INNOVATION IN AUTOMOTIVE INTERIOR MATERIALS AND PROCESSES

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PRESENTED AT:
WARD’S AUTO INTERIORS 2016
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• Identify innovative trends in interior materials and processes

• Examine their significance

• Provide examples for:
  - acoustics
  - foams
  - skins
  - coated fabrics
  - composites/3D printing
  - the human machine interface (HMI)

• In the interests of time some innovative interiors technologies have been omitted, for example:
  - composite floor/combined with damping foams
  - hybrid cross car beam
  - acoustic headliner
  - drive-by-wire which could → weight/cost save via elimination of:
    -- steering shaft
    -- brake pedals
The HMI evolution:
- Buttons → touch screens → smart materials and thin film technologies
- Wi-Fi interiors as enabling technology for voice activation

Convenience and Comfort:
- Trim materials: soft touch, luxury feel, even lower gloss
- Continued VOC reduction
- Improved ergonomics

Stronger, Lighter, and Integration:
- More stronger/lighter materials: weight reduction
- Parts integration, “smart” materials where feasible

Environmental, Recycling:
- Today: Lower oil/gas price challenge recycle efforts /fuel economy
- Continued drive for sustainability
- Government directives as driver

Acoustics: Cabin quietness, essential element for perception of refinement

SOURCE: INTEVA; ROBERT ELLER ASSOCIATES LLC, 2016
CONSUMER NEEDS AND WANTS

TECHNICALLY FEASIBLE

MATERIALS AVAILABILITY
MEET SAFETY/ CAFE STANDARDS
FABRICATION PROCESSES

HAS PROFITABILITY BEEN DRIVEN OUT THE SUPPLY CHAIN?

HARMONY BETWEEN INTERIOR COMPONENTS

LAUNCH TIMING

COMMERCIAL VIABILITY

GOOD DESIGN

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
INTERIOR SOFT TRIM PROCESSES/MATERIALS: THE ACTION TODAY

NOTE:
- Indicates recent share gain, “smart” coatings could enter several material types
(a) Polyurethane dispersion (PUD) coated fabrics gaining share, improved TPO grades and SEBS will challenge
(b) Growth process

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
INTERIOR PROCESSES/MATERIALS: FUTURE DIRECTIONS

MATERIALS:
- Natural fiber reinforcement
- Cellulosic nano reinforcements
- Role for graphenes
- Role for carbon fibers
- Smart textiles and thin film sensors

PROCESSES:
- 3D printing
- Smart coatings
- Wi-Fi interiors

FUNCTIONS:
- LED lighting
- Sensing
- Voice activation
- Shielding

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
MAGNESIUM: INTERIORS GROWTH RESTARTING

- Density advantage vs steel and aluminum. Recent growth started in Europe.
- Higher per kg cost: Mg (3.75); Al (1.54); steel (0.40-0.98).
- Ability to mold in thick/thin sections (partially offsets higher $/kg raw material cost).
- Average Mg usage/vehicle in NAFTA still small: ~ 10 lbs.

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
FIBER REINFORCED THERMOPLASTICS: ENTERING SEATING

Cut-away views of the Gen 3 seat show the inner portion of the composite seat back frame and illustrate other features incorporated into the seat, including its Vibratec double-layer foam seat cushion and breathable fabrics. Source: Johnson Controls
GRAPHENE APPLICATIONS IN AUTO INTERIORS

SMART TOUCH

- Hands on sensing
- Seat comfort
- Auto adjust
- Heating

SMART DISPLAYS

SOURCE: GRAPHENICS; UNIVERSITY OF ALABAMA OFFICE OF VICE PRESIDENT FOR RESEARCH AND DEVELOPMENT; ALABAMA INNOVATION AND MENTORING OF ENTREPRENEURS
GRAPHENE APPLICATIONS IN AUTO INTERIORS (CONT’D)

CONDUCTIVE FABRICS/THREAD

NEW COATINGS

SOURCE: GRAPHENICS; UNIVERSITY OF ALABAMA OFFICE OF VICE PRESIDENT FOR RESEARCH AND DEVELOPMENT; ALABAMA INNOVATION AND MENTORING OF ENTREPRENEURS
3D PRINTING: POTENTIAL FOR EXPANDED ROLE IN AUTO INTERIORS

• Major enabling technology: evolving far beyond prototype manufacturing
• Benefits: In combination with carbon fiber (or other fiber/fabric reinforcements), can produce parts with:
  - No/low waste
  - High temp/high strength/light weight/versatile shapes

• Potential interior targets: XC beam, floor and roof modules, mechatronics(e.g. in door)

• 3D = mfg. + use of composites+ scale up = high-potential revolution

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
GROWTH MARKET FOR SBC-TYPE TPEs: FLOOR MATS

• Early-mid growth stage
• OEMs entering to capture market
• Ability to add styling cues
• Post consumer, post industrial recycle
• High value – add
• An aftermarket product
• Key enabler: laser sizing
• Based on SEBS/SBS formulations

• Typical hardness 50-75 Shore A
• Non slip, scratch / abrasion resist
• Can be used in multiple positions
• Easily colored
• High capital investment for molding equipment

PHOTO: THERMOFLEX CORP; HEXPOL TPE; COMMENTS: ROBERT ELLER ASSOCIATES LLC, 2016
CONNECTED/AUTONOMOUS CAR: OPPORTUNITIES FOR PLASTICS AND TPEs?

