

# Dashboard renovation technology for vintage vehicles

István Péter Kondor <sup>1\*</sup>,

<sup>1</sup> Department of Information Technology, GAMF Faculty of Engineering and Computer Science, John von Neumann University, Hungary <https://orcid.org/0000-0001-7815-4278>  
<https://doi.org/10.47833/2026.1.ENG.014>

---

## Keywords:

Dashboard, Renovation technology, Vintage vehicle

## Article history:

Received 17 November 2025  
Revised 5 March 2026  
Accepted 17 March 2026

## Abstract

*In vintage vehicles, interior components such as upholstery, seats, and plastic elements often deteriorate to a condition that necessitates restoration. Because these parts are typically no longer commercially available, specialized renovation technologies must be applied. Dashboards are particularly susceptible to cracking caused by environmental factors—especially UV radiation—as well as to fading of their plastic coatings. This study presents the development of a restoration technology designed specifically for dashboards affected by such degradation. The proposed method includes detailed surface preparation, reconstruction of missing or damaged sections, and retexturing and refinishing of the surface to achieve a durable and authentic result.*

---

## 1 Introduction

The restoration of plastic surfaces in vintage motor vehicles has emerged as a distinctive and increasingly important field within automotive conservation and materials engineering. While the mechanical and structural rehabilitation of classic vehicles has long been the focus of scholarly and industrial attention, the preservation of interior and exterior polymer-based components remains comparatively underexplored. This gap is noteworthy, as plastics introduced during the mid-20th century—such as ABS, PVC, and early polyurethane blends—played a pivotal role in shaping vehicle ergonomics, aesthetics, and manufacturability. After decades of exposure to ultraviolet radiation, temperature fluctuations, mechanical stress, and chemical contaminants, these materials undergo complex degradation processes that manifest as discoloration, embrittlement, surface cracking, and a gradual loss of structural integrity. Consequently, the authentic restoration of plastic components has become a technical challenge that demands a deeper understanding of polymer aging and innovative refurbishment methods. In contrast to metal or wood restoration practices, which are supported by well-established methodologies, the refurbishment of aged automotive plastics often requires interdisciplinary approaches that integrate materials science, surface chemistry, and advanced fabrication technologies. Traditional repair solutions—such as sanding, filler application, and repainting—may restore visual appearance but typically fail to address microstructural deterioration or long-term stability. Moreover, many legacy polymers used in vintage vehicles are no longer manufactured or are incompatible with contemporary repair compounds, necessitating the development of tailored solutions. Recent advances, including solvent-welding techniques, polymer-specific surface reconditioning, additive manufacturing for part reconstruction, and nanocomposite coatings, offer promising pathways for achieving durable and historically accurate restorations.

This paper aims to provide a comprehensive assessment of current and emerging technologies for the refurbishment of plastic surfaces in vintage vehicles. It examines the mechanisms of polymer degradation common to automotive environments, evaluates the effectiveness of established repair practices, and presents novel material-based approaches that enhance both aesthetic fidelity and mechanical performance. Special attention is given to the balance between authenticity and

---

\* Corresponding author.  
E-mail address: [kondor.peter@nje.hu](mailto:kondor.peter@nje.hu)

functionality—an essential consideration in the field of vehicle preservation, where restorers must navigate the tension between maintaining historical accuracy and ensuring practical longevity.

