Patent FR 2009742 of 24/09/2020

Publication number INPI 3 114 273

Genesis of a new generation of automotive structure

V 2.3 06/08/2025

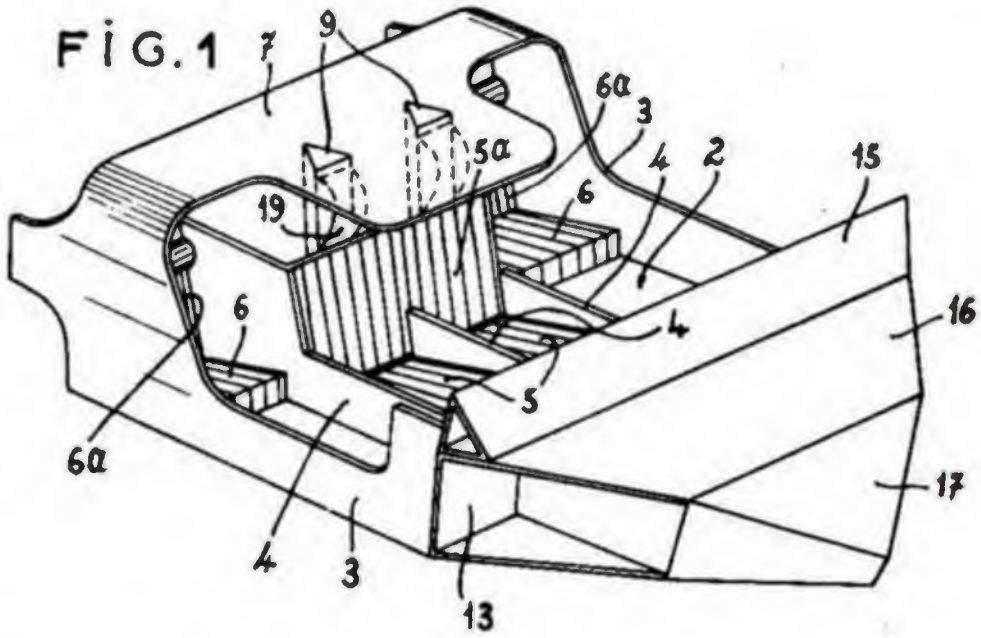
1966: Jean CELLE — practicing single seater car racing

Albi race track

Magny-Cours

What a great road handling, what a great dynamical and aerodynamical efficiency!
What about transferring that to a 4-seater car?

This idea led to the submission of a patent for a 4-seater automotive structure, like 4 single-seater cockpits slotted together, on a same horizontal plane:



Brevet No 1.523.328 du 13 mars 1967
Structure pour automobile

Illustration for the patent registered on 13 March 1967 (patent number 1.523.328), automotive structure for a 4-seater grand tourer type

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13 April 1967: Nuccio Bertone confirming he received the patent...

bertone

CARROZZERIA BERTONE S. A. S. - CORSO CANONICO ALLAMANO, 201 - TELEFONO 783.222 - GRUGLIASCO - CASELLA POSTALE 216|FERR. - TELEGR. BERTONECAR - TORINO

servizio commerciale

Egr. Sig.
Jean Celle
11, Rue Boissac
69 - LYON - 2me
Francia

Grugliasco, 13 aprile 1967

Oggetto : brevetto struttura automobilistica

Ci riferiamo alla Sua cortese lettera del 10 corrente per segnalar-Le che abbiamo esaminato il brevetto da Lei gentilmente comunicatoci.

Si tratta di una applicazione quanto mai complessa che può essere determinata solo da un telaio appositamente costruito e quindi riguardante soprattutto le Case costruttrici più che un carrozziere.

Comunque La ringraziamo per la Sua segnalazione e non mancheremo di tenerLa al corrente qualora trovassimo qualche argomento di un certo interesse per la nostra azienda.

Con l'occasione voglia gradire i ns. migliori saluti.

Carrozzeria BERTONE s.a.s.
N.Bertone

EP/gl
SC/1199

1973: Paris motor show, Bertone presents the “Trapeze”, directly inspired by my patent!

L'ÉQUIPE MOTEURS — MARDI 2 OCTOBRE 1973

Bertone innove pour le Salon — 2 OCT. 1973

Au Salon de l'Auto, qui ouvrira ses portes jeudi, vous pourrez voir une intéressante étude de Bertone pour une 4 places à moteur central.