Printed circuits
RF Shielding
Housings
High temp plastics and TPEs
Wire/cable
Seals
Flexible connectors

Trunk of a self steering vehicle

PHOTO: NEW YORK TIMES
• Wire/cable:
  - could grow from 2.4 km-4.0 km per vehicle
  - drive-by-wire could further increase demand
  - BUT wireless communication (via Wi-Fi could reduce amounts required)

• Flexible connectors: number of connectors will increase from 280 to 350 per vehicle

• Computers: average number per vehicle will increase from 26 in 2006 to 40 in 2018
  BUT computer function could centralize → reduced number of computers

• Shielding requirements will increase and become critical

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
APPROACHES TO INTERIOR ACOUSTIC CONTROL

High damping foams (acoustic and anti-flutter function). Underbody (a)

Note: See some examples of acoustic approaches on GMC Yukon
(a) For example pumpable high damping foams (Teroson) from Henkel. Replace heavy bitumen sheets (weight save)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016
PUMPABLE HIGH DAMPING ACOUSTIC FOAMS

Modal analysis of midsize SUV, exited at front mounts

**Control:**
- No damping foam
- Standard anti-flutter

**Frequency shift with pumpable high damping acoustic foam (Teroson from Henkel)**

Damping foams can shift the resonant frequencies

**IMAGE: HENKEL CORP., 2016**
### IMPROVEMENT TARGETS IN INTERIOR SKIN/FOAM BI-LAMINATES AND COATED FABRICS

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indentation recovery</td>
<td>Important for contact surfaces (a)</td>
</tr>
<tr>
<td>Laser score read-through</td>
<td>Almost all IP skins have converted to invisible passenger side</td>
</tr>
<tr>
<td></td>
<td>driver-side airbags</td>
</tr>
<tr>
<td>Tailoring haptics (c)</td>
<td>Via controlling polyolefin foams/ surface coating</td>
</tr>
<tr>
<td>Performance requirements</td>
<td>- Abrasion resistance; Chemical resistance (b)</td>
</tr>
<tr>
<td></td>
<td>- Stain cleaning; Denim (blue dye cleanability) (e)</td>
</tr>
<tr>
<td>EU interior emissions req’ts</td>
<td>Becoming more severe (d)</td>
</tr>
<tr>
<td>Moving into hand wrap applications (a)</td>
<td>Requires different stiffness/compression requirements</td>
</tr>
<tr>
<td>More leather-like look</td>
<td>Coated fabrics becoming competitive with leather</td>
</tr>
</tbody>
</table>

Note:
(a) Door trim panel, armrest, console cover
(b) NEP (N-ethyl pyrrolidone) resistance requirement being phased out in Europe (VDA standard)
(c) Via both surface touch coatings and foam modification
(d) Interior emission requirements are currently more severe than U.S. or Europe
(e) Requirements increased at GM/ford 1-2 years ago (requires compromise between blue dye and coffee stain cleanability)

**SOURCES: BENECKE KALIKO, TORAY, O’SULLIVAN**
Trade name: Aquence® 5101 from Henkel

Application: laminating foil to substrate for IP, Door trim, others

Incumbent: 2K PU adhesives

Cure: blocked isocyanate, cures on command

Application: spray

Benefits: - aqueous system, low coating weight
- long pot life (14 days), much longer than 2K systems
- high temp resistance (105°C)
- solvent free
- no mixing

Typical coverage: 50 GSM
## SLUSH MOLDED TPE-S INSTRUMENT PANEL SKINS

**Photo: So.F.teR**

<table>
<thead>
<tr>
<th>SKIN TYPE</th>
<th>SHARE (%)</th>
<th>PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>25</td>
<td>Slush molding</td>
</tr>
<tr>
<td>TPO</td>
<td>50</td>
<td>Extrusion; Calendering; Thermoform</td>
</tr>
<tr>
<td>TPU</td>
<td>20</td>
<td>Spray; slush molding</td>
</tr>
<tr>
<td>TPE-S</td>
<td>-</td>
<td>Slush molding; potential new challenger</td>
</tr>
<tr>
<td>Leather/textile</td>
<td>5</td>
<td>Hand wrap; luxury vehicles</td>
</tr>
</tbody>
</table>

**SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016**
• Interiors is a major innovation zone: inter-materials / inter-process challengers to incumbents

• New suppliers entering (Apple, Microsoft, Google) bringing new technologies and associated functionalities that will change material and process capabilities

• The major drivers/opportunity frontiers are:
  - weight save (from new control and sensing modes (voice, light, motion, touch)
  - luxury look and feel (haptics)
  - process improvement to replace outdated component fabrication technology
  - role for 3D composite manufacturing with new materials/process combinations
  - electrical/electronic architecture
  - sensing technology and associated materials (thin film sensors)
  - acoustic improvement

• The major materials challengers are
  - foams (several types including vibration damping foams to replace bitumen)
  - thermoplastic elastomers (TPEs)
  - new generation fillers/reinforcements (carbon fibers, graphenes, cellulosics)
  - improved conductive and “smart” materials

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2016