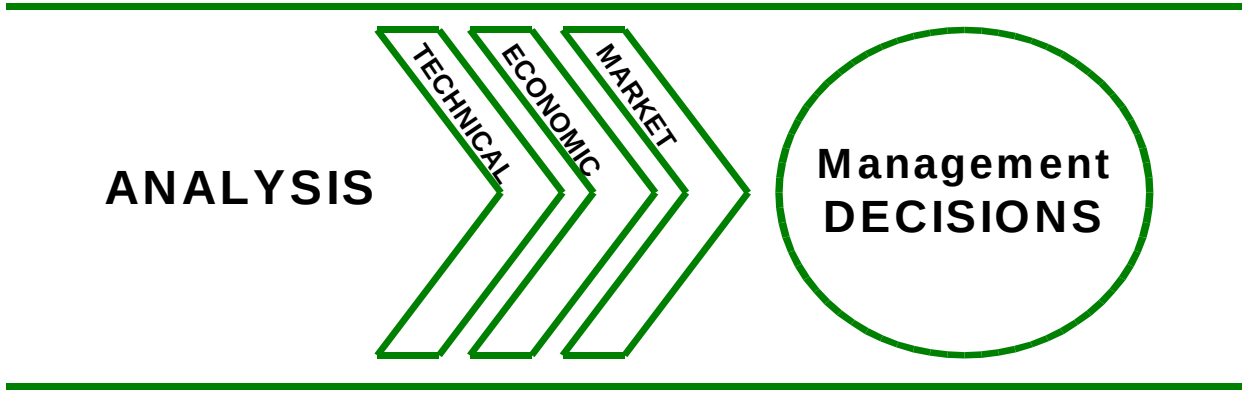

Robert Eller Associates LLC

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

AUTOMOTIVE INTERIORS TECHNOLOGY RESPONSES TO ECONOMIC AND GLOBALIZATION PRESSURES

PRESENTED BY:

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PREPARED FOR:

Auto Interiors Show
Detroit, MI

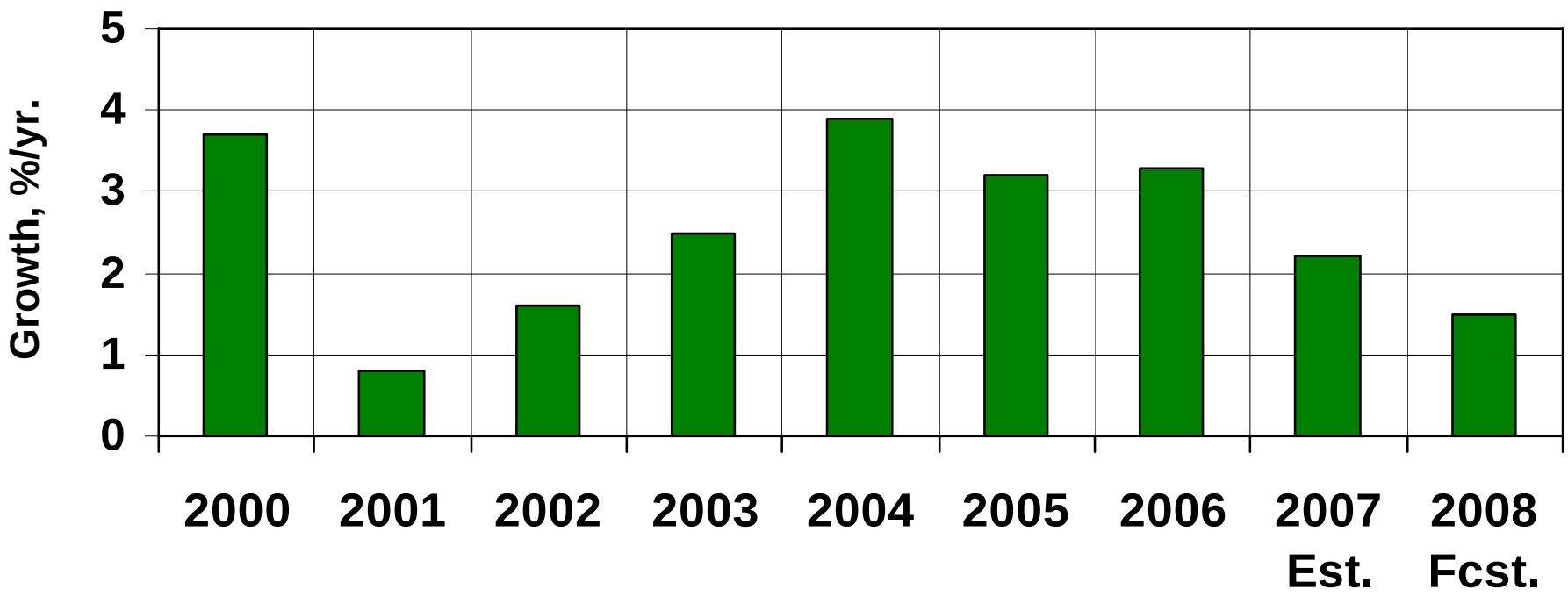
June 5, 2008

R/mydox/papers/ATI 08.ppt

PRESENTATION OBJECTIVES

- **IDENTIFY MACRO-ECONOMIC EFFECTS ON AUTOMOTIVE INTERIORS**
- **EXAMINE AUTOMOTIVE SUPPLY CHAIN TURBULENCE EFFECTS**
- **IDENTIFY THE DRIVING FORCES FOR AUTOMOTIVE INTERIORS SUBSTITUTION**
- **PROVIDE AN OVERVIEW OF CURRENT/FUTURE INTERIORS TECHNOLOGIES**
- **EXAMINE THE PLASTIC RESIN FABRICATION TECHNOLOGY COUPLE**