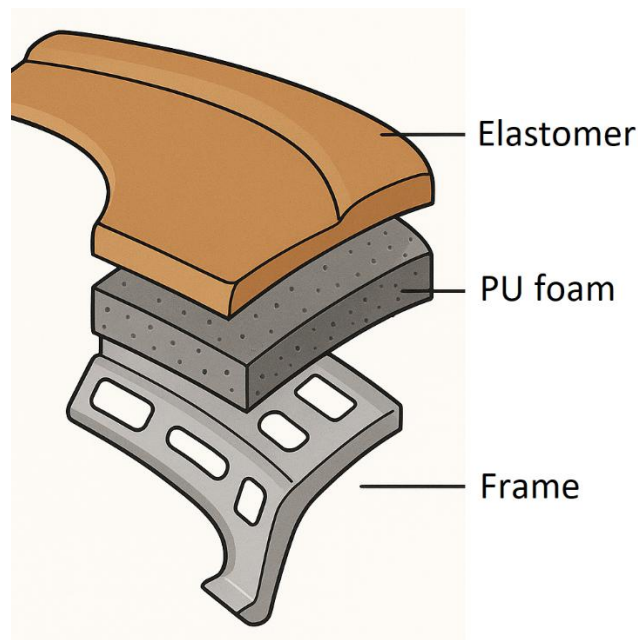
By synthesizing knowledge from conservation science, polymer engineering, and automotive restoration practice, this study seeks to establish a coherent framework for selecting and optimizing restoration strategies. The findings contribute to the broader discourse on sustainable heritage conservation and support the development of standardized methodologies for the long-term preservation of polymer-based components in classic automobiles. [1-5]

## 2 Dashboard materials and structure

Vehicle instrument panels, commonly referred to as dashboards, represent one of the most complex structural and aesthetic components of the automotive interior. Their design integrates mechanical, ergonomic, and safety considerations, while their material composition has evolved substantially over the past decades. Modern and historical approaches to instrument-panel construction reflect advancements in polymer science, manufacturing technologies, and regulatory requirements such as occupant protection and crash performance.

Early instrument panels were typically constructed from metal substrates, often steel, shaped and painted to accommodate gauges and switches. With the growth of mass production and the rise of automotive ergonomics in the mid-20th century, manufacturers progressively adopted polymer-based materials to reduce weight, improve manufacturability, and enhance tactile quality. Today, most dashboards consist of a multi-layered assembly combining structural carriers, energy-absorbing layers, and decorative surfaces.

The structural backbone of contemporary instrument panels is usually a rigid carrier made from polypropylene (PP), ABS (acrylonitrile-butadiene-styrene), or fiber-reinforced composites. These materials provide high dimensional stability, favorable molding characteristics, and compatibility with integrated mounting points for electronics, HVAC systems, airbags, and steering-column components. Fiber reinforcement—commonly glass fibers—is often incorporated to increase stiffness while maintaining comparatively low weight. The structural layout of a typical dashboard is illustrated in Figure 1.



*Figure 1. Dashboard structure*

Covering the structural carrier is a foam layer designed to enhance impact protection and improve tactile comfort. Polyurethane (PU) foam is the most widely used material, applied either through injection molding or in-mold foaming processes. This foam layer acts as an energy-

absorbing medium during collisions, and its density and thickness are carefully engineered to meet safety standards while preserving design geometry.

The outermost surface, known as the skin, serves both functional and aesthetic purposes. Skins are typically manufactured from PVC, TPO (thermoplastic olefin), thermoplastic polyurethane, or, in premium applications, real or synthetic leather. These materials offer durability, UV resistance, and the ability to replicate fine-grain textures that reduce glare and enhance perceived quality. Manufacturing methods—such as slush molding, vacuum forming, or spray foaming—allow precise replication of surface details and color consistency. [6-10]

Additionally, the instrument panel integrates a wide array of embedded technologies, including wiring harnesses, sensors, display modules, and airbag systems. The increasingly digital nature of dashboards, with touchscreens and advanced HMIs (Human–Machine Interfaces), has driven further refinement in material compatibility, thermal management, and structural integrity. The materials used for dashboards and the structural design are listed in Table 1 by vehicle category.