4 places en quinconce sur ce prototype Bertone

On pourra le voir au Salon de Paris, sur le stand Bertone. C'est un prototype unique réalisé par le célèbre carrossier italien, qui a cherché à résoudre le difficile problème de l'habitabilité pour quatre personnes dans une voiture à moteur central.

La solution est originale avec quatre places en quinconce.

Certes on peut le voir sur nos photos, la visibilité semble partielle avec une surface vitrée très importante. On ne relève aucun angle mort.

Quant au groupe propulseur, il s'agit de celui de la NSU RO 80 qui est monté en position centrale.

L'Automobile - Novembre 1973

BERTONE

Public Relations Department

Grugliasco, October 1973

Press Release no. 7/73

Alongside production models at the Paris Motorshow, Bertone will also be presenting a unique prototype which goes by the name of «TRAPEZE» (x) and uses the engine of the AUDI-NSU RO 80.

This vehicle is an attempt by Bertone at examining in greater detail the very difficult but interesting problem of passenger space in vehicles with a central engine.

Given the unquestionable superiority of the features of Gran Turismo vehicles with a central engine as compared with traditional solutions, it only remains to reconcile these features with general comfort.

Excellent results have been obtained with crosswise positioning of the engine to give two seats (for example, the Miura on which this solution was adopted as far back as 1966).

The problem becomes more difficult, however, if you want to position the engine lengthwise (for optimum distribution of weight) and, at the same time, seat four passengers.

The «TRAPEZE» is an attempt at solving this problem. It is an experiment to find a new solution of accomodating passengers inside the vehicle. The arrangement adopted has considerable advantages over the traditional one. The disaligned position of the rear passenger with respect to the one in front povides him an excellent view. Also, the two front seats which are very closed together allows the rear passenger to stretch his legs out in the wide gap between the front seat and the side door, thus guaranteeing the comfort of all four passengers. This solution also allows the rear passengers to get out of the vehicle easier.

The wide gap between the front seat and the side door also acts as a safeguard in the case of collisions on the side, thus increasing the safety of the passengers.

On the «TRAPEZE», Bertone has also been able to try out a few purely aesthetic solutions with regard to protection on the side. The functional aspect of this problem is being tackled by the technical people. We believe that the rigorous specification put forward by the American DOT on safety, after the inevitable deadlock period which we are probably still going through, constitutes an excellent "challenge" to the designer to solve the numeros problems put forward from the aesthetic point of view which, although meeting the undeniable demands of safety, have effected considerably the public at large.

Concrete dependable research into these problem is economically demanding and only within the possibilities of large-scale manufacturers and research centres.

Bertone has tried to look beyond the immediate future logically and practically even it means not confronting the problem as a whole which will be possible when the contrasting problems with regard to safety are solved.

DIMENSIONS

- Length	4080 mm.
- Width	1830 mm.
- Height	1100 mm.
- Wheel Base	2430 mm.
- Front track	1390 mm.
- Rear track	1530 mm.

Carrozzeria Bertone S.p.A.
Servizio Pubbliche Relazioni

(x) The name of the vehicle is derived from the special arrangement of the passengers inside.

This automotive structure patent was too innovating at the time!