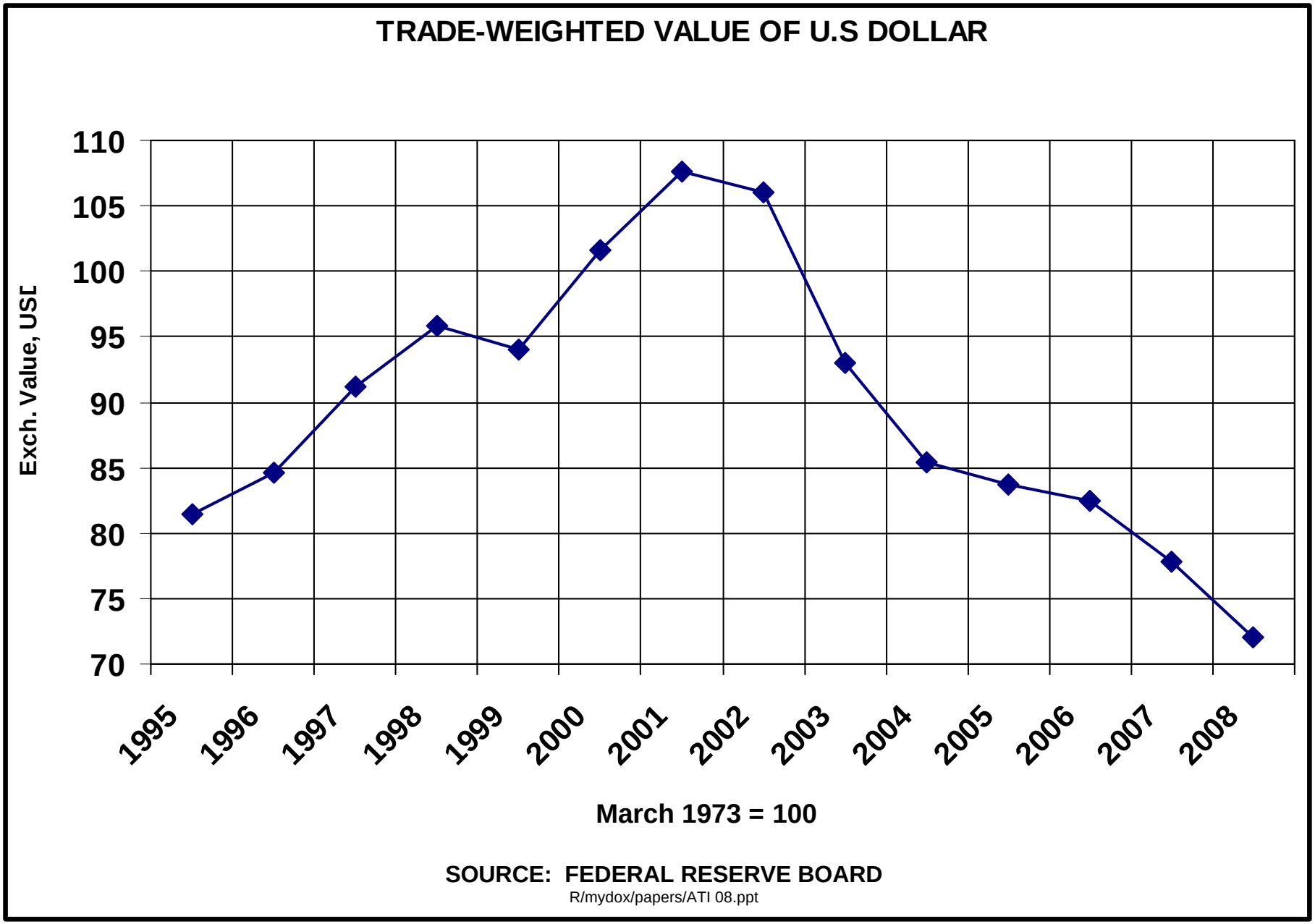
U.S. REAL GDP GROWTH



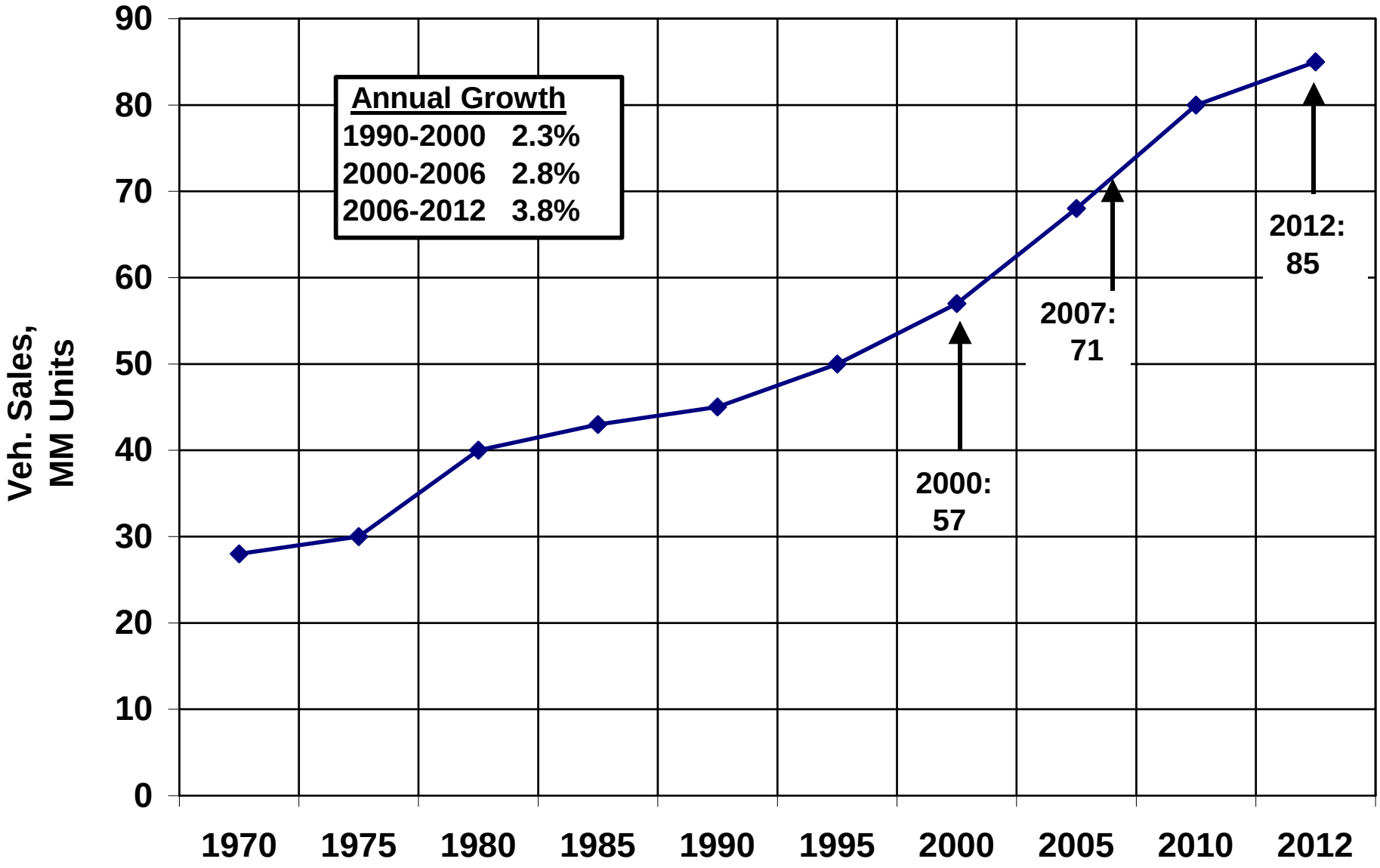
SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

b/mydox/Auto Industry/US Vehicle Sales.xls

U.S. DOLLAR DECLINE



GLOBAL VEHICLE SALES OUTLOOK



GENERAL MOTORS

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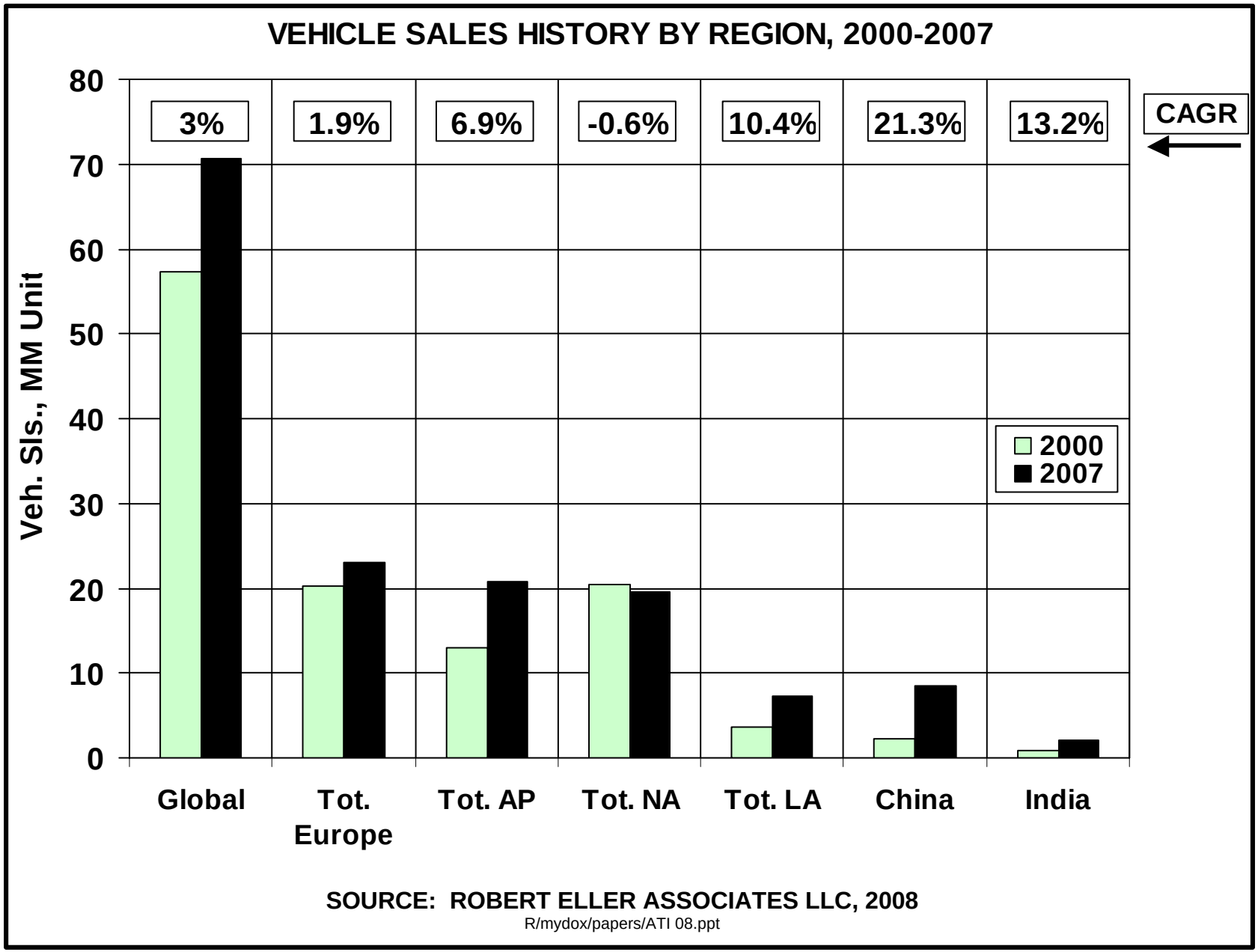
U.S. GDP GROWTH RATE & VEHICLE PRODUCTION

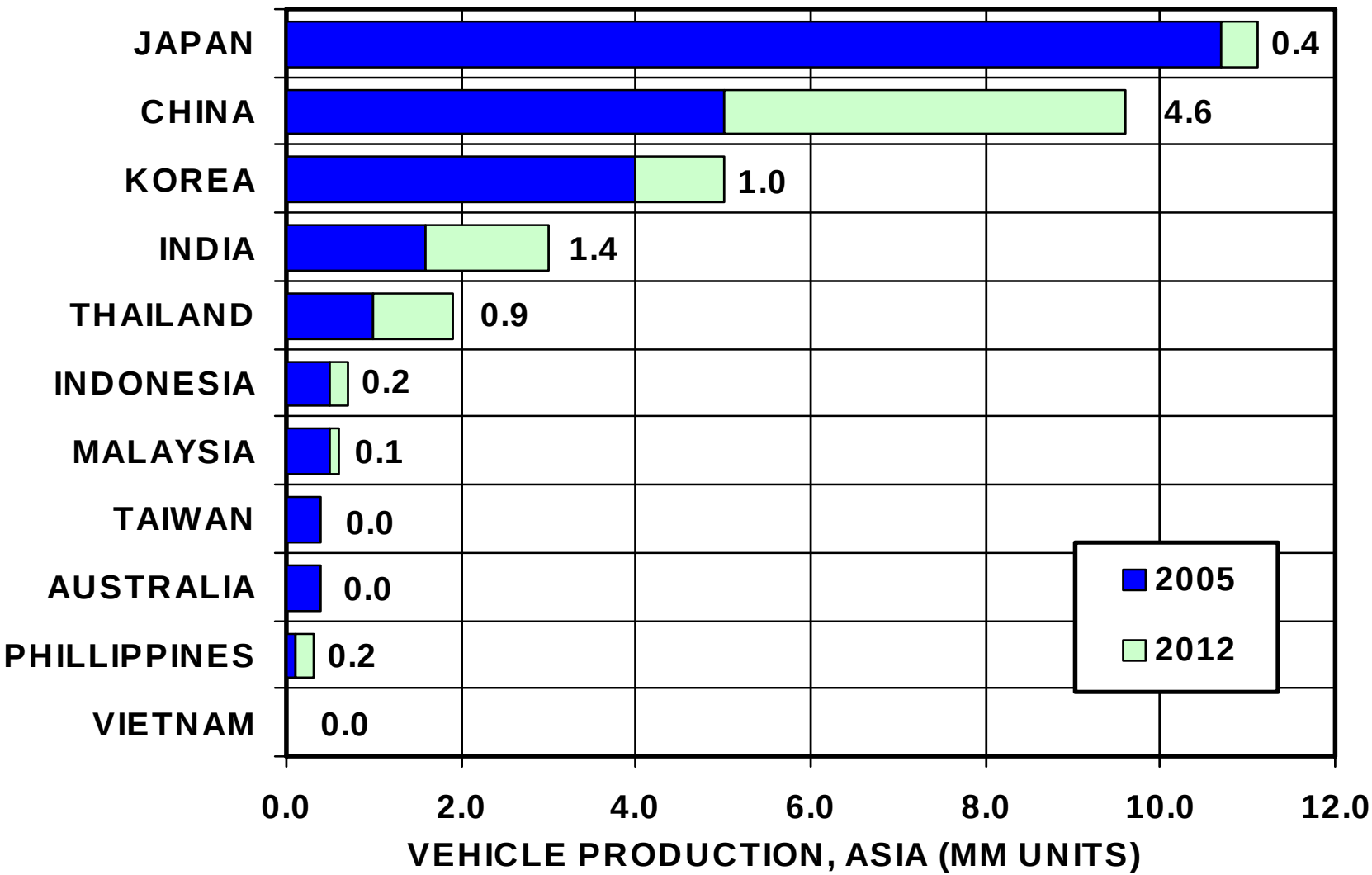
YEAR	GDP GROWTH RATE, %	N. AMERICAN VEHICLE PROD'N., MM UNITS	Y/Y PROD'N. DECLINE/ GAIN, %	NOTE/EXAMPLE
2001	0.8			9/11 attack
2002	1.7			
2003	2.4	16.3	41.2	
2004	3.7	16.3	0.0	
2005	3.1	16.4	0.6	Profitability decline
2006	2.9	15.9	-3.0	Profitability decline, bailouts, consolidation
2007	2.2	15.5	-2.5	Profitability decline, bailouts, consolidation
2008	1.5	14.5	-6.9	Profitability decline, credit difficult to obtain, further acq'ns. of distressed suppliers
2012		16.3?		

