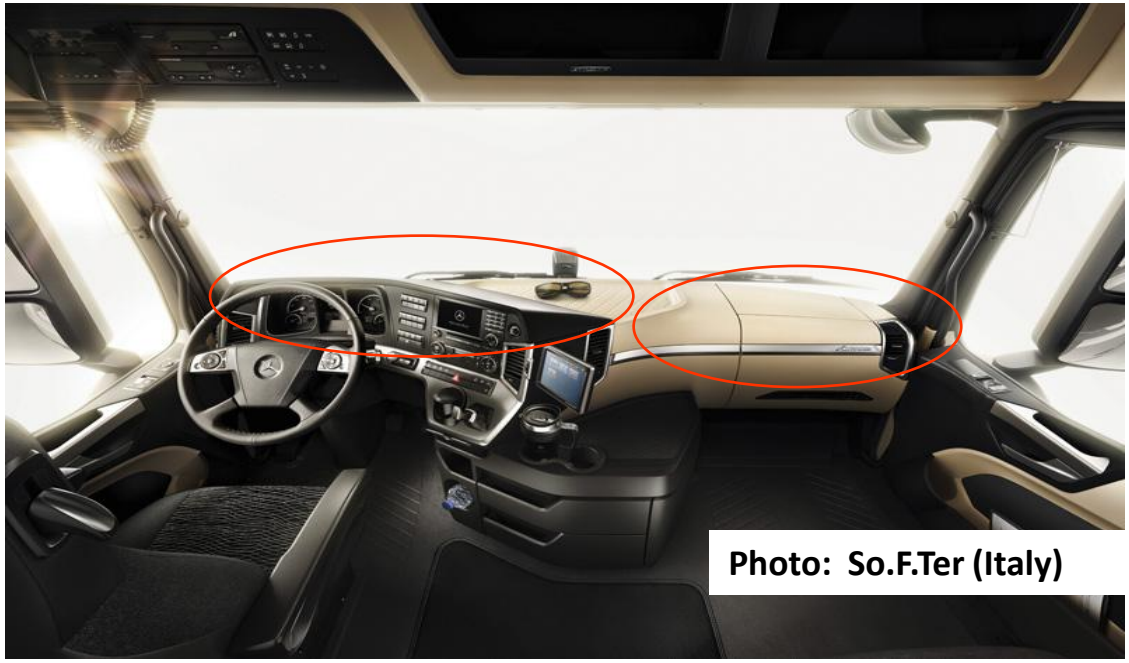
- Pricing power vs mass market competitors

TPEs STARTING IN COATED FABRICS

PHOTO: KRATON

PVC: the dominant incumbent strongly entrenched, cost effective
SBC-TPEs: Phthalate-free, UV resistance, low temp properties, hand/drape range