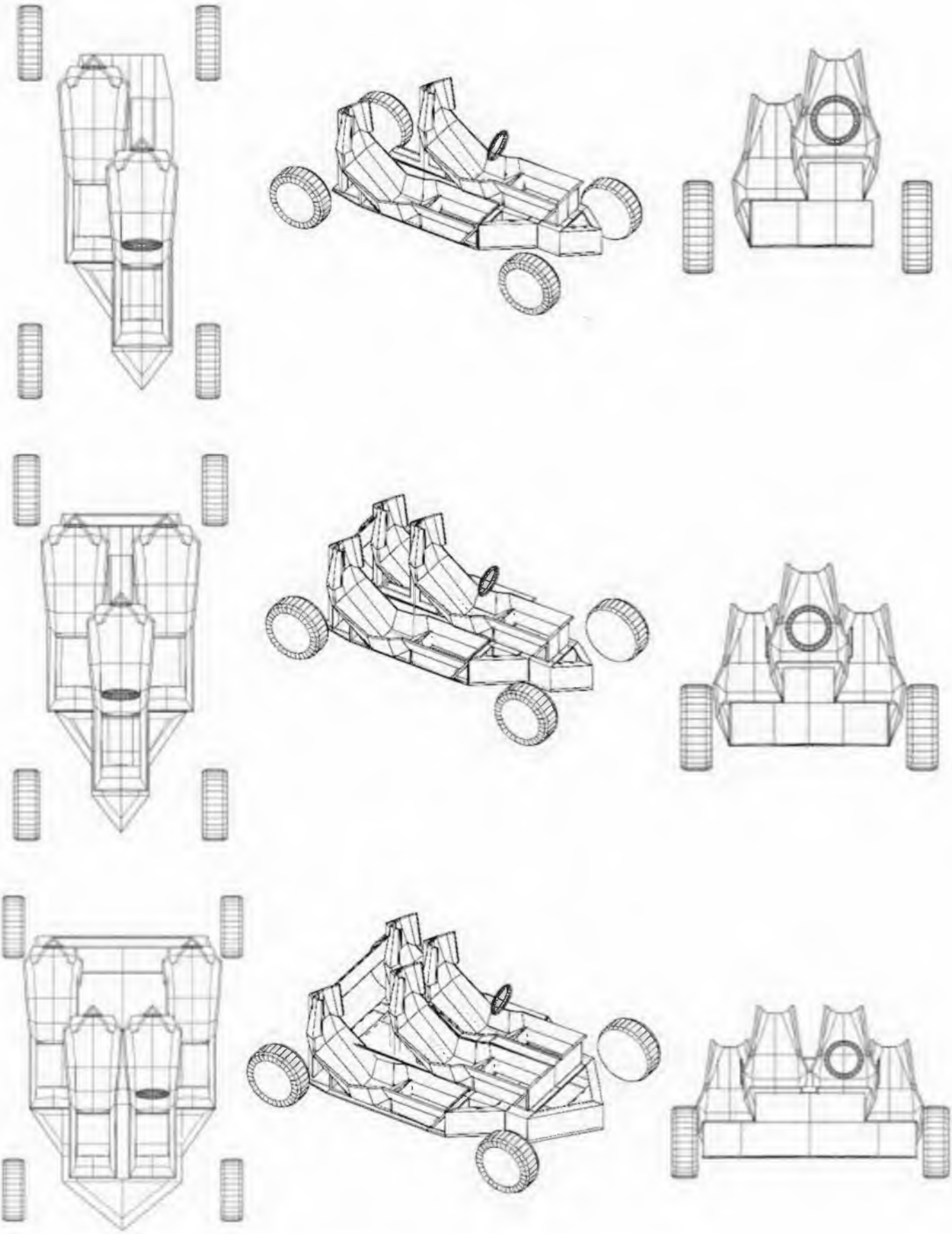
Cars' architecture is still very much based on the horse carriage model… Here a 2-axle carriage, pulled by 2 horses, prefacing (here 2 CV) in medieval style the cars of centuries to come:

VW ID.3's structure: in the UK, they call that a "Saloon car". We clearly see how it descends from carriages! The back position is quite vertical, the legs are cramped, even more so at the rear. The rear passengers have the front passengers' headrests in front of them instead of seeing the road!

2020: for the past few years I have been thinking that the fact to have the seats staggered not only on 2 dimensional planes (longitudinal and lateral) but on 3 dimensional planes, by also making use of the height factor, would allow to reduce the width of a 3 or 4-seater structure even further, by adopting the shape of Formula 1 seats, as can be found in the RP1 sports car from Elemental Cars. In the patent's implementation, the raised position of the driver central structure allows the driver to have their eyes at an appropriate height to allow for proper visibility towards the front on roads with declivities. Too low a driving position would prove dangerous on that aspect. You have marshals watching for dangers on motor racing tracks, but not on roads!