*Table 1. Dashboard Material Structure by Vehicle Category*

<b>Layer / Function</b>	<b>Economy Class</b>	<b>Mid-Range Class</b>	<b>Premium Class</b>
<b>Structural Frame</b>	PP (polypropylene) or ABS injection-molded plastic	PP+GF (glass fiber–reinforced polypropylene)	PP / ABS combined with magnesium or aluminum frame
<b>Energy-Absorbing Layer</b>	EPP (expanded polypropylene) – thin layer	PU foam (cast)	Multi-layer PU or memory foam structure
<b>Surface Cover (Visible Layer)</b>	Hard PVC or TPO (thermoplastic olefin)	Soft-touch PU or TPE (thermoplastic elastomer)	Genuine leather, microfiber leather, or soft PU with stitching
<b>Decorative Inserts</b>	Painted plastic or decals	Chrome-plated or aluminum-look ABS	Real wood, aluminum, or carbon fiber trim
<b>Manufacturing Process</b>	Single-step injection molding	Two-step (frame + foam layer)	Multi-step RIM (Reaction Injection Molding) with vacuum-formed skin
<b>Touch &amp; Appearance</b>	Hard, glossy, simple surface	Soft, matte, pleasant texture	Luxurious, stitched, premium finish
<b>Recyclability</b>	Limited (due to material blends)	Moderate (single-component TPE improves it)	Often low (multi-material laminated structure)

### 3 Renovation technology

Restoring a cracked dashboard in a vintage automobile is a meticulous process that combines surface repair, material reconstruction, and aesthetic refinishing. Because dashboards in older cars were commonly made from vinyl-coated foam, early plastics, or composite structures that degrade with age, the restoration requires careful planning and a step-by-step methodology to ensure both durability and authenticity. The following detailed guide outlines the full restoration process, from initial assessment to final finishing.

#### 3.1 Initial Assessment and Preparation

The first stage of any dashboard restoration is a comprehensive evaluation of the component's condition. Cracks in old dashboards can range from small surface fissures to deep structural splits where the underlying foam or substrate has deteriorated. The inspector should gently press various areas of the dashboard to identify soft spots, foam collapse, or delamination. Special attention must be given to areas around air vents, gauge clusters, speaker grilles, and edges, as these are particularly vulnerable to stress and thermal expansion. Once the dashboard's condition has been documented, it must be prepared for repair. In most cases, removing the dashboard from the vehicle

yields better results, because it allows access to the back side of the structure and provides a stable working environment. Removal typically involves detaching trim panels, disconnecting wiring harnesses for gauges and switches, loosening mounting bolts, and carefully sliding the dashboard out of the cabin. After removal from the vehicle, the dashboard was cleaned using a neutral detergent solution at 35–40 °C, followed by air drying for 12 h. Solvent-based cleaners must be used sparingly to avoid further damaging the aged materials.



Figure 2. Dashboard removed for renovation

Mechanical surface preparation was performed in sequential abrasive stages:

Table 2. Surface preparation stages

Stage	Grit size	Purpose
1	P 180	Removal of degraded surface layer
2	P 240	Surface leveling
3	P 320	Pre-filler preparation
4	P 400	Feathering before priming
5	P 600	Final smoothing before coating

### 3.2 Opening and Stabilizing the Cracks

Once the surface is clean, the cracks must be prepared for repair. Somewhat counterintuitively, restorers often widen the cracks slightly to remove brittle material and to create a V- or U-shaped channel that allows the repair compound to bond more effectively. A rotary tool with a controlled-speed 8,000–12,000 rpm, burr, or a sharp utility knife, can be used for this shaping process. Care must be taken to avoid cutting into reinforcement structures beneath the vinyl or plastic surface. After shaping, the cracks should be cleaned again, this time using a plastic-safe degreasing agent. At this stage, some restorers reinforce large cracks with backing material from behind the dashboard. Fiberglass mesh or flexible plastic strips can be glued behind the crack using epoxy resin, helping stabilize the repaired area and preventing future splitting.



Figure 3. U-shaped cracks milled into the dashboard

The geometric parameters of the channel indicate that the depth ranges from 4 to 10 mm, while the width ranges from 2 to 10 mm. Cracks longer than 50 mm were reinforced from the rear side using fiberglass mesh bonded with epoxy adhesive. The technical parameters are listed in the table below.