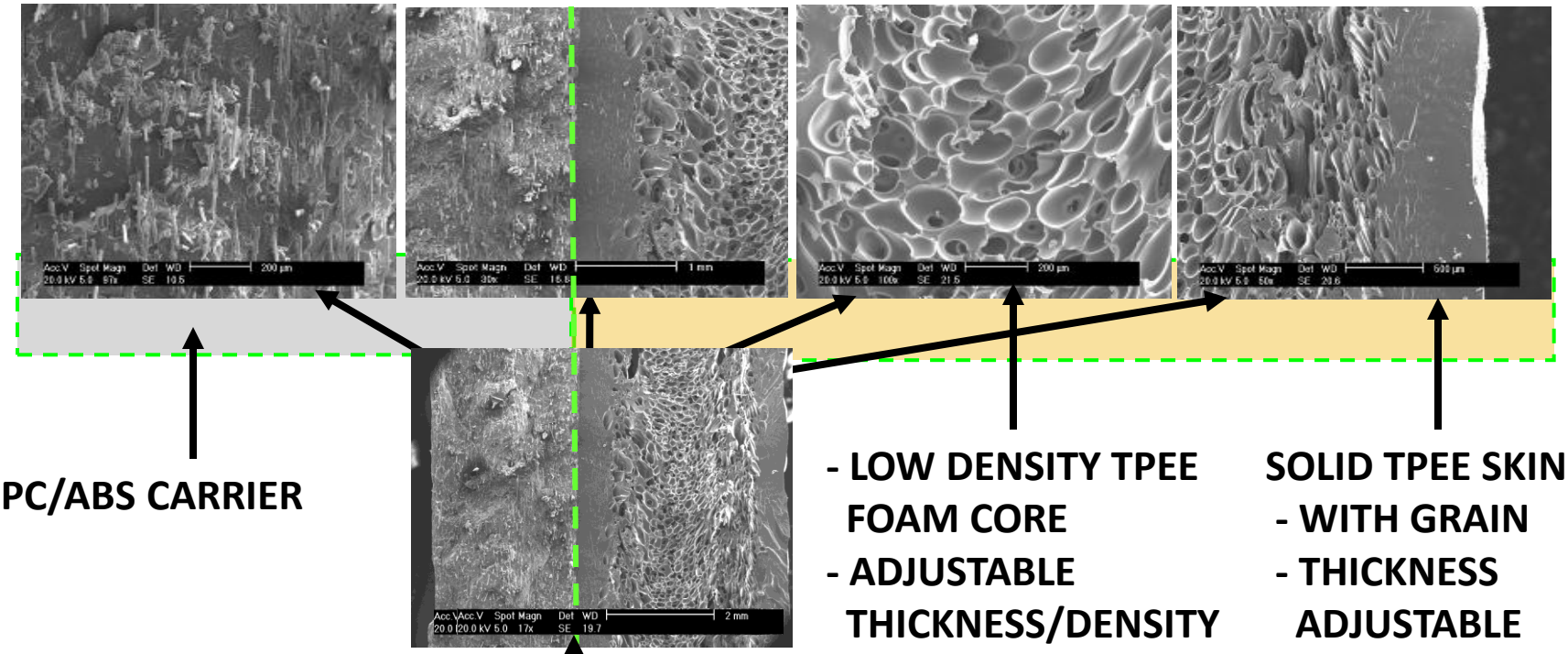
DOLPHIN PROCESS: TPE ROLE IN REDUCING STEPS IN AUTO INTERIORS



Applications: Soft touch instrument panel, door trim, glove box
Vehicle: Daimler Actros
TPE type: COPE (TPEE)
Substrate: PC/ABS
Key benefits:

- **Entire part in single injection machine(two barrel rotary platen) with expansion/decompression option**
- **8 step process→ 2 step**
- **Cost save vs off line skin forming (slush, thermoform or PU spray), substrate injection, PU foaming**

DOLPHIN INTERIOR TRIM STRUCTURE: INTEGRAL SKIN/FOAM /SUBSTRATE



PC/ABS CARRIER

- LOW DENSITY TPEE FOAM CORE
- ADJUSTABLE THICKNESS/DENSITY

SOLID TPEE SKIN:
- WITH GRAIN
- THICKNESS ADJUSTABLE

SOLID INTERFACE

PHOTOMICROGRAPH SOURCE: So.F.Ter; TREXEL

HEALTH CARE: A HIGH GROWTH TPE SECTOR

- High value market , driven by PVC replacement

- Example targets:
  - Multilayer films for range of bag and film applications
  - IV tubing sets
  - Respiratory therapy
  - Closures

- Key TPE properties:
  - Re-sealing
  - Bondability to polyolefins (e.g. for closures and multilayer films)
  - Clarity
  - Melt strength
  - Elastic properties

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

TPE IN HEALTH CARE: DRIVEN BY PVC REPLACEMENT PRESSURES

PHOTO: KRATON

Application: IV bag
TPE type: H-SBC (SEBS)
Key properties: Elasticity, low temp, clarity, PP compatibility, melt strength
Processing: Extrusion, calendering

PHOTO: KRAIBURG

Application: Infusion bottle closure
TPE type: H-SBC (SEBS)
Key properties: Re-sealing, bond to polyolefins
Processing: 2 component injection

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

SUPER-TPV FAMILIES

ACRYLIC RUBBER BASED

ZEOTHERM® TPV (ZEON CHEMICALS-DOMINANT SHARE)

FLUOROPOLYMER BASED

FluoroXprene® (FREUDENBERG-NOK)

SILICONE BASED

TPSiV® (DOW CORNING-MULTIBASE)

EVA BASED

HIPEX® (KRAIBURG)

Note: Withdrawn from market: DuPont™ ETPV; Daikin's DAI-EL Fluoro TPV™

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/…/Super TPV Families 2012.ppt

RENEWABLE BIO-TPEs BEGIN MARKET PENETRATION (EXAMPLES)