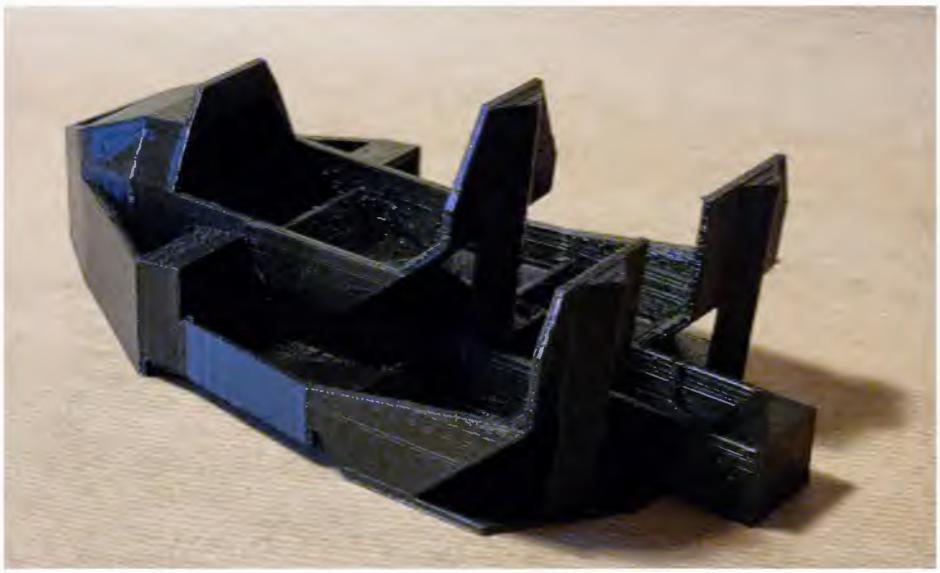
Elemental Cars' Spider RP1 - See: https://elementalcars.co.uk/the-rp1/design-2/

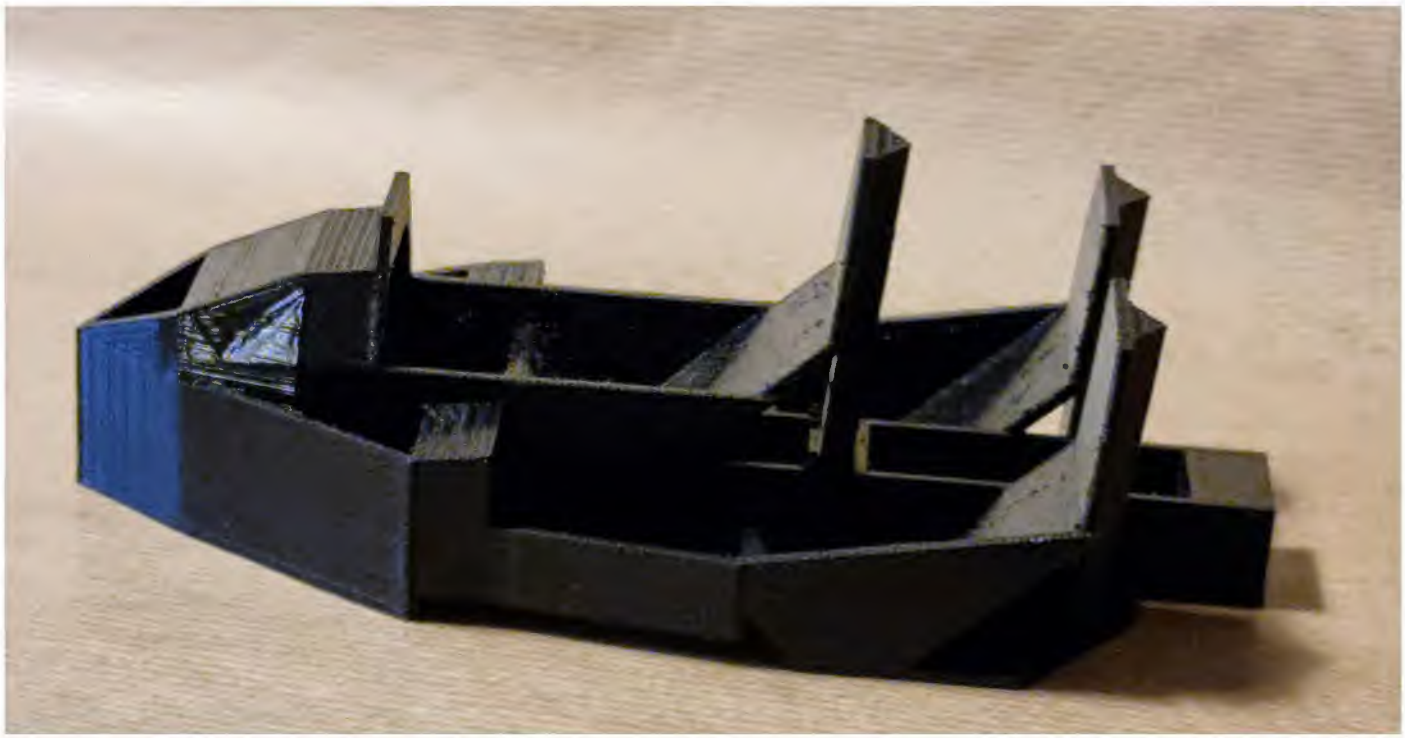
The patent offers a revolutionary approach, by creating a space without any seats fitted in the cabin. Instead, the car central chassis is created by the slotted seats structure. Seat upholstery is fitted in each passenger's space, which are defined by the car's structure/chassis, just like in Formula 1:



Illustrations for the international PCT of the automotive structure patent FR2009742 of 24/09/2020 for 2,3 or 4-seater cars.