Table 3. Epoxy parameters

Mixing ratio	2:1 (resin: hardener)
Pot life	20–25 min at 23 °C
Initial cure	6 h
Full cure	24 h

### 3.3 Rebuilding the Foam and Surface Layer

In dashboards where the underlying foam has collapsed or separated from the surface layer, reconstruction is necessary. Expanding polyurethane foam or two-part flexible filler compounds can be used to rebuild the damaged areas. The foam is typically applied from the underside or injected through small access holes. After curing, the foam is trimmed and sanded to match the original contour. The next step is restoring the outer surface. Specialized dashboard repair fillers—usually flexible epoxies, urethane-based compounds, or vinyl repair materials—are applied into the widened cracks. The filler must be spread smoothly using a plastic applicator and then sanded lightly with fine-grit sandpaper. Multiple application and sanding cycles may be necessary to achieve a seamless transition between repaired and original areas.



Figure 4. Polyurethane foam filled channels

Collapsed foam regions were reconstructed using two-component expanding polyurethane foam. The technical parameters are listed in the table below.

Table 4. Foam characteristics

Free expansion ratio	8:1
Cream time	30–45 s
Tack-free time	8–10 min
Machining time	60 min

After curing, excess foam was trimmed and sanded (P240–P320). Surface contour tolerance was maintained within  $\pm 0.5$  mm compared to original geometry.

### 3.4 Recreating Texture and Grain

To create the surface pattern, it is necessary to prime the polished prepared surface, which ensures the closure of the pores and the adhesion of the next layer. Flexible urethane filler was applied into prepared channels.



*Figure 5. Primed surface prepared for texturing*

The application parameters were as follows: a maximum thickness of 2 mm per layer, a flash-off time of 30–40 minutes between layers, a final curing time of 4 hours before sanding, and final sanding prior to priming performed with P400–P600 grit abrasives. A plastic adhesion promoter was applied in a thin, uniform layer with a wet film thickness of 8–12  $\mu\text{m}$  and a flash-off time of 10 minutes. The flexible primer was applied using an HVLP spray gun with a 1.7 mm nozzle at a pressure of 1.8–2.0 bar, achieving a dry film thickness of 25–35  $\mu\text{m}$ , with a 15-minute flash-off time between coats; it was sandable after 2 hours, reached full cure after 12 hours, and was lightly sanded with P600 prior to texturing.

One of the most critical and challenging steps is reproducing the texture of the original surface. Dashboards from different eras and manufacturers featured various grain patterns, ranging from fine-pebble vinyl textures to deeper sculpted grains. To replicate these textures, technicians often use grain pads or molds. A grain mold can be created by pressing a silicone molding material onto an undamaged section of the dashboard or a similar surface. Once cured, this customized mold is used to imprint texture onto the repair compound. Heat guns or specialized thermal pads help soften the surface for correct impression transfer. For more uniform textures, pre-manufactured grain papers or spray-on texture coatings can also be used, though precision molds typically yield more authentic results.



*Figure 6. Textured polyester-sprayed surface*

In most cases, textured polyester filler can be applied to the prepared primed surface, although with this method the surface pattern differs slightly from the original, however this does not affect the veteran certification process and is a significantly cheaper solution. The technical parameters of the polyester texture applied by spray paint are shown in the table below.

*Table 5. Technical parameters of the polyester texture*

Nozzle diameter	2.0–2.5 mm
Spray pressure	2.0–2.2 bar
Application distance	20–25 cm
Texture layer thickness	150–300 $\mu\text{m}$

The curing time was 30 minutes to become dust-free, 4 hours before recoating, and 24 hours to reach full cure. The figure below shows an original and a surface created with textured polyester filler.