SOURCES: IMF, WARD'S, ROBERT ELLER ASSOCIATES LLC, 2008

REGIONAL AUTO MARKET GROWTH



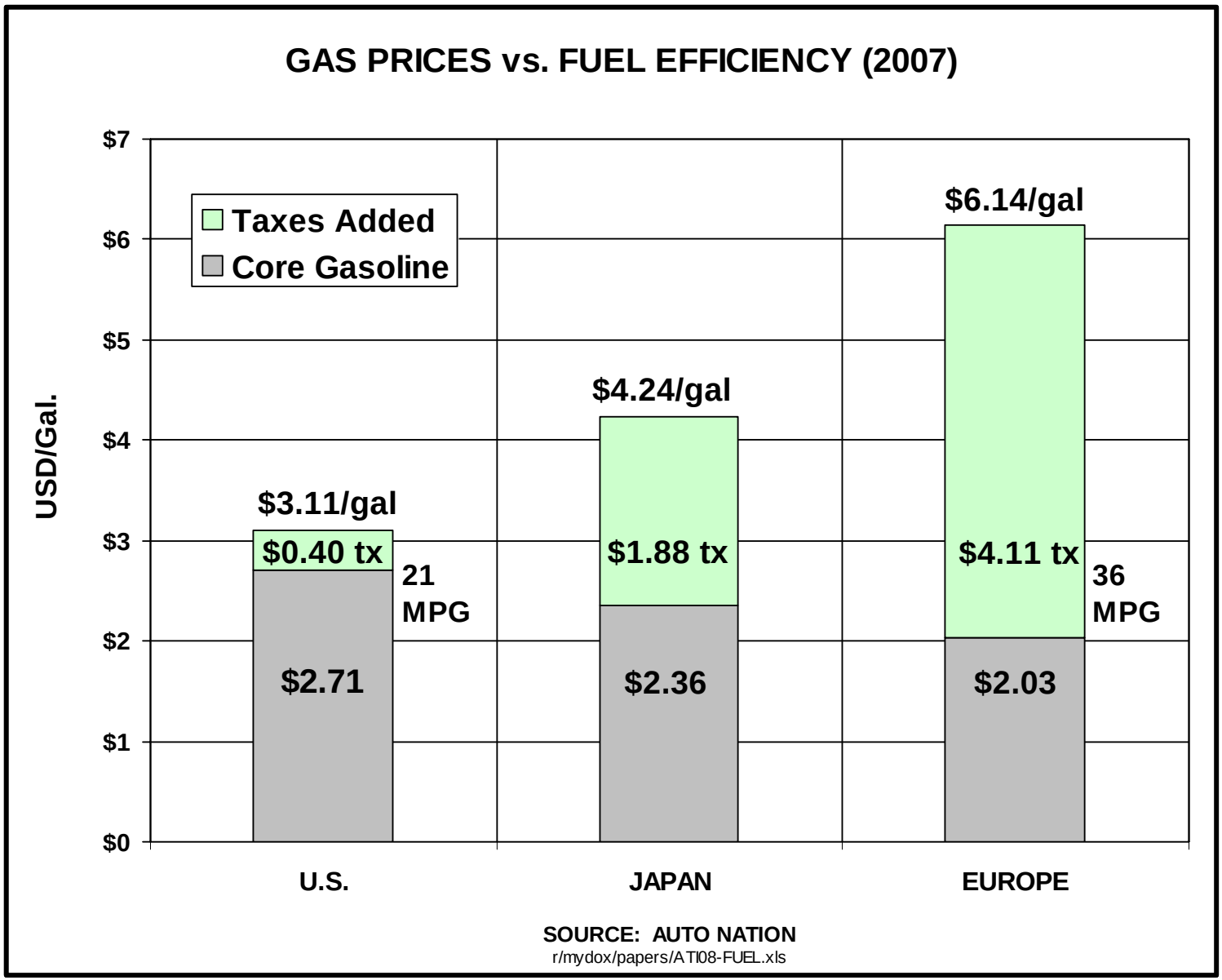
PROJECTED AUTO PROD'N. IN ASIA: 2005-2012



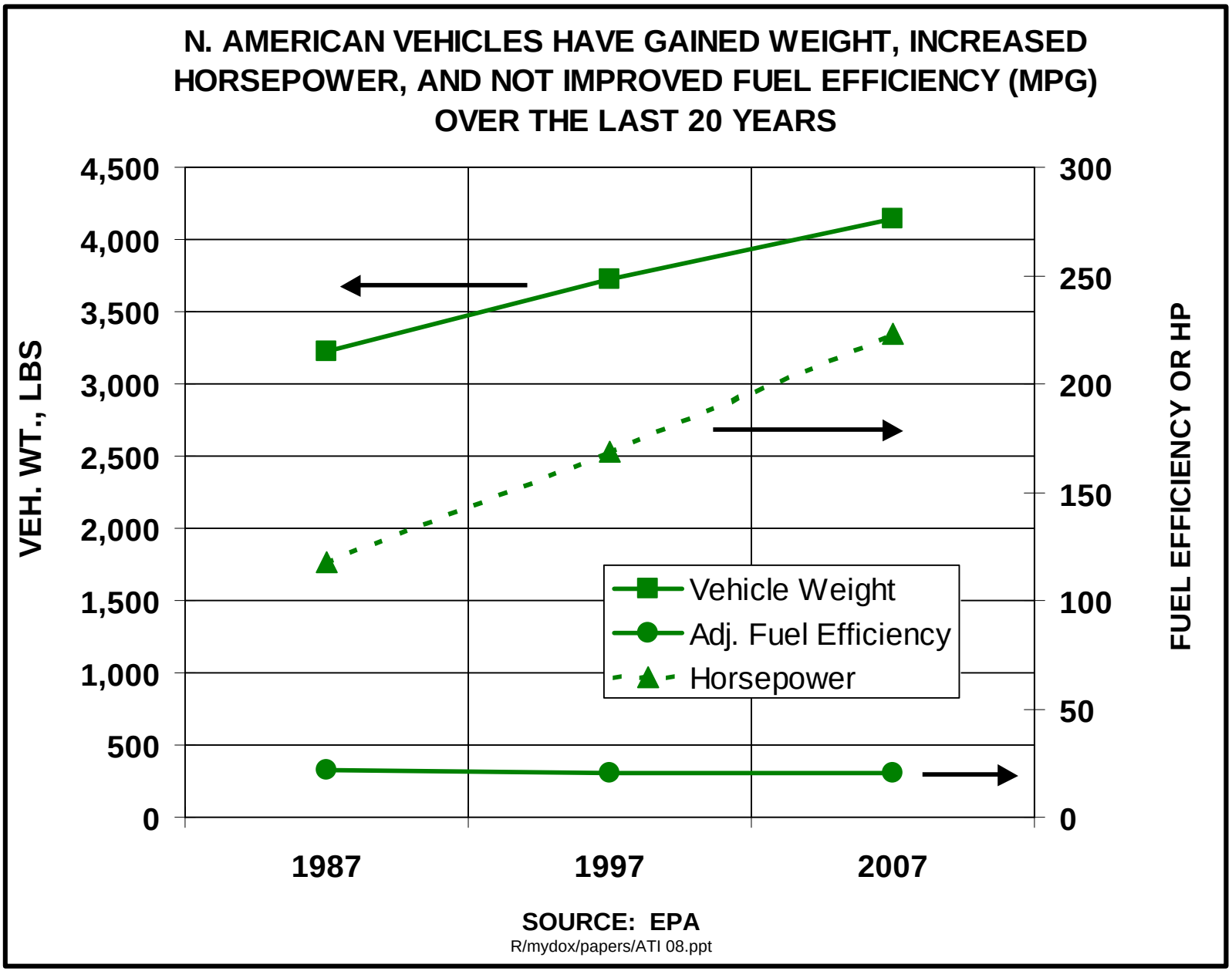
7MM NEW VEHICLES ARE EXPECTED TO COME FROM CHINA, INDIA AND THAILAND BY 2012.

