

Auto Body Construction

History and Technique

Overview

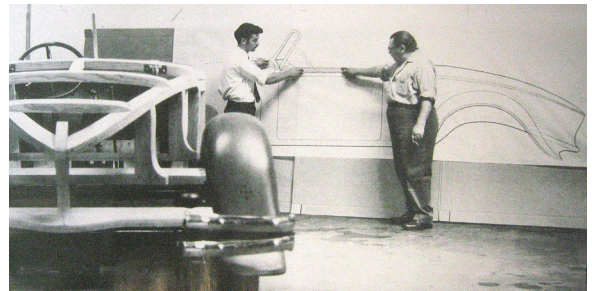
This discussion will focus on four major types of body construction:

- Body on frame (wood sub-structure and pressed steel sub-structure)
- Body as frame (monocoque or unibody)
- Hybrids
- Tubular (superleggera)

History

In the decade before the Great Depression a revolution in automobile body construction took place. Sheet steel or aluminum, sometimes fabric, clad over an ash-wood frame was still the popular technique of constructing touring bodies. Although this labor-intensive style of body construction persisted with some sports cars, notably MG to 1955 and Morgan to this day, the manufacture of pressed steel outer panels and inner structure became much more cost effective for high volume production, which justifies the great investment in large stamping dies and presses. The term “saloon” was associated with this all-metal body construction technique. Only a fabric roof insert persisted on many closed body styles up to WWII.

In 1913, the Dodge brothers hired Edward G. Budd to adapt for automobiles his all-metal pressed steel building process developed for railway cars. Investment in tooling and machinery offset, then decreased the investment in time and skilled labor, while increasing dimensional consistency and parts interchangeability. An additional benefit was that the body stylist would no longer be as constrained by the angularity required with wood-frame body construction. In 1919 the all-steel saloon went into production and contributed to Dodge selling their millionth car in 1923. In 1927 William Morris introduced Budd's automotive body fabrication technology in England.



Until the introduction of the monocoque technique of automobile construction, all car bodies were a separate unit, attached to the primary structural member of the automobile, the frame, which supported the drive train and suspension. As the name implies, it was first used in high volume production by the French company Citroen when they simultaneously introduced front-wheel-drive in 1934 with their 7CV Traction Avant. Shortly thereafter, Chrysler and DeSoto introduced the Air-flow, a styling and engineering benchmark in the U. S. but a marketing failure because of its appearance. Then Cord introduced their 810 and 812 models which closely followed the layout and construction design of the Traction Avant. However it must be noted that the first all steel automobile body/chassis/frame combination was built by Vauxhall in 1903 using heavy plate steel. Then in 1911, Lagonda also in England, introduced but quickly abandoned again this structural concept in a much more stylish 11.1 hp model, but in 1922 Lancia in Italy was much more successful with their monocoque Lambda model.

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In the U.S., there were several early attempts to build unit bodies. Chrysler's 1934 Airflow cars were essentially a space frame with rigidly attached skin to form an integrated unit. While very sturdy, this was heavy, and difficult to build. The Lincoln Zephyr, introduced in 1936, used a similar form of construction, but abandoned it after a few years.

More significantly, Nash and Hudson pioneered different versions of unitized construction in the 1930s. Hudson still used a vestigial frame, mostly as a way of assembling the running gear and other components in the factory, and attached a body engineered as an integral part of this structure. The two main assemblies were mated up with many small bolts, presaging the modern unit body that is welded together. Later in the 1930s, Nash introduced cars that were completely welded together. This type of unit body is still used in the majority of passenger cars built today. Only the doors and front fenders are attached with bolts.

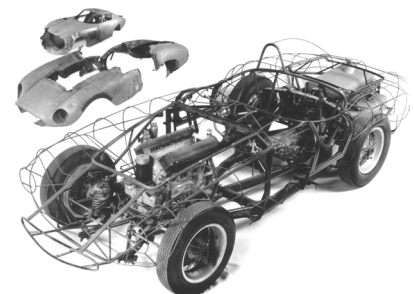
In 1935 GM also became serious about constructing automobiles using this new concept. But since U.S. models were quite large, they chose to test these principles on the Opel Olympia in Germany. Not until their introduction of the Corvair did monocoque construction techniques get applied to mass produced cars for the American market, with the notable exception of Frasier Nash in the early 1950s.