3-seater structure, in Grand Tourer styling. 3D impression of this structure:





Each passenger benefits from optimum protection in the event of a collision. The bodyshell's front shape, be it in 2, 3 or 4-seater version, provides an avoidance feature from partial front collisions.

A car body that covers this structure as closely as possible -front wheels, rear wheels, boot- gets closer to the overall shape desired for optimal aerodynamics.

This type of structure allows for a very aerodynamical shape, strongly inspired by the kingfisher biomimicry, same as on the fast Japanese trains Shinkansen, which shape coefficient (Cx) and drag area coefficient (SCx) break all records…

The lead car in the N700S series model that will begin service on the Tokaido Shinkansen Line from July 1 (Tatsuya Shimada)

The best automotive Cx known to date is found on the Panhard CD Le Mans 64: 0.12. Sports car with 2 front seats, which raced in Le Mans in 1964. The abreast front seats entailed a larger windscreen compared to the patent's 3 seater version. Moreover, the front engine hindered the achievement of an optimal shape.

By using a kingfisher-type biomimicry that is more advanced than on the "bird-beaked" Japanese fast train Shinkansen, as well as the other aerodynamics developments discovered since 1964, it must be possible for a 2-seater car to equal or further improve this record Cx!

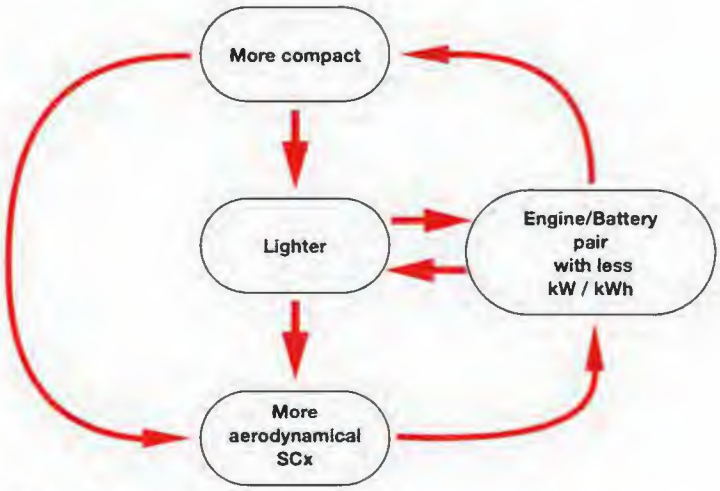
Benefits of a structure of seats slotted on 3 dimensional planes for 2, 3 or 4-seater cars

For each version of this patent, be it 2, 3 or 4-seater, the seat structures, slotted, constitute the car's central structure frame. Around this frame, all the car's parts, such as suspensions, wheels, engine (if not in the wheels), the electric engine command modules, and a luggage space are then added. The skin that wraps around all of these interior parts determines a car body that has optimum aerodynamics, with the kingfisher as model.

Possible feature for the three options: fitting electric engines in the wheels, like Elaphe engines, chosen to equip the 3-wheeled Aptera. The one engine per wheel concept is biomimicry from animals that have great acceleration muscle ability in their four legs. As for the kangaroo, his power is focused in his oversized rear legs compared to the front legs, like rear-wheel drive cars.

Apparently, the inconvenient of placing an engine in a wheel is the increase of unsprung mass (18kgs for a 40 kW / 54 BHP maximum power), which slightly impacts the wheel kinetics on irregular road surfaces. But this is compensated by the use of a 4-wheel drive system, allowing for smaller diameter and lighter wheels, and by the absence of a transmission axle (which would otherwise increase the unsprung mass in the power wheels).

Virtuous circle in terms of economy and ecology: as an example, for an electric car, in comparison to the models currently sold, we have here a more compact structure, allowing for a more aerodynamical, more rigid, and lighter car body, which generates less mechanical frictions, and leads to a lower need of power for the same performance. This allows to fit a battery block of lower capacity, lighter and smaller in size, as well as a less powerful electric engine, which is lighter and smaller in size too... This is a virtuous circle dynamic, which results in an optimum structure and shape, and is similar to what occurs in living beings after a long evolution of each species, leading to the best energetic yield possible.



Benefits during manufacturing process

This invention allows for a lower need in material, energy and workforce for the manufacturing of this type of automotive structure. It therefore allows to significantly reduce its manufacturing cost and the retail price in order to make the vehicles produced affordable to a greater number of motorists, rental or carpooling companies. Less material for the smaller and lighter structure: less extraction of minerals and rare soils, this is a benefit both from an ecological and social perspective. Corporate Social Responsibility!

Benefits in use

Active/Passive safety

The weights distribution, predominantly towards the centre of the vehicle, contributes to a very safe road handling.

Batteries positioning in the car's central third section, instead of in nearly the full width, reduces strongly the moment of inertia along the car's longitudinal axis. This is also an added improvement in the safe ability to handle sudden swerves (moose test).

The "kingfisher" car body shape, very suited to this structure, positions the centre of pressure behind the centre of gravity and the centre of adhesion, giving the car a great stability in regard to lateral winds.

This type of car, very aerodynamical, requires less power for the same speed, which translates into less engine noise and less aerodynamics noise: double benefit for a more silent cabin.

The front structure's V shape provides a great ability of semi-frontal shock absorption and of obstacles avoidance.

The sides are quite tall, as in a one-seater car cockpit, so as to make the whole block of seats structures very solid. This allows to avoid the use of thick windscreen pillars to protect the cabin as seen on classic cars which cabin have a parallelepipedic volume, fragile by nature, with doors opening down to car floor level, and require big pillars for proper resistance to shocks.

The driver's visibility field, over 180 degrees, is achievable thanks to the possibility of very thin windscreen pillars. This allows for improved active safety in comparison to current cars which voluminous windscreen pillars obstruct part of the visual field, causing a potential risk of accident.

The wrapping structure of passengers' spaces, with back rest pillars that are holding the roof, is a distinctive advantage in comparison to current cars. The seat structures, bonded with the whole car structure, can be used to support a reinforced roof, equivalent to the halo of Formula 1 cars, for each occupant, in order to provide an optimal protection at head level.

The central position of the driver in the 3-seater version or of the front occupants in the 4- seater version increases their protection in case of lateral or partially frontal shock. Considering the high number of single - or frequently double - occupancy vehicles in most journeys, this means a decreased risk of serious or fatal injury in the event of an accident.

The battery capacity requirements being reduced, this allows to fit the battery in the structure's centre, under the driver, and between rear passengers. As a result, the absence of battery on the car's sides increases passive safety in case of a lateral collision.

Reducing motion sickness

Rear passengers have a view towards the road in front of the vehicle, which suppresses an important element when it comes to car sickness, both in thermal and electric cars. Regarding electrosensitive passengers, the fact that the batteries are not under the rear seats, as well as the proposal to fit the engines in the wheels, move away sources of electromagnetic radiation and reduce the risk of car sickness even further.

Purchase and usage cost

The lower purchase cost in comparison to conventional vehicles of a similar capacity is intrinsically related to this structure shape which allows for a reduced use of material, the installation of a smaller capacity - but with greater driving range - battery, and the use of an engine of a lower power but which provides better performance thanks to the reduced car weight and the very low SCx. All this results in the reduction of both manufacturing cost and retail price.

The lower running cost induces low amortisation thanks to the reduced purchase cost, combined with the low energy consumption of vehicles based on this type of structure.

The decreased energy consumption (about 2 times less kWh on dual-carriage ways and motorways), allows as well to stop less frequently for shorter and cheaper recharge. This contributes to a reduced need in electric recharge bases compared to an automotive pool that needs 2 times more energy, and that takes 2 times longer to recharge. This is a gain of time for users and also, at a macro-economical level, a significantly lower need of electricity production.

A lighter car thanks to this type of structure, is an advantage for less wear on the tyres (cost for the user) and on the roads' surfaces (cost for collectivity, see AASHO study -1). Current electric cars, heavier than their thermal equivalents, due to the weight of high-capacity batteries, have their tyres wear faster. This tyre wear has a double economical and ecological cost: increased tyre production and spread of micro and nano particles of rubber, together with an increase of atmospheric pollution and pathologies related to this increