Role of Glass in Automotive Design Synthesis: Functional and Aesthetic Aspects

George D. Liamadis
Dipl Arch, PgD/MA Automotive Design
Aristotle University of Thessaloniki

Keywords

Due to the continuous technical progress of glass as a material, designers are now able to make increasing use of transparent areas in automobiles. Glass plays a key role in the synthesis of automotive forms, determining the relation between full and empty space, and the contrast of light and dark areas. Due to its sleek, highly reflective surface, glass further emphasizes the form of the car, through the reflections of light and the surroundings on panels. Extended glass surfaces are perceived as a styling element related to advanced automotive technology. Size of windows, not only indicate the typology and character of the vehicle in terms of styling, but also determine driver and passenger's perception of internal space, speed and safety. While small glass surfaces are used by some manufacturers to create close, protective interiors and robust exteriors to make cars look and feel more safe, quite the opposite may be thought of as a safety feature. Indeed, by incorporating extended glass surfaces, we enhance driver's visibility, thus achieving an increased perception of speed and therefore we reduce subjective safety feeling, making drivers more responsible in terms of their own risks. In addition, increased eye-contact with pedestrians and other motorists, tend to make drivers more socially aware and sensitive regarding the consequences of their actions. Car interior is neither an exclusively private nor a public space. Different degrees of privatization of car interior space can be achieved due to variable opacity (electrochrome) glass. Furthermore, glass is starting to perform many more functions: defrosting windscreens with incorporated radio aerial, heat-reflectant glass and coming soon anti-intrusion and water-repellent glass. Taken into account that it can also now be moulded in increasingly complex forms, glass is expected to allow designers an even more freedom in synthesis of automotive forms, thus enforcing its role in car design and styling.

Introduction

Transparency plays a significant role in synthesis, whether research is upon architectural, industrial or automotive design.

The evolution of automotive forms, has always been to some extend dictated by the physical limits imposed by glass as a material. Today, approximately 15-20% of a car's external surface is glass, percentage which is subject to further increase, bearing in mind the enhanced freedom offered to designers by the continuous progress of glass as a material and the introduction of plastic alternatives such as polycarbonate. Glass, apart from the major and archetypical role of providing a closed and yet transparent cell that turns driving into an all-weather activity, is now commissioned to satisfy various other functional and aesthetic requirements in automotive design and styling.

This paper aims to research these functional and aesthetic aspects of the role of glass in contemporary automotive styling trends, through diachronic principles of the architectural/design synthesis.

Transparency and Reflectiveness: Full and Empty Space

Two are the basic inherent qualities of glass that determine its role in automotive applications: it is a transparent and highly reflective material. What the human eye most of the time perceives is no other than a combination of these two qualities. However, this is a non-static combination and according to the surrounding environment and light conditions, one may prevail upon the other.

In his 1932 article "The Automobile Standard and Artistic Creation", Walter Gropius discussed the varied possibilities of the car designer's art: " Nowadays designers lay stress on the essential research, on understanding the function of those objects, which are to be created, and they use the

specific laws of form-making – that is, laws of rhythm, proportion, of light-dark contrast, of balance and of the full and empty space – adopting them logically to the technical procedures used by the engineer".

Glass has a key role in these principles of synthesis. When reflections prevail upon transparency, glass represents the dark areas of the form in the above-mentioned light-dark contrast, while when it comes to transparency, glass is the empty space in the balance between full and empty. Both these contrasts are crucial in design synthesis as, when used properly, can effectively provide the vehicle with the desirable character and indicate its function. A typical example is that of the proportion between glass and solid parts in sports cars and in small utility cars. In sports cars, glass surfaces are fairly small when compared to solid, opaque metal areas. Windows, specially the side ones, are low participating to the car's limited overall height, and enhancing by this horizontality the impression of a stretched body, synonym of dynamism and speed. Quite the opposite applies for city commuters. These small cars incorporate taller glass areas, to emphasize verticality, and thus express the feeling of enhanced visibility and spaciousness though within a short overall length. A similar formal language applies in the styling of the so-called "voitures a vivre" (MPVs such as

Renault Espace, Scenic or even more Fiat Multipla), best suited to express the message of a "car to live in".