SOURCES: CSM; ROBERT ELLER ASSOCIATES LLC, 2008

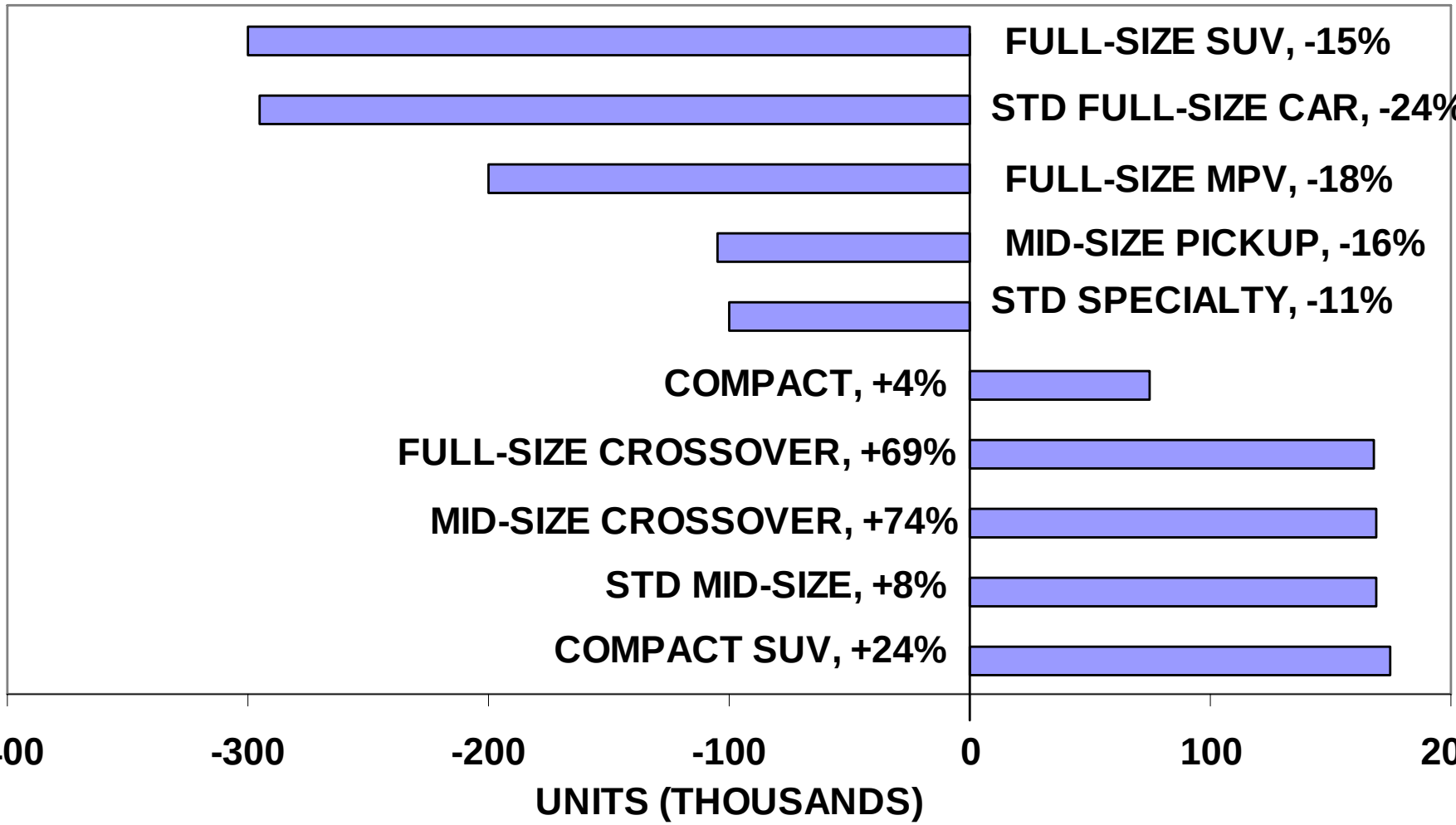
FUEL EFFICIENCY REQUIREMENTS WILL DRIVE SUBSTITUTION



U.S. VEHICLE FUEL EFFICIENCY



U.S. VEHICLE FLEET COMPOSITION SHIFT, 2006-2007



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

FLEET TRENDS: AUTOPLASTICS IMPACTS

"In Geneva, the focus was on the U.S. – how to cope with the currency crunch and adapt Europe's green technology in a country headed for $4 gasoline." *AUTO NEWS 3-10-2008*

"As automakers feel heat from environmental movement, engineers find solutions that are quick, clean and cheap."
AUTO NEWS, 3-10-2008

"U.S. Auto Makers Show European Flair"
WSJ 3-25-2008

"As dollar dives, automakers juggle global strategies."
AUTO NEWS, 3-10-2008

"Cheaper small cars are part of VW's U.S. plan."
AUTO NEWS, 3-10-2008

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

EUROPEAN SMALL CARS ARE PP INTENSIVE

VEHICLE	PP (kg)	PP/PLASTICS (%)
Citroen C4	90	56
Toyota Aygo	47	52
Toyota Auris	71	51
Toyota Yaris	64	47
Opel Corsa	65	44
Ford Mondeo	72	41
Fiat 500	60	49
Mercedes C-Class	72	34

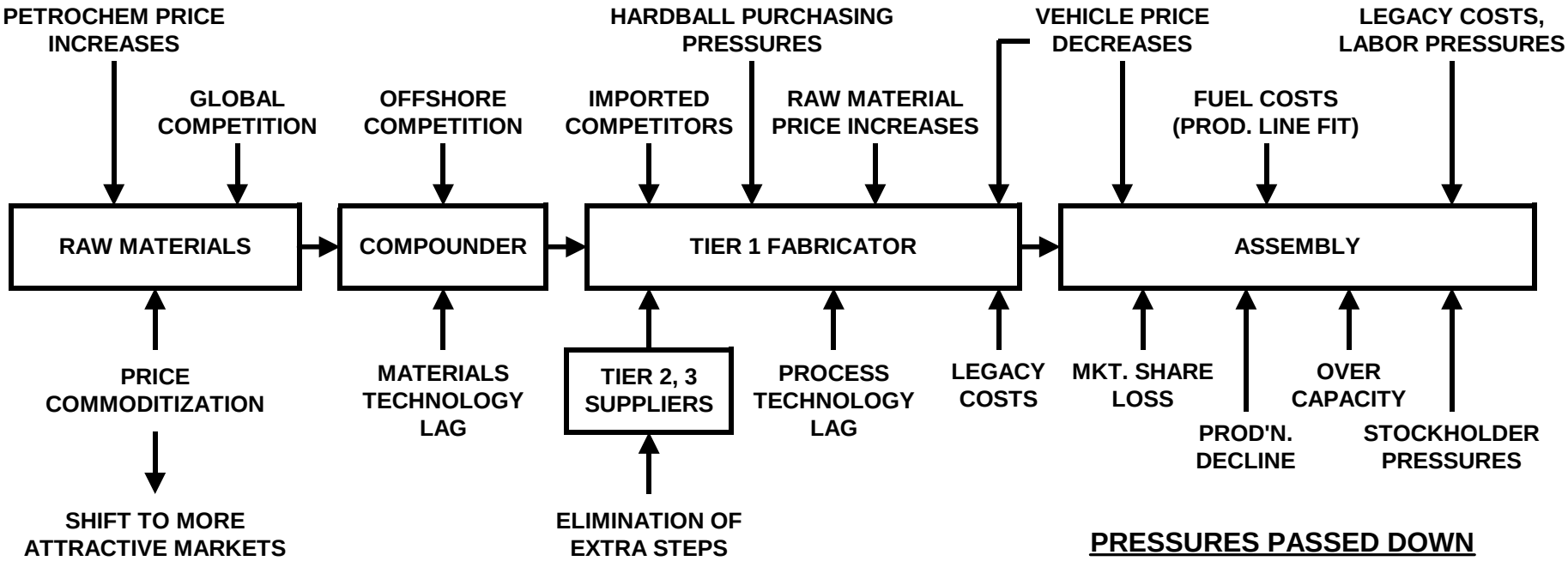
Source: Mavel

KEY AUTOMOTIVE TRENDS & DRIVING FORCES

TREND	AUTOPLASTICS IMPACT
Dollar weakness	- Foreign investment in N. America (state wealth, plastics fabricators) - Increased U.S. vehicle exports
Stagnant Western auto growth/rapid non-West. auto growth	- Investment in non-Western regions by U.S. Tier 1s - Reluctant U.S. capex by U.S. Tier 1s - Plastics suppliers invest in non-Western regions
Raw material price increase	- Tier 1/compounder profitability squeeze - TPO preference - Optimize material efficient solutions - Fabrication technology optimization trend (reduced unit operations, scrap reduction) - Petrochem investment shift to monomer-rich regions (asset light strategies) - Autoplastics supply chain consolidation
Fuel efficiency pressures	- U.S. fleet shift toward PP intensive vehicles - Light-weight solutions gain share
Cont'd. U.S. domestic OEM share loss	- Japanese/European/Korean Tier 1 and TPE compounder share gain

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

AUTOPLASTIC SUPPLY CHAIN IMPLOSION



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
- INEFFICIENT PROCESS TECHNOLOGIES
- SALES/MARKETING COSTS
- EXCESS LABOR COSTS
- OVER-GLOBALIZATION?