TPE FAMILY OR COMPONENT	RENEWABLE RESOURCE EXAMPLE	EXAMPLE SUPPLIERS	NOTE/RENEWABLE CONTENT, %
COPA	Castor oil	Arkema, Evonik	25 – 94
COPE, (TPEE)	Polyols from corn	DuPont, DSM	20 – 60
TPU	Polyols from corn	Lubrizol, BMS, GLS	20 - 70
	Bio-propylene glycol	BASF/Oleon	From fats/oils
PP	Ethanol from sugar	Dow, Braskem	In TPE formulations
Butadiene	Biomass	Versalis (ENI – Italy)	2 step via butanediol
	Waste gas CO	Invista/Lanza Tech	
SEBS (H-SBC)	Oyster shells	CTS	Other renewable fillers
SEBS (H-SBC)	Starch/Hydrocarbon	CTS using Gaialene®/Roquette	Substitute for PP in formulations
Starch/TPE	Starch	Cereplast	30 – 50% starch
PP carbonate	(CO_2+ PP oxide copolymer)	Novomer	- 40% CO_2 by weight - PP substitute? - Clarity/O_2 barrier

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

VALUE ADD TPE STRATEGIES

TPE TYPE+	+FABRICATION TECH	+COATINGS	+ FIRE RETARD	+ FOAMING	+ ADHESION
• s-TPV • High heat • Soft touch	• 2 shot (c) • Core back (c) • 3D blow (c) • Co-processing	• Aero gels (a) • Slip coat (b)	• Non-hal • Low smoke	• Core back • MuCell • Dolphin	• To ETPs • To rubber

(a) For example: polyimide aerogels. Adapted from space research (crosslinked, light weight, porous). Improve acoustics, thermal insulation

(b) Adjust COF, feel, systems cost save (e.g. in body/glazing seals)

(c) Offer systems cost savings

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

SUMMARY

- TPE life cycle: maturing →commodity and specialty segments. Paths to value add

- Asia shift:
  - Decreased Western TPE demand
  - Large multinationals adapting to broader range of Asian quality/price tiers
  - China slowed GDP growth (auto growth remains high)
  - Re-shoring of TPE customer base to West (primarily starting in U.S.)

- TPE industry structure shifting in response to :
  - Maturing supply side (maturing of some TPE grades)
  - Low cost raw materials search (shale gas abundance in U.S., affect European competitiveness in EPDM and POEs?)
  - Global market shifts toward Asia (partially modulated by re-shoring to U.S.)

- TPE properties envelope expanding:
  - New applications in auto, health care, packaging, consumer
  - SBCs, most rapid properties expansion
  - Many opportunities for value add
  - Role for process/materials combinations

SUMMARY (cont'd.)

- **Auto remains major global demand driver :**
  - **Recovery in U.S., severe auto recession in Europe**
  - **EPDM substitution (e.g. hose, body/glazing seals)**
  - **Interior skins/soft touch remain battleground**
  - **"Green" demands stimulate TPE substitution**

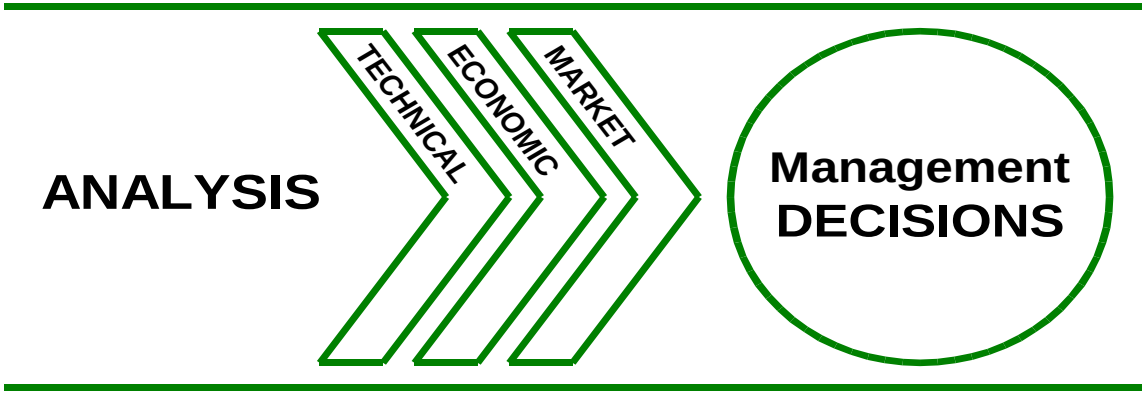
- **Global recession effects:**
  - **Decline of China exports→ Europe, U.S. shifts to domestic markets**
  - **Some TPE raw material price declines**

- **Health care:**
  - **Fast growth TPE market**
  - **PVC replacement decisions (China and West)**

- **s-TPVs: Reaching for high performance specialty rubber markets**

- **Bio-TPEs: Momentum starting. Capable of competing in the marketplace**

THANKS FOR YOUR ATTENTION



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