Proportion between solid and transparent parts determines how we perceive the overall volume of a vehicle. This is one of the main reasons why certain cars may look under- or oversized, smaller of larger than they really are. A proper handling of these aspects on behalf of the designer, may lead to the creation of a form incorporating certain desired characteristics: for example a large limousine that hides its volume (see BMW 7 series vs. previous Mercedes S-class), an A-segment car that looks more spacious than its rivals, or a car that although classified in one segment aims partly to the next bigger segment market (Citroen C5).

Car designs proportioned in favour of solid rather than transparent, tend to look muscular, thus providing a visual feeling of strength and safety. This is a typical aspect of German car design, incorporated to reflect their cars' high standards of passive safety and reliability, onto the body form. In contrast, most of French car design incorporates larger glass surfaces, thus achieving a balance that best suites their national characteristic of elegance. Proportioning not only successfully relates to the national identity of the product, but brand identity in particular as well. High beltlines and narrow side glazing is a synonym of Alfa Romeo's sports identity while the opposite applies

Car Segment		Glazing/paneling (height)
Sports Car (Audi TT)		4/10
C Segment (VW New Beetle)		5,3/10
B Segment (Renault Clio)		6,3/10
Medium MPV (Fiat Multipla)		8,4/10
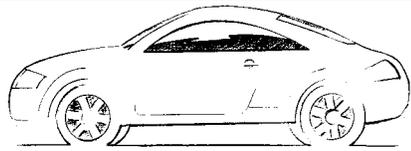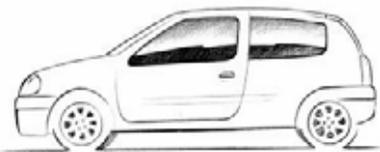
Fig.1: Car typologies and the proportion of side glazing height to panelling height

for the PSA Peugeot-Citroen Group.

However, apart from transparency, glass under most lighting conditions reveals one more of its basic qualities as a material: its sleek surfaces constantly reflect light and images of the surrounding environment. In contrast to architecture where the form is a synthesis of volumes, in automotive design, forms are defined through intersecting surfaces and reflections. Glass panels form a unity together with the similarly reflective metal panels of the car body, emphasizing the overall shape through the reflections. This is undoubtedly the most interesting aspect of the role of glass in car design synthesis. Despite the general similarities between automotive and architectural design and the common basic principles of form-making, a major difference in the use of glass is hereby remarked. While most building materials (that consist the "full", solid), have rough non-reflective surfaces and therefore are in a relation of contrast to the glass surfaces (covering the "empty", transparent), quite the opposite applies to car design. Here, both full and empty space is represented by reflecting materials, thus creating not only the contrast of solid and transparent, but a unity of reflected images at the same time. Light and image reflections are constantly changing as car passes by, further emphasizing movement and creating an illusion of transformation which is inherent part of a running car's impressionistic nature (in fact it is our perception of the car that is impressionistic).

Finally, regarding reflections, it is worth to mention the extended use of glass usually being made in public transportation means, in order to reflect images of the surrounding cityscape. This way, visual consequences arising from the use of modern ultra-high-tech transport systems in traditional environments is eliminated, and trams such as the ones of Strasbourg and Milan are harmonically embodied in historical city centers.

Perceptions of space, speed and safety

Size of windows on cars, not only indicate the typology and character of the vehicle in terms of styling, but also determine driver and passenger's subjective perception of internal space, speed and safety.

Indeed, extended glazing is usually incorporated in small urban commuters to create a feeling of spaciousness for the objectively cramped interiors. This feeling is also desired in other kinds of utility vehicles such as the pre-mentioned MPVs, where functionality and liveability of character seek for visibility and roominess. Brightness of interiors may often be part of the brand identity of some manufacturers, while others are rather orientated towards close, protective interiors and robust exteriors that make cars both look and feel safer. Such characteristics, typical of the German prestige saloons, are often expressed through small windows, restricted views and dark materials that tend to look classier.

Besides, size of the windows in a car determines passenger's perception of speed. Indeed, small glass surfaces translate into restricted view, less visual information, less moving objects around, and therefore restrained feeling of speed and relaxed journey. This is an additional reason why fast or prestige cars have small windows. However, interesting seem to appear concepts of sport-cars that incorporate large glass surfaces and due to the resulting increased feeling of speed, offer the pleasure of subjectively fast driving at relatively lower actual speeds.