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

SUPPLY CHAIN SHIFT/ FLEET COMPOSITION EFFECTS

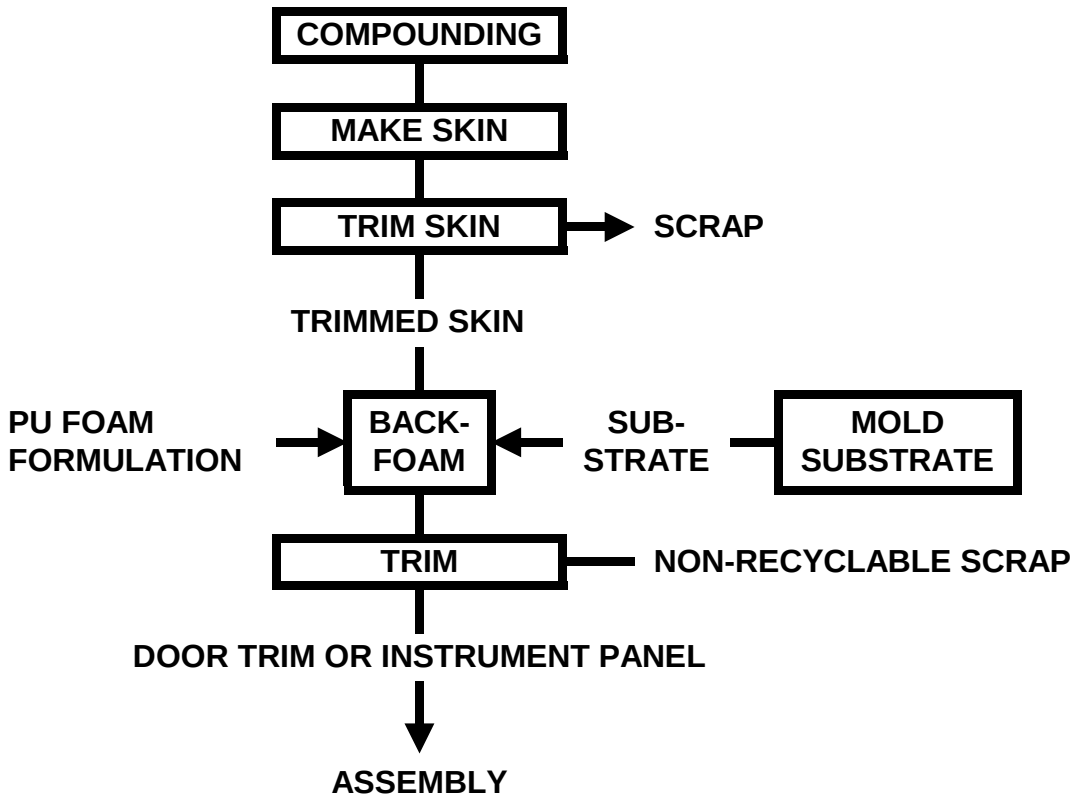
- **Supply chain implosion drives resin/compound/ fabrication/technical innovation (restraining effect of cash/profitability crunch)**
- **Resin suppliers forward integration to compounding?**
- **Tier 1s shifting to in-line compounding**
- **Expanding resin property envelopes**
- **Strengthening of Japanese resin suppliers/ compounders in N. America and Europe**
- **Renewed growth of European compounders in N. America ($ weakness driver?)**

EXAMPLE TECHNOLOGY SHIFTS IN AUTO INTERIORS

- Multi-component molding (several processes)
- In-line compounding (ILC, DLFRT, IMC)
- Interior semi-structural substitutions
- Elimination of IP cross-car beam?
- Thermoplastic elastomer (TPE) growth (olefinic and styrenic)
  - Styrenic TPE vs. olefinic TPE for airbag doors
  - Body seal substitution for EPDM rubber
- Growth of injection molded foams
- Increased use of single compound for multiple interior and exterior components (Fiat 500 example)
- Innovation in rear storage area
- Continued substitution for thermoset rubbers
- Lighting innovation
- Plastic glazing effects

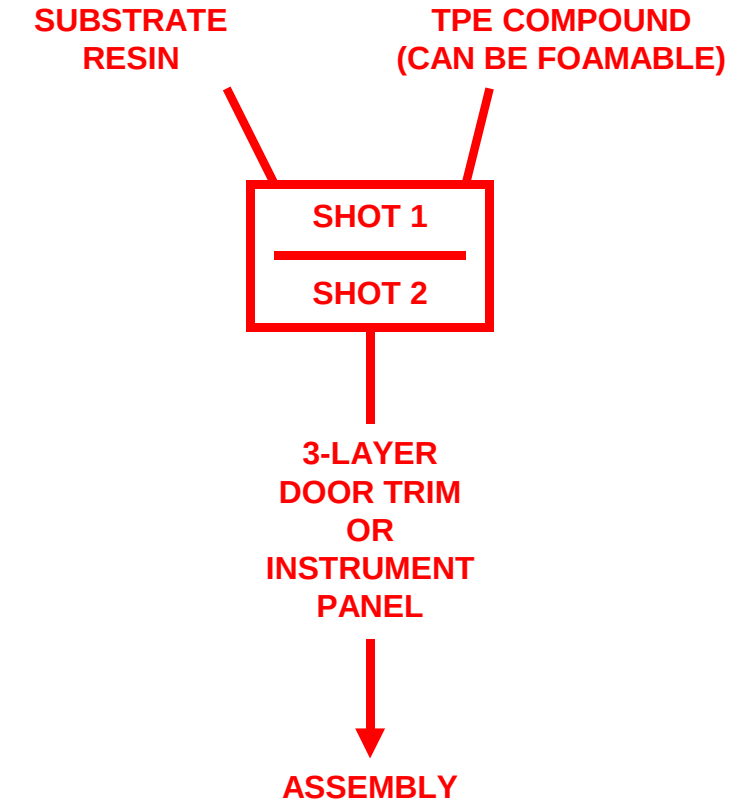
NEW HIGH GROWTH TPE FABRICATION TECH.: LARGE-PART, 2-SHOT MOLDING

CURRENT PROCESS



- LABOR INTENSIVE
- HIGH SCRAP
- MULTI STEP
- MULTI MATERIAL
- NON-RECYCLABLE
- DIFFICULT CRAFTSMANSHIP

2-SHOT



- 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

LARGE-PART, 2-SHOT, SOFT TOUCH MOLDING

Part: Instrument Panel Upper
Skin Compound: COPE (Foamed Pibiflex from P Group)
Substrate: PBT/ASA (Ultradur^{R} S4090IGX from BASF)
Injection Machine: Engel
Foam Technology: Trexel