*Figure 7. Original surface texture (right) and surface sprayed with textured polyester filler (left)*

### 3.5 Coloring the surface

After the texture has been restored, the entire dashboard must be prepped for refinishing. A flexible adhesion promoter is applied first, ensuring proper bonding between the repaired surface and the topcoat. This is followed by a primer specifically formulated for vinyl, plastic, or polyurethane surfaces. Color matching is essential for maintaining authenticity. Modern automotive 2K interior paints—typically flexible urethane dyes—offer UV resistance, elasticity, and long-term durability. It is recommended to spray the paint with a 1.3 LVLP spray gun in 1.5-2 lines. The technical parameters of the final paint spraying are summarized in the table below.

*Table 6. Application parameters of painting*

Atomization pressure	1.2–1.5 bar
Number of coats	2
Flash-off between coats	10–15 min
Dry film thickness per coat	20–25 $\mu\text{m}$
Total dry film thickness	40–50 $\mu\text{m}$

The curing time was 20 minutes to become dust-free, 6 hours for handling, and 48 hours to reach full chemical cure. Once the color coat has fully cured, a protective matte or semi-gloss topcoat may be applied. This provides additional UV resistance and helps replicate the original sheen of the dashboard material. The restored dashboard can then be reinstalled. All electrical connections, mounting points, and trim components must be reattached carefully to avoid stress on newly repaired areas. Proper alignment ensures that vents, gauges, and switches fit cleanly into the restored surface.

*Figure 8. Assembled complete restored and painted dashboard*

## 4 Discussion

The restoration methodology presented in this study demonstrates that the renovation of aged and structurally deteriorated dashboards can be performed with a high degree of accuracy and durability when modern materials and controlled repair processes are applied. The results highlight several key insights regarding both the challenges and the opportunities inherent in refurbishing polymer-based components of vintage vehicles. First, the investigation confirms that the predominant forms of dashboard degradation—cracking, UV-induced embrittlement, and foam collapse—are the direct consequences of long-term environmental exposure and material aging. These degradation mechanisms are consistent with the known behavior of mid-20th-century polymers such as PVC, ABS, and polyurethane, which undergo chain scission, plasticizer loss, and surface oxidation over time. The restoration workflow developed in this study aligns well with these aging patterns, as it focuses on stabilizing weakened substrate regions, reconstructing the foam structure, and re-establishing a cohesive and flexible outer surface layer. Second, the application of structured mechanical preparation—specifically the widening of cracks into controlled U-shaped channels—proved essential for achieving lasting repairs. While this step may initially appear counterintuitive, it ensures proper adhesion of filler materials and removes brittle, non-load-bearing polymer fragments. Similar approaches are widely used in composite repair and plastic welding technologies, reinforcing the validity of the method within the broader context of materials engineering. The use of modern polyurethane foams and flexible filler compounds also demonstrated significant advantages. These materials compensate for the limitations of legacy dashboard polymers, offering higher elasticity, improved thermal stability, and compatibility with contemporary coatings. Their ability to integrate smoothly with the remaining structural segments of the dashboard suggests that hybrid old–new material systems can achieve both mechanical performance and aesthetic authenticity—an important requirement for vintage vehicle conservation.

However, certain limitations must be acknowledged. The long-term durability of reconstructed dashboards—particularly in vehicles that continue to be used regularly—requires further investigation. Although the selected materials provide improved UV resistance and flexibility, real-world performance under fluctuating temperatures and mechanical stress can only be assessed through longitudinal studies. Additionally, the restoration process is labor intensive and requires specialized tools and skills, which may limit its applicability for hobby-level restorers or low-budget projects. Another consideration is authenticity. While the described methodology aims to replicate the original appearance and tactile qualities of the dashboard, the use of modern materials inevitably introduces deviations from the original composition. For collectors who require absolute historical accuracy, alternative approaches such as additive manufacturing with period-accurate polymer formulations may be worth exploring in the future. Despite these limitations, the presented renovation technology represents a significant advancement in the preservation of vintage vehicle interiors. By combining traditional craftsmanship with modern material science, it offers a pathway for extending the lifespan of dashboards that would otherwise be impossible to replace. The approach provides restorers with a structured, repeatable workflow that balances authenticity, durability, and practicality.