Such a concept may also be introduced as a safety feature. Considering the existence of a subjective, non-measurable kind of safety (apart from the conventional terms of active and passive safety), one should say that safe may rather be a car that prevents drivers from attitude of speeding, than one that creates the feeling of subjective over-protection. Providing the drivers with good views, we create an over-perception of speed that makes them more sensible/responsible in terms of their own risks.

Enhanced visibility can be advantageous for some more reasons. Increased eye-contact with pedestrians and other motorists, tend to make drivers more socially aware and sensitive regarding the consequences of their actions, specially if urban cars is the case. Research carried out with owners of Twingos, Fiat 500s and Pandas and Nissan Micras in three Swiss cities by Pascal Amphoux from Lausanne's Ecole Polytechnique Federale shows that these drivers attribute a "specifically urban quality" to this type of vehicle. It takes several forms. The driver is attracted by his environment. Thanks to the transparency and agility of his car, he feels he is in direct contact with the urban landscape, maintains a special relationship with other car drivers, and feels at one with other small cars. He is also involved in communication, real or imaginary, with pedestrians. On the other hand, drivers of "large" cars display attitudes of distance, protection, and even detachment with regard to the environment[1]. We may therefore conclude that there is a well-established relation between glass as a means of transparency and the creation of safe and friendly automobiles.

Finally, good visibility not only outwards, but through other cars is also crucial in terms of safety, as it enables drivers to watch through the leading traffic, and be aware of what is taking place further front in order to take the necessary precautions or achieve faster reactions.

Private and Public Space

Fig. 2: Tinted glass in American car sulture: over-privatization of a public activity arises questions of ethics.

Any kind of inhabitable construction, whether static or mobile, is a physical boundary between private and public space. Indeed, house interiors are no other than private spaces allowing individual activities, essential for the psychism or, in other words, the spiritual welfare of human nature. Glass comes as a means to allow visual contact inside out when desired. While degree of privatization can be fully adjustable in case of houses, not the same applies for other inhabitable places. Car interior is neither an exclusively private, nor a public space. Under normal circumstances, drivers and passengers of different cars can see each other, far more in the case of urban commuting when they move quite close to each other. We could hardly ignore or underestimate passenger's need for privacy, this being one of the major advantages of private motoring vs public transportation. Use of certain kinds of glass may allow visual contact inside out but not vice versa. This is the case of American limousines incorporating dark tinted glass, to visually protect drivers and VIP passengers in the back seat.

Fig. 3: Latest research shows that transparency makes drivers more socially sonscious. Here, Citroen's latest concept car "Osmose".

However, considering that driving is a public action, as our mobility takes place in a shared road network and interacts with other's mobility, matters of ethics may arise on whether drivers should be visually exposed or not. Visual isolation introduces a model of social behaviour where anonymity may serve unacceptable actions.

"There are times when you lose your cool in the traffic and end up hurling the sort of insults at some other driver you wouldn't use to your worst enemy face to face. Then unusually, the pair of you pull up side by side at the lights and all you feel is a slight sense of embarrassment and a somewhat stronger impulse to avoid eye contact." This model of driver behaviour, perhaps more common in the Latin countries than elsewhere, was described as part of the brief given to students commissioned to design "A Car for a Friend". The main idea behind this project was that when you are inside a roofless car or even an ordinary one that has almost half its surface made of glass, it is more difficult to cut yourself off from the rest of the world.[2] Here, transparency as a means to un-privatize the car interior, is used to create a more socially conscious driver profile.

Quite the opposite applies in the case of car design concepts that incorporate solid and aggressive styling cues with small glazing areas. Such paradigms observed lately in both the form of prototypes and concepts presented in automotive design courses, may be considered to express socio-cultural trends of uncertainty, defence or even fear towards a future that "is no more what it used to be" –to quote French poet Paul Valery's famous words.

We should therefore conclude that the role of glass exceeds the paradox of a material that becomes invisible or reflective according to the viewpoint, permeable to light but impermeable to air, water, noise or energy. Apart from being a selective membrane, which both is and is not a limit, glass defines a whole sociology of space, in the sense that transparency between private and public space may discourage or patronize models of social behaviour.

Glass Curvature: Streamlining and Aerodynamics

Perhaps no other milestone in the technology of glass has ever been more influential in the evolution of automotive forms, than introduction of glass curvature. Indeed, curved glass grew to a keystone in the history of both streamlining as a historical aesthetic phenomenon and aerodynamics as a scientific concern to minimize drag.

Streamlining appeared as soon as the late 20's, when car racing started to research how to

[1] [1] R&D, The Road of Innovation, issue No 18, Renault Corporate Communications, France 2000
[2] [2] Project in European Design Institute by Carsten Astheimer, ("Transparent Thoughts", Auto & Design, issue 113, p.82)
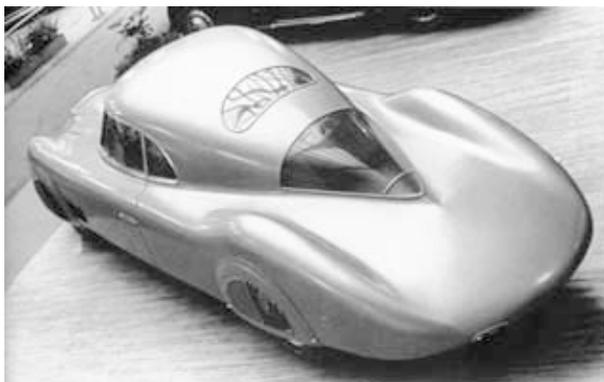
Fig. 4: Glass curvature allowed exceptional streamlined forms like the 1937 Pinin Farina Lancia Aprilia Berlinetta Aerodynamica or the Citroen DS19.

into two components: physically verifiable shape offering the least possible wind resistance, and the 'form' in which it appears. Therefore automotive design has been enabled to move from volumetric homogeneity and harmonious, unaggressive dynamism of streamlining, to heterogeneous 'wedge' shapes, still aerodynamic but also appropriate to contemporary functional and aesthetic needs. Within this context, glass curvature, relieved from exaggeration of the past, has attained a golden mean between eliminated resistance, undistorted vision, simplicity of construction and aesthetic quality.

Glass and Automotive Typologies

We have already mentioned the significant role of glass (both overall glass surface and the proportion of glazing/paneling) in the determination of different car typologies, from city commuters and MPVs to sports cars.

Fig. 5: 1968 Quasar city car, by Quasar Khahn.

Fig. 6: 1972 Kar-a-sutra, by Mario Bellini.

maximize speed by reducing wind resistance, and manufacturers came to explore styling as a means to optimize sales by moving consumers beyond mere subsistence into the complex area of taste. Although early streamlined automobiles incorporated V-shaped faceted windscreens, curved glass was introduced in concept cars no later than the early 30's. By the 50's, wraparound windshields, despite difficulty of construction and problems of distorted vision, became the trademark of an aesthetic language that would dominate American market, while streamlining became for critics almost a synonym for this vulgar 'made in Detroit' goods aesthetic. Europe made use of glass curvature in a more discreet way to provide well-balanced sculptural forms of absolute beauty. Such results of astonishing bodywork as the famous Citroen DS19 would hardly have been reached without the potential of glass curvature. Curved glazing changed the appearance of the car's whole upper structure, allowed more interior room to be included in car body design and enabled stylists to mold smoother, more continuous body lines.

Today, research to minimize drag is rather for the optimization of effectiveness than the maximization of speed. To this extend, even if not in the first line as in the 70's and 80's, it has remained entirely up to date, justified in terms of ecology and environmental politics. The formerly coherent formal statement of streamlining has split

Hereby, we examine some cases of excessive use of glass in concept cars inspired by alternative

forms of automotive culture. One could hardly find a better example of transparency in automobiles than the Quasar city car. Presented in London of the 60's by the architect/designer Quasar Khahn, this glass room on wheels intended to bring about a minimal approach (with a maximal impact) in terms of urban motoring image. Due to a transparent form that eliminated the visual perception of the body cell itself and abolished any interior-to-exterior separation, fully exposed fashionably dressed passengers were given a leading role, compatible with the socio-cultural trends of the time.

A rather interesting overview of social situations, clearly biased by the social values of the actual period, was Mario Bellini's "Kar-a-sutra", presented in 1972. The concept, regarded to have inspired the MPVs of the 80's, dealt with the relationship between living and travelling, viewing the car as a territory and basis for the modern, western culture. The presence of transparency and light is essential within a concept with flexible interior and furnishing made to suit the social situation instead of people adapting to a certain set of furniture.

Large areas of glass on Citroen's latest concept, "Osmose", also seem to highlight the objective to address the broader issue of a more responsible mode of usage, open to the outside world, and reflecting the interchangeability of the status of pedestrian and the status of motorist. This passenger car initiates a new form of relations between pedestrians and motorists, suggesting mobility shared by people who in theory have nothing in common apart from the fact that they happen to be going in the same direction.

Modern versions of "cars to live in" (voitures a vivre), like Nissan's latest Chappo incorporate extended glazing on the roof, while the same applies for similar production models that often come with double sunroofs.

Extended research upon new vehicle typologies likely to emerge in the near future, come from well-established Automotive Design courses. An original concept regarding the use of glass, is the "All-Terrain Tourist Vehicle" by A.Koning presented at the 2000 Industrial Design Graduate Show in Coventry University. It is a vehicle with glass all around to facilitate sightseeing in tourist areas. RCA student Pierre-Olivier Garcia has gone one step further with his "car to visit London" incorporating windscreen with head-up display to provide useful information (maps, history, museums etc.). Torkel Dohmers of RCA, based his "widescreen" vehicle that allows users to explore and interact with cityscape, on external panels of variable transparency and head-up displays.

Current automotive research and development is moving towards Telematics, ITSs and Automated Highways. If cars of the near future will

Fig. 7: 2000 Xine, concept of a "widescreen" car based on variable opacity glass technology, by T. Dohmers, RCA student.

be automatically guided through intelligent navigation systems rather than being driven, visual contact with the outside world will be no more necessary in terms of "driving". However, cars incorporating no windows at all, like the "Concept 2096" developed (by the Automotive Design Department at Coventry University in 1996) as a prediction for cars 100 ahead, are very unlikely to emerge due to social and psychological reasons. At the contrary, development of automation may further promote extended use of glass, as passengers will be free to enjoy the trip and the surrounding scenery.

Due to the continuous technical progress, glass is starting to perform many more than the basic functions: variable opacity (electrochrome) glass that enables adjustable degree of privatization of the car interior, defrosting windscreens with incorporated radio aerial, heat-reflectant glass that adsorbs and reflects back infra-red rays and coming soon anti-intrusion and water-repellent glass with a surface that water rolls off. Taken into account that it can also now be moulded in increasingly complex forms, glass is expected to allow designers an even more freedom in the synthesis of automotive forms and typologies, thus enforcing its role in car design and styling.

Bibliography:

- Conran T., "Design", Conran octopus, London, 1996.
- "Industrial Design-Reflections of a century", Edit. by Jocelyn de Noblet, Paris, 1993.
- Jencks Ch., "What is Postmodernism", Academy Editions, UK, 1996
- Liamadis G.D., "Transportation Means for the city of Thessaloniki", Automotive Design Dissertation, Coventry University, 1997.
- Lichtenstein Cl., Engler Fr., "Streamlined, A Metaphor for Progress", Lars Mueller Publishers, 1999

- Margolius I., "Automobiles by Architects", Wiley-Academy, UK, 2000
- Philips, "Vision of the Future", V+K Publishing, The Netherlands, 1996.
- RCA, "Moving Objects", Eye Q Limited, London, 1999
- Rees Ch., "Concept Cars", Anness Publishing Limited, London, 1999
- Riley R.Q., "Alternative Cars in the 21st Century", Society of Automotive Engineers, U.S.A., 1994.

Journals:

- Auto & Design, Torino, Italy

- Co-Design journal, UK, 1996-1998.
- Domus, Editoriale Domus, Milan, 1997-2001
- Ottagono, Milan, Italy, 1997-2001
- R&D, Renault, 1999-2001

Web sites:

- http//www.cardesignnews.com
- http//www.fiat.com
- http//www.ppg.com
- http//www.renault.com
- http//www.vw.com

Poster 20