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

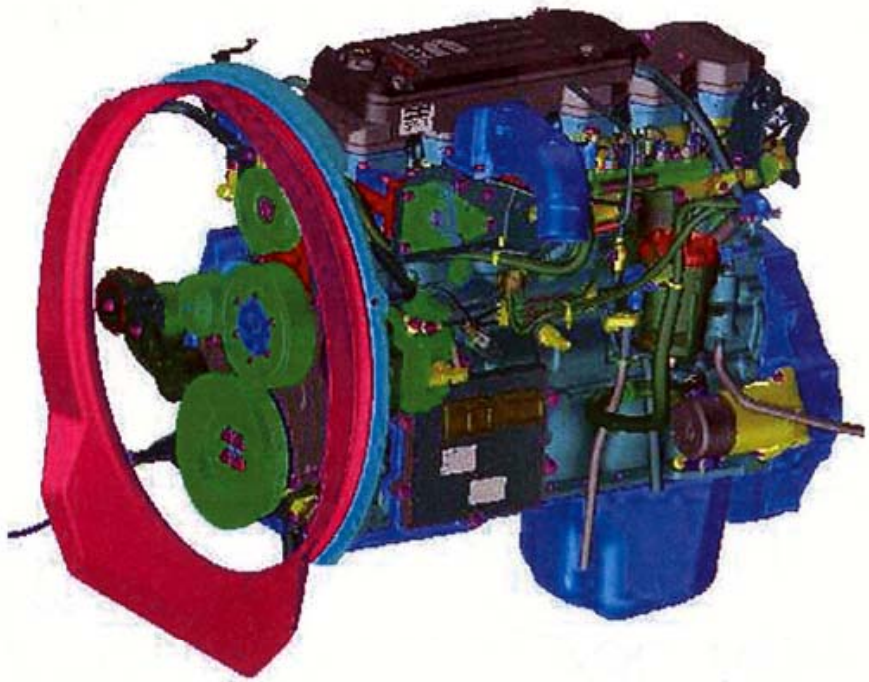
2-SHOT, SOFT TOUCH BROADENS APPLICATIONS

Photo Source: ***Plastics News***

Vehicle: **Chrysler Jeep Liberty '08** **Process:** **2-shot**

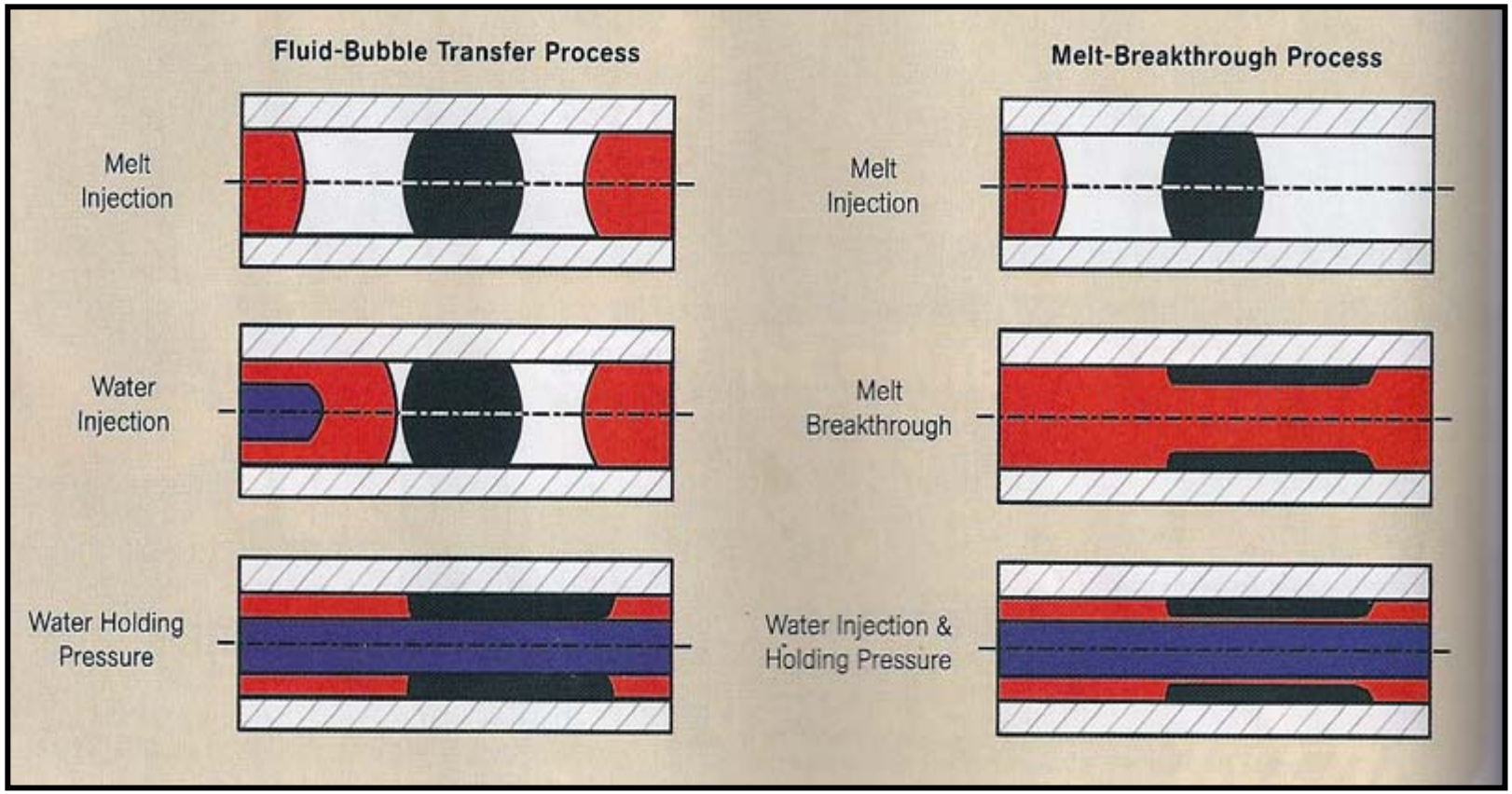
Skin: **Localized TPE soft touch** **Tier 1:** **IAC**

SIDE BY SIDE 2-SHOT MOLDING



Product: Fan shroud
Manufacturer: Sur-Flo
Material Type: TPV (Nexprene)
TPE Supplier: Solvay Engineering Polymers
Note: Used in Dodge Ram HD pickup

SEQUENTIAL 2 COMPONENT WATER ASSIST



Two approaches: Fluid transfer and melt breakthrough
Competition: 3D sequential co-extrusion blow molding
Developer: IKV (Germany)
e.g. mat'ls.: PP (hard segment) + TPE (soft segment)
Initial example applications: cooling ducts, air intakes

IN-LINE COMPOUNDING(ILC)

- **Competes with glass mat thermoplastic (GMT)**
  - **ILC generally has better properties**

- **Example current/potential applications:**
  - **Seat pans/backs**
  - **Door hardware module/door carrier**
  - **Hatchback inner panel**
  - **IP carrier**
  - **Rear trunk module**
    - **-- load floor**
    - **-- spare tire well**
  - **Underbody shields**

ILC PROPERTIES vs. LGF PELLETS

PROPERTY	UNITS	ILC-PP	LGF-PP	% GAIN FOR ILC
Tens. Mod.	GPA	9.7	9.8	-1
Flex. Mod.	GPA	8.1	8.2	-1
Tens. Str.	MPA	145	113	+28
Flex. Str.	MPA	201	161.3	+25
Notched Izod	KJ/M^2	33	22	+50

Source: Husky

IN-LINE COMPOUNDING: CURRENT STATUS

- Example of efficient supply chain response
- Starting with GF reinforced resins
- Competes with LGF-PP, concentrates, GMT
  - ILC generally has better properties
  - ILC raw material cost, process cost save vs. LGF-PP
  - Equipment costs 50-75%> conventional injection
  - Large parts (<5 lbs.) favor ILC
  - LGF-PP has 80-85% market share
- 3 equipment suppliers competing (Krauss Maffei in lead)
- Example interior applications:
  - Seat pans/backs
  - Door hardware module/door carrier
  - Hatchback inner panel
  - IP carrier
  - Rear trunk module

SPARE TIRE WELL: SUBSTITUTION TARGET

Vehicle: Mercedes C-Class
Weight: 4.3 kg
Substitution drivers:
- Impact strength for crash resist.
- Ability to integrate shape features
- Corrosion resistance

Mat'l.: GMT-PP combination (random glass mat & fabric)

SPARE TIRE WELL: NATURAL FIBER TARGET

Vehicle: Mercedes A-Class
Material: Abaca fiber/PP
Substitution drivers:
- Good stiffness weight balance
- Green solution
- Energy saving (natural fiber vs. glass roving)

CARGO MGT.: INNOVATION TARGET ZONE

Sources: Zumhagen Co.; Robert Eller Associates LLC, 2008

Vehicles: Ford: Escape, Mariner, Tribute
Cover: Blow molded PP
Well Structure: Expanded PP foam
Surface: Molded-in carpet

BIOPOLYMER CANDIDATES

- **Natural Fibers:**
  - **vegetable (bast, kenaf, leaf, fruit, wood)**
  - **animal (wool, hair)**
  - **mineral (long/short glass mats, basalt)**
  - **carbon fibers (high-end applications)**

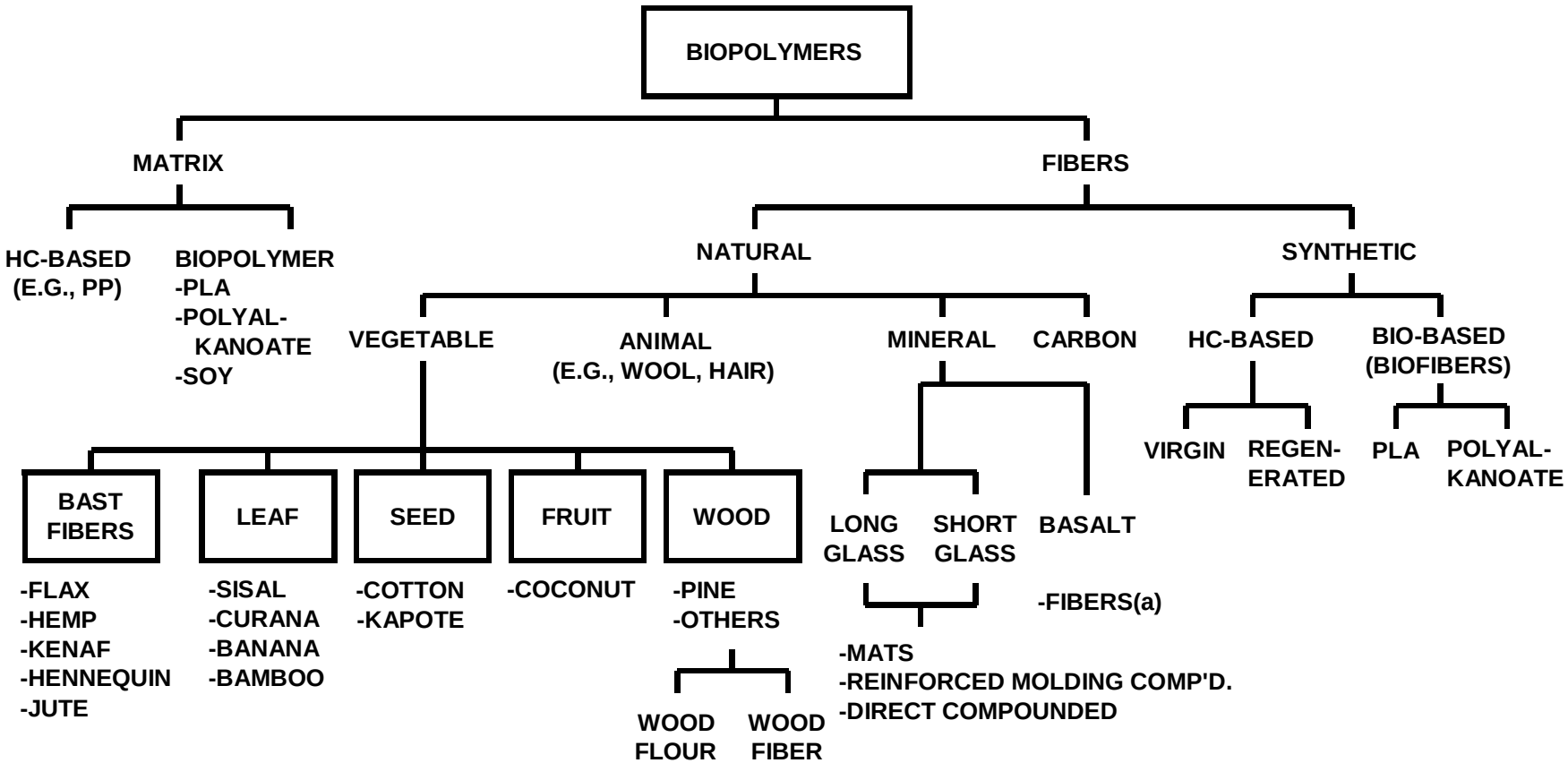
- **Polylactic Acid (PLA)**

- **Soy (Ford seating)**

RECENT TOYOTA BIOPOLYMER ACTIVITY

- **Past Kenaf use: in 27 (mostly high end) models since 2000**
- **Recent Kenaf commitment:**
  - **Toyota Boshoku starting integrated production facility in Indonesia from seeds through molded parts**
  - **Joint development with Indonesian Tobacco and Fiber Crops Research Institute (ITFCRI)**
  - **Key challenges are**
    - **-- stabilization of quality**
    - **-- cost efficiencies via volume production**
- **Seed quality is key**
  - **-- stable crop yields**
  - **-- ability to grow in arid regions**