In 1948, Hudson introduced yet another form of unitized construction. In this version, the entire body structure from the firewall back was welded together as a single unit. A separate front structure carrying the engine and front suspension was bolted on, as was all of the front-end sheet metal. This was done as much for assembly considerations as anything. Many GM cars, starting in the late 1960s, were built in a similar fashion to the Hudson.

Many automotive "coach builders" died a slow death after the rise in the popularity of the monocoque technique of automobile construction. Coach builders were the tailors of the automobile business, offering custom body and interior styling and design services along with their catalog of their latest "house" designs.

In fact most high-end automobile manufacturers concentrated on the engineering and design of the mechanical components of their automobiles, not unlike many commercial vehicle manufacturers today. The buyer would order a complete automobile chassis, then shop a large variety of coach builders for a stylish body and interior. The chassis would be shipped to the coach builder for completion of the final product for the buyer.

Still another style of body construction is exclusively associated with Italian designs houses. The Italian Carrozzeria Touring (coach builder) first adapted it for road cars and named it Superleggera (means super light) from German race car designs, starting around 1937. Instead of using wood or steel framing, they fabricated a tubular frame for the body which they covered with an aluminum or steel body skin.



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The Germans borrowed this concept from the Dutch aircraft industry, specifically some of Fokker's designs of WWI. Previous lightweight construction efforts involved covering a wooden body frame with imitation leather, or even more unusual was fabricating a body entirely out of wicker.

Although an oversimplification, Touring's Superleggera system may be thought of as a substitution of bent and welded steel tubing for the structural wood in the body. They formed and shaped thin-wall tubing to the desired contours and shaped sheet steel or aluminum to this to create the body. This technique allowed for incredibly new looking curves and streamlining. If your restoration project is manufactured using this style of body construction (even used by Aston Martin as late as the mid 1960s, such as James Bond's famous DB-5) you are likely to encounter challenges similar in scope and greater in complexity than a wood-framed tourer body. This is particularly true if your project has sustained accident damage which was not properly repaired. Also when the body panels are made of aluminum, dielectric corrosion is a common and terminal condition of age where steel tubing and aluminum touch. This is just as damaging but not as ugly as rust.

An automobile "platform" is the current term used to refer to a manufacturer's chassis designed entirely from sheet metal or composites. But initially a platform was made of round cross-section tubing of various thicknesses and diameters welded together to make a frame, plus sheet metal welded to this tubing to provide additional structural rigidity, floors, and inner body panels. Oval and square section tubing was also used later. Platforms that used tubing were much too expensive for mass production and low-priced automobiles. Hence, high-volume platforms were made of sheet steel stampings and box sections entirely, with some exceptions. The VW bug is a good example.

Beautiful post-war examples that illustrate this subject include:

- Mercedes 300SL (contemporary tubular) versus the 190SL (monocoque construction)
- Jaguar XK 120 to 150 (body on frame) versus the E-Type (combination of monocoque with tubular sub-frame progression)
- VW bug (stamped steel platform with stressed steel body)
- Ford GT40 (early example of a complete monocoque design on a fully enclosed body race car)

Fiberglass examples include the 1953 Corvette (body on frame) and the 1958 Lotus Elite (first attempt to create a monocoque fiberglass body)

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Implications for the Auto Restorer



What does this mean for the restoration of an automobile? By far the easiest type of body construction style to restore is the saloon style (unless you are so lucky to find good wood all about in a tourer style of body). This also applies to convertibles or roadsters which tend to collect a lot more moisture in their first life. These all-steel bodies mounted on separate chassis-frames are less complex because they are a simpler structural designs with minimal complexity added for structural stiffening. Generally the most challenging restoration subject is the monocoque style which incorporates many closed structural box-sections that are perfect rust incubators, until special treatment of the steel and careful design eventually helped eliminate much of this disease during the last two decades of the twentieth century. Finding and correcting wrenching damage caused by a collision is also much more complex in a monocoque automobile.