Future work may focus on comparative testing of different filler materials, UV-protective coatings, and texture reproduction techniques, as well as the integration of digital tools (e.g., 3D scanning and printing) to further enhance accuracy and efficiency. Such developments could contribute to the establishment of standardized restoration protocols within the field of automotive heritage conservation.

## References

- [1] Mark Sonnenschein, Benjamin L. Wendt, Alan K. Schrock, Jean-Marie Sonney, Anthony J. Ryan, The relationship between polyurethane foam microstructure and foam aging, *Polymer*, Volume 49, Issue 4, 2008, Pages 934-942, ISSN 0032-3861, <https://doi.org/10.1016/j.polymer.2008.01.008>.
- [2] Mayer-Trzaskowska, P.; Robakowska, M.; Gierz, Ł.; Pach, J.; Mazur, E. Observation of the Effect of Aging on the Structural Changes of Polyurethane/Polyurea Coatings. *Polymers* **2024**, *16*, 23. <https://doi.org/10.3390/polym16010023>

- 
- [3] Dobrotă, D.; Bărbușiu, A.-M.; Sava, G.-A.; Oleksik, V.Ş. Functional Additives in Automotive Polymer Matrices: Compatibility, Mechanisms, and Industry Challenges. *Polymers* **2025**, *17*, 2328. <https://doi.org/10.3390/polym17172328>
- [4] Vieyra, H.; Molina-Romero, J.M.; Calderón-Nájera, J.d.D.; Santana-Díaz, A. Engineering, Recyclable, and Biodegradable Plastics in the Automotive Industry: A Review. *Polymers* **2022**, *14*, 3412. <https://doi.org/10.3390/polym14163412>
- [5] Shifa Xu, Shengjie Liu, Chunhui Huo, Jinyu Xu, Chao Han, Zixiao Zhu, Hongliang Wu, Meng Ling; Laboratory Investigations into Degradation Mechanism of Polyurethane Concrete Properties under Various Immersion Conditions. *J. Test. Eval.* 2026; <https://doi.org/10.1520/JTE20240618>
- [6] Soykan U, Khaleel M, Cetin S, Yahsi U, Tav C. Investigation of the relation between free volume and physico-mechanical performance in rigid polyurethane foam containing turkey feather fibers: Part 2. *Journal of Cellular Plastics.* 2022;58(6):893-915. doi:10.1177/0021955X221144541
- [7] Al Rifaie M, Abdulhadi H, Mian A. Advances in mechanical metamaterials for vibration isolation: A review. *Advances in Mechanical Engineering.* 2022;14(3). doi:10.1177/16878132221082872
- [8] Arese, M.; Cavallo, B.; Ciaccio, G.; Brunella, V. Characterization of Morphological, Thermal, and Mechanical Performances and UV Ageing Degradation of Post-Consumer Recycled Polypropylene for Automotive Industries. *Materials* **2025**, *18*, 1090. <https://doi.org/10.3390/ma18051090>
- [9] Zhao, W.; Luo, S.; Zhuo, Q.; Liang, Y.; Li, Y.; Dong, H.; Qin, L.; Li, Y. A Comprehensive Study on the Degradation Behavior and Mechanism of Expanded Thermoplastic Polyurethane. *Polymers* **2025**, *17*, 1033. <https://doi.org/10.3390/polym17081033>
- [10] Braga, I.C.; Udriou, R.; Nedelcu, A. Novel Method for Failure Modes Detection in UV-Cured Clear Coated Polymer for Automotive Interior Mechatronic Devices. *Polymers* 2022, *14*, 3811. <https://doi.org/10.3390/polym14183811>