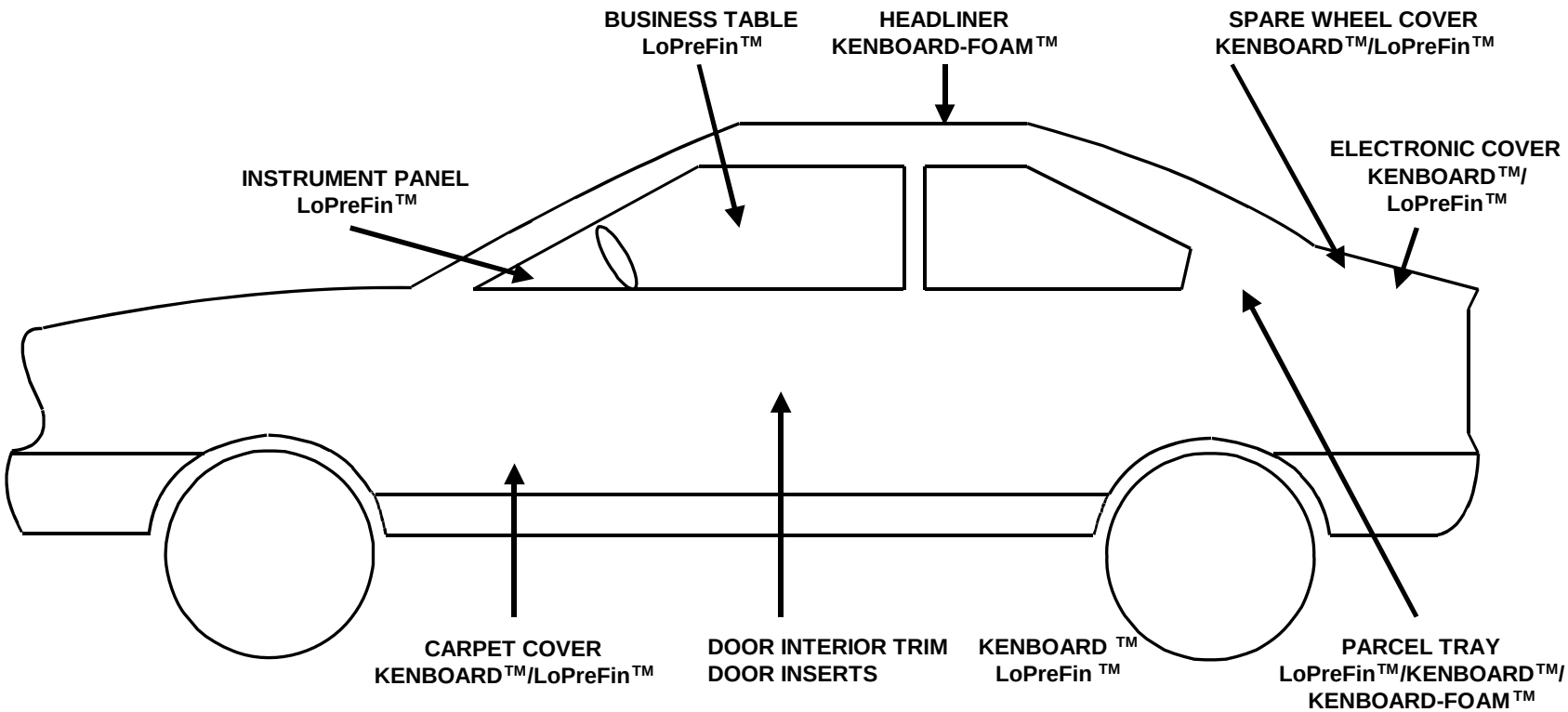
BIOPOLYMER CANDIDATES FOR AUTOMOTIVE APPLICATIONS



NOTE: (a) CANDIDATE FOR HEADLINERS (TOYOTA)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

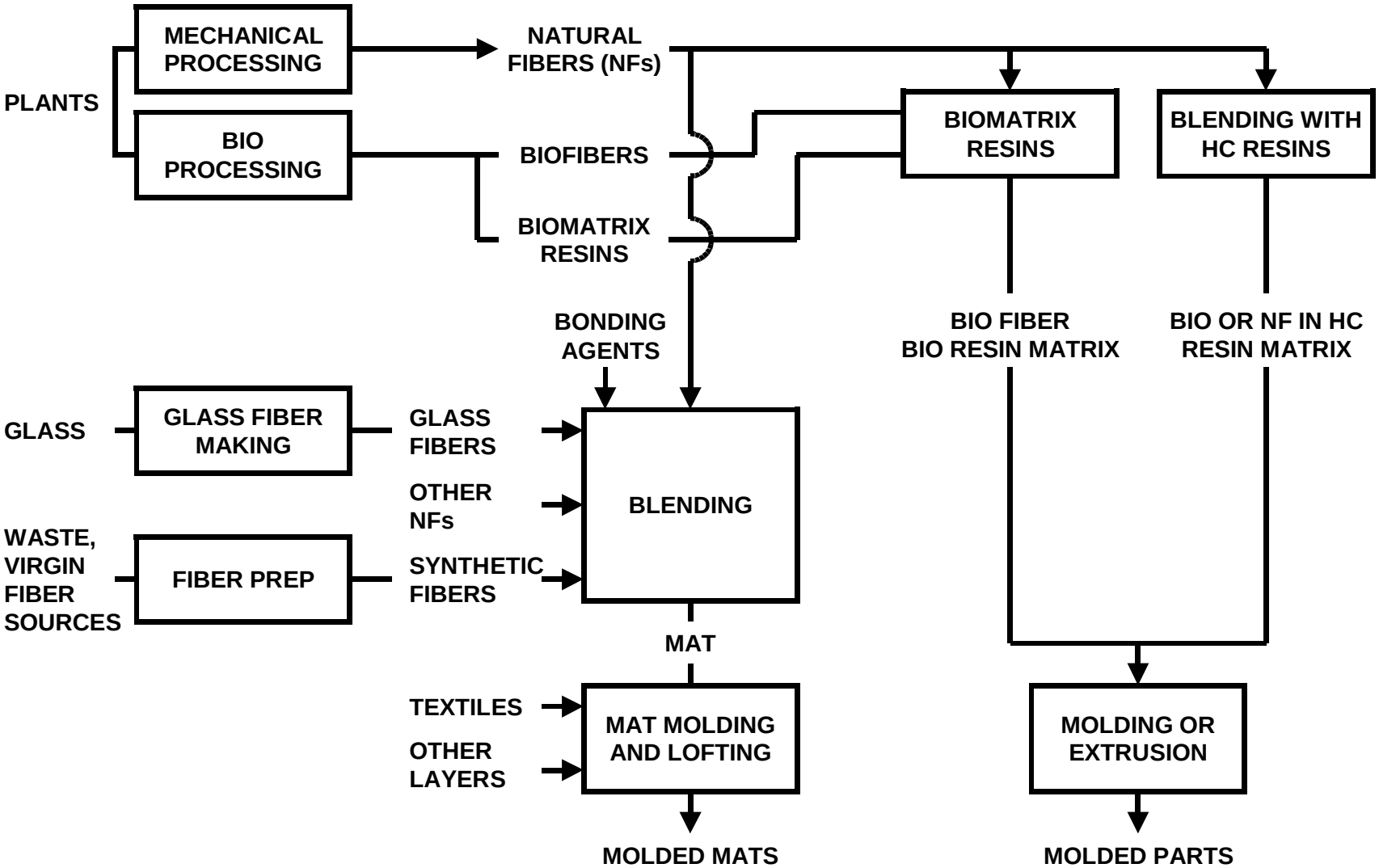
NATURAL FIBER APPLICATIONS



SOURCE: R+S TECHNIK GmbH

Quelle und Foto: Daimler Chrysler

PATHS TO AUTOMOTIVE MARKET FOR NATURAL AND BIOFIBERS



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

LEDs AND LIGHT PIPES SHIFT INTERIOR LIGHTING

Technology: LEDs, gaining power, smaller footprint
Applications: Cascading illumination, instruments, logos
Substitution drivers:
- Night/day lighting
- Reduced night vision interference
- Lighting footprint reduction
- Cost save vs. bulbs

PU CONTINUES DOMINATION OF HIGH END

Photo Source: Grammer

Vehicle: BMW 5 Series
Part: Center front armrests
Material: Molded PU

TREND TOWARD SELF-SUPPORTING IPs?

Eliminates cross-car beam

Dimensions:	**Narrower/thinner IP; frees up space**
Some displays:	**Invisible until required**
Commercial status:	**3 launches in 2008?**
Tier 1:	**Faurecia**

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

CONTINUED GROWTH OF 2-TONE

Photo Source: Robert Eller Associates LLC

Vehicle: BMW (2-color door trim panel)
2-color Skin Supplier: TS Trim
Substrate: Wood fiber/PP
Tier 1: JCI

LEATHER PROLIFERATION

Photo Source: Robert Eller Associates LLC

Vehicle: Corvette
Skin: Leather upper
Substrate: PP
Tier 1: IAC

Notes:
- Invisible (seamless) airbag cover
- Logo in leather

CRAFTSMANSHIP EXAMPLE

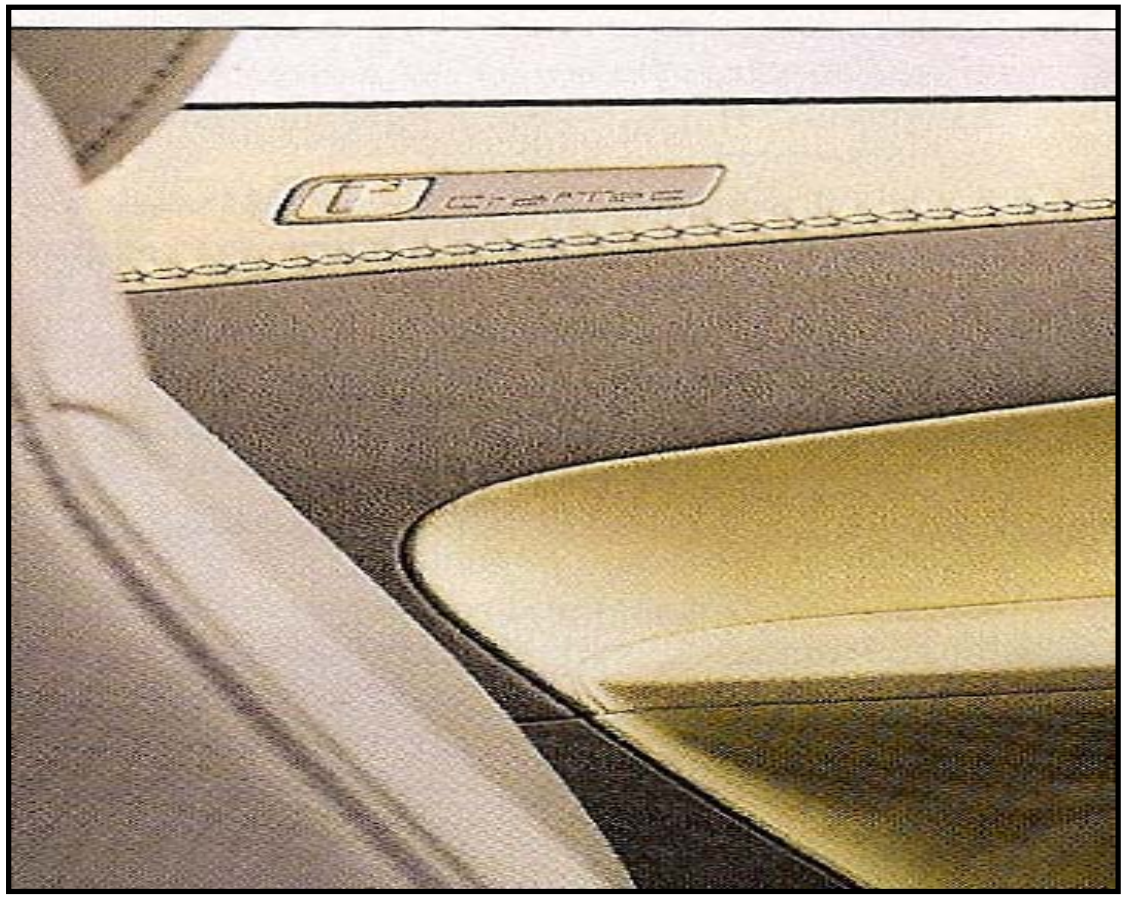


Photo Source: ***Automotive News***

Vehicle: None yet Tier 1: JCI
Process: "Perfect Fit" TF skin, injection molded substrate
Note: Perfect Fit minimizes gaps between surfaces and colors. Perfect Fit is evolution of CrafTec process. Decoration can be via painting or stitching (JCI CrafTec process).

MONO TPO SOLUTIONS TAKING OFF

Photo Source: Fiat

Vehicle:	**Fiat 500**
Resin supplier:	**Borealis (Daplan EE168AE)**
Molder:	**Plastal (Poland)**
Resin:	**Single material TPO (also used for exteriors and bumper)**

INTERIOR UPGRADE EXAMPLE

Photo Source: Robert Eller Associates LLC

Vehicle: Chev. Malibu '08

Module: Instrument panel

Tier 1: Faurecia

Notes:
- 2-tone TPO skin (O'Sullivan)
- Deep instrument cluster
- Sculptured 2-tone surface

INTERIOR UPGRADE EXAMPLE

Photo Source: Robert Eller Associates LLC

Vehicle: Chevrolet Malibu ('08)
Component: Rear door trim panel
Tier 1: JCI
Notes:
- Broad color range, contrasting colors break up monotone look
- Faurecia is IP Tier 1; Delphi is console Tier 1

INTERIOR UPGRADE EXAMPLE

Photo Source: Robert Eller Associates LLC

Vehicle:	Chevrolet Malibu 2008
Module:	Front door trim panel
Tier 1:	JCI?
Note:	2-tone skin/foam 60% coverage

USE OF TPO SKIN AND DESIGN UPGRADE

Photo Source: Robert Eller Associates LLC

Vehicle:	Dodge Ram (2009)
Module:	Instrument panel
Tier 1:	Visteon
Upper Panel:	TPO
Retainer:	PC/ABS

Notes:

- **Stitching on sport version**
- **2-tone tech. (all trim levels)**
- **Upper and lower glove boxes; large, best-in-class glove box volume**
- **Redesigned instr. cluster face**
- **Lg. HVAC louvers in center stack**

ONE PIECE IP TOPPER PAD APPROACH

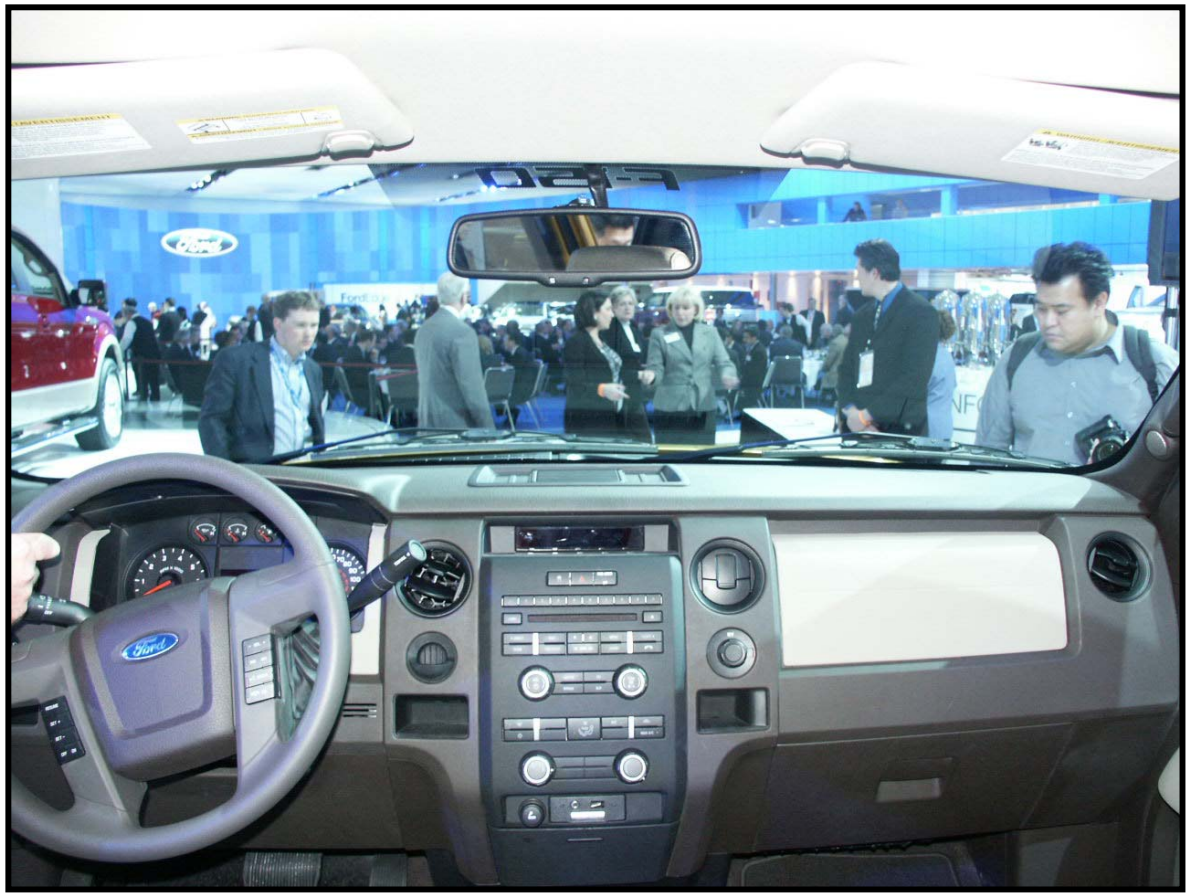


Photo Source: Robert Eller Associates LLC

Vehicle: Ford F-150
Module: Instrument Panel
Tier 1: JCI (via Saline plant acquired from ACH)

Notes:
- Large, visible, vertical airbag door
- Integrated Topper pad

SOME EXAMPLE INTERMATERIALS/ INTERPROCESS COMPETITIONS

COMPONENT	CHALLENGER	INCUMBENT
Door trim skin	- 2-shot TPE	- TF-TPO - PUs
GF-PP applic. (several)	- ILC	- LGF-PP
Headrest/some seat applic.	- EPP	- PU foam
IP skin	- PU/IM 2-shot - TPE 2-shot	- PU spray - Slush(a) - TF-PP
Headliner substrate	- Ltwt. GMT	- GF-PU
Spare tire tubs	- LGF-PP - ILC-PP; GMT	- Steel - SMC

Note: (a) May be TPU, PVC, TPE slush

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008

SUMMARY

- **Macroeconomics:**
  - **driving + limiting technology innovation (in U.S.)**
  - **severe profitability squeeze**

- **Supply chain turbulence will continue and reshape:**
  - **industry structure (path to market)**
  - **interiors technologies**
  - **profitability**

- **Fuel prices:**
  - **major weight-save driving force**
  - **shifting fleet composition (OEM profitability impacts)**

SUMMARY (Cont'd.)

- **Interiors technology drivers:**
  - **internationalization of the N. American fleet**
  - **supply chain efficiency**
  - **upgrade quality/craftsmanship requirements**
  - **PP continued share gain (via new technologies)**
  - **GF-PP structural capability share gains**
  - **bioplastics share gain**

BOTTOM LINE

- **Economic and market drivers are in place.**
- **Improved interiors technologies are available.**
- **Capital availability/willingness to commit in N. America uncertain.**