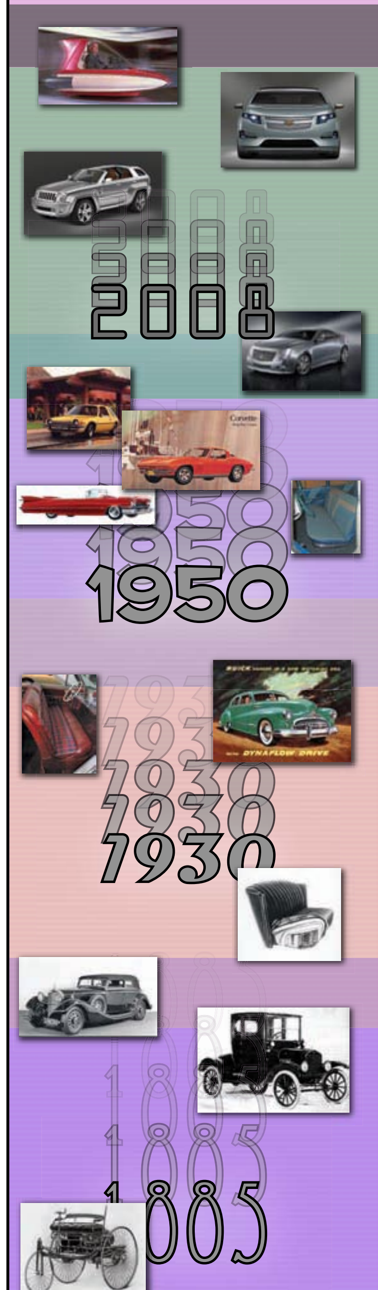
Automotive Cushioning Through the Ages



Material and Construction

Molded Foam (Hot or HR): Individual molded polyurethane foam cushions with complex contours and encapsulated components that are directly assembled on designated frame types. Cushions can be single composition or they can consist of multiple firmness or density zones. These zones are created via chemistry and process (HR) controls and/or component insertion (Hot or HR). After molding, the cover stock is attached to the cushion during the seat build process. Alternatively, a trim cover may be adhered to the cushion during the molding process (mold-in-place).

Components: Cover stock, molded foam, trim attachment, reinforcement cloth, foam inserts, and border wire.

Attached components: Slab foam topper, heater pads, occupant detection sensor, and heating/cooling duct work.

Slab Foam: Individual cushions are fabricated by cutting sections from slab stock foam and gluing them together to form a finished cushion. These sections may be cut from multiple foam types to provide specific hardness or density at targeted locations in the cushion. Additional components for trim attachment or wear prevention are also glued to the cushion.

Components: Cover stock, trim attachments, reinforcement cloth, and slab foam.

Rubberized Hair: An individual or discrete part is molded by combining animal or vegetable hair and latex rubber. This type of cushion is used in two capacities:

1) The molded cushion is contoured so that it fits onto the seat structure, which may or may not include a spring suspension. This pad could also have a foam topper adhered to its surface.

2) Molded as a topper pad for use with traditional polyurethane foam cushions.

Components: Cover Stock, molded pad, topper foam, non-woven materials, trim attachments, metal seat frame.

Latex Rubber Foam: Seats that included latex foam cushioning came in two varieties:

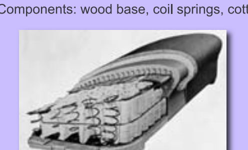
1) Initially latex foam was molded or cut into reasonably thin sections that were then used as a topper material in the previously described sprung seats.

2) Full size cushions were individually molded or cut and shaped from a block sample to achieve the finished pad shape. This cushion replaced the coil spring construction used in sprung seats. The latex cushion was either placed on a solid wood base or rested on a series of horizontal sinusoidal springs attached to a metal frame.

Components: Cover Stock, latex foam, metal springs, wood, metal frame, and topper material.

Sprung Seating: Manual fixing of coil springs to a board; assembly is covered with a cloth or burlap material, multiple layers of padding are added on top of the spring assembly. Padding can include cotton, natural fibers, etc. A trim cover is attached to complete the seat. The seat is assembled using glue, nails, staples, and stitching.

Components: wood base, coil springs, cotton batting, and cover stock.



Cushion Manufacture

HR Foam: An HR foam cushion is produced as a discrete part in an individual tool (mold). The tool rotates on a carousel or racetrack production line past several work stations and through different processing environments. During the 4 – 10 minute cycle that it takes to make a cushion, components are inserted into the tool, a multi-stream pour head delivers a metered amount of foam chemistry, the tool closes and it proceeds through an oven that maintains the heat of the tool at 60° - 70°C. When the part is pulled the tool proceeds down the line and the process starts all over again. Once the foam cushion is removed from the tool it must be crushed, which breaks open the closed cells, and prevents excessive shrinkage. HR foam cushions range in density from 25 – 80 kg/m3 and they can be made from a foam chemistry that uses TDI, MDI or a blend of both isocyanates. HR foam is also used in foam-in-place applications.

Hot Foam: A hot foam cushion is produced as a discrete part in an individual tool (mold). The tool rotates on a carousel or racetrack production line past several work stations and through different processing environments. During the 15 – 20 minute cycle that it takes to make a part, components are inserted into the tool, a pour head delivers a metered amount of foam chemistry, the tool closes and proceeds through an oven that heats it up to 120° C. After the part is pulled the tool from the mold the tool is cooled back down to 40° C and the process starts all over again. Hot foam cushions range in density from 24 – 50 kg/m3 and are made with a foam chemistry that utilizes TDI as an isocyanate.

Slab Foam: A multi-component mix of chemicals, the main two being polyol and isocyanate, are combined at a pour head and the mixture is continuously poured onto a moving belt. The foam rises in a free state, while it is contained on both sides. This process produces a block of foam that is approximately 61 x 2.4 x 1.2 meters. Typical slab foams are produced in the density range of 20 to 60 kg/m3. The block is cured for a minimum of 24 hours under ambient conditions before it is cut in to smaller sections for post processing into the final product. The process includes complicated slicing, contouring, and gluing of one to several slab foam materials and components to obtain a finished cushion.

Rubberized Hair (aka Gummihaar and Gummikokos): The curled fibers are straightened and treated with a latex rubber solution, shaped in a perforated metal mold before being dried and vulcanized. The fibers themselves should be resilient (animal hair preferred), however coil and sisal fibers can also be used, but presumably they give inferior products. The rubber latex is applied to the fiber mats by traversing spray guns on both sides of the fiber pad or batting. The latex is then dried with hot air at 140°C and applied at 2,000 feet/min (approximately 600m/min). A 25mm thick pad with a finished weight of 4oz/ft. (1220g/m2) will contain equal parts of fiber and latex (binder of 55% solids).

Latex Rubber Cushions:
Two manufacturing processes have been used – the Dunlopillo, where a latex froth is made using a very intense Oakes shear mixer and a sodium silicate catalyst. The other process developed by B.F. Goodrich produces foam blocks from which fabricated auto seats are manufactured. This Talalay process requires a vacuum to be pulled on the latex blend followed by an injection of carbon dioxide, which is blasted into the material. The latex blocks are produced in a mold with pins from each side (top and bottom) to help freeze the latex foam during manufacture

Sprung Seats: Individual components are fabricated and assembled together.

Drivers

Future Trends: Lower VOC Foams, Thinner Seats,
Lower Energy / Carbon Footprint Processes,
Incorporation of Recycled Materials, and
Composite Foam Seat Constructions

2008: Accelerated Interest in Lower Mass Foam Seating

2007: Introduction of Vegetable-Oil Based Polyols in Foam Seating

2006: Global Harmonization of Standards Commenced

2006: Trend Toward Decreased Part Thickness Necessitating Foam Density Increase

2004: FMVSS 202a Legislation Introduced

2000 – 2005: Improved Foam Cushion Durability and Comfort Implemented

Early 2000s: Introduction of Flip-Fold Seating

Early 2000s: Inclusion of Airbag Sensors in Seats

Late 1990s – Early 2000: Some OEM Preference for Increased Resiliency

Late 1990s: Commercialization of Heated and Cooled Seats

Late 1980s: Mass Introduction of Heated Seats

1980s: Just in Time Manufacturing Accepted and Promoted

1980 – 2000: Continuous Foam Density Reduction

Late 1970s – Early 1980's: Replacement of Bench Front Seating with Split and Bucket Types

1972: FMVSS 302 Federal Standard Issued

1962: H-Point Manikin Standard Released (SAE J-826)

Late 1950 – 1960s: Foam Standards / Specifications Developed / Issued

Advantages and Disadvantages

HR Foam:

Advantages
- Low Hysteresis Loss / More Resilient
- Lower Energy Cost
- Short Cycle Time
- Wide Process Range (hardness, density, and resiliency)
- Isothermal Mold Temperature
- Higher Compliance with FMVSS 302
- Formulation Can Replicate Latex
- Pour-in-Place Capability

Disadvantages
- Crushing Required
- May Need Post-curing
- More Susceptible to Moisture / Humidity

Hot Foam:

Advantages
- Discrete Process
- Lower Densities
- Good Physical Properties
- No Crush Needed
- Less Susceptible to Moisture / Humidity
- Breathable

Disadvantages
- High Energy Costs
- Long Process Times
- High Number of Molds
- High Waste
- High Hysteresis Loss / Low Resiliency
- Tool Temperature Cycling Required (eg 40°C / 120°C)

Slab Foam:

Advantages
- Economical to Produce
- Low Density Grades Possible
- Relatively Consistent

Disadvantages
- Fabrication Required
  - Expensive
  - Labor Intensive
- Limited Usable Density Range
- Non-Discrete Process
- Scrap (85% efficient)

Rubberized Hair:

Advantages
- Breathable
- Natural Product

Disadvantages
- Labor Intensive
- High Energy Cost
- Odor
- Questionable Comfort
- Suspect Durability
- Part / Product Consistency

Latex Foam:

Advantages
- Low Hysteresis Loss / Good Resiliency
- Natural Product

Disadvantages
- High Density
- Long Cycle Times (Demold)
- High Energy Cost
- Long Cure Time
- High Cost
- Odor
- Low Tear Resistance

Sprung Seats:

Advantages
- Tunable Spring Suspension
- Handcrafted Appearance

Disadvantages
- High Cost
- Labor Intensive
- High Mass
- Many Components

Chemistry

Future Chemistries …….Recycled material content and Low VOC

2005 (onwards)
HR Molded Foam
- Incorporation of polyols with vegetable-oil content

1990 (onwards)
HR Molded Foam
- MDI based chemistries

1990s
HR Molded Foam
- All water blown chemistry, No F-11 (freon)

1980s
HR Molded Foam
- Addition of auxiliary blowing agents, eg. F-11 (freon)

1970 (onwards)
HR Molded Foam
- High molecular weight polyols and TDI or TDI/MDI blend or special isocyanates
- Lower energy input

1960s
Hot Molded Foam
- Polyether polyols and TDI.
- High energy input

1955 (onwards)
Slabstock Foam
- Polyester polyol and TDI
- Polyether polyol and TDI

1930 (onwards)
Latex Rubber Foam
- Natural or synthetic rubber and blowing agent and heat energy

Molded Polyurethane Foam Industry Panel

Mission Statement
The Industry Panel Mission is to Create Automotive Seating Foam Specifications that are Practical and Functionally Driven to Achieve Basic Commonality Within the Automotive Industry and Establish Best Practices

OEM Members
Chrysler LLC: John Reynolds
Ford Motor Company: Brian Witkowski
General Motors: Diane McQueen, Wayne Reeder, and Joe Pellerito

Industry Members
BASF: Roy Pask
Bayer Material Science: Brian Neal
Dow Chemical: Bob Dawe
Huntsman: Bob Lockwood
Johnson Controls: Jim McEvoy
Lear Corporation: Asad Ali and Ash Galbreath
Magna Seating: Jeff Corkins
The Woodbridge Group: Ron Blair, Hamdy Khalil, Dave Miller, and Mark Weierstall

Web Site Coming Soon:
- Full "Cushioning Through the Ages" Report
- Industry Panel Polyurethane Foam Specification
- Recommended Technical Papers
- Molded Foam Guidelines
- Industry Panel Background
- Links to Member Companies and Industry Groups

www.moldedfoam-ip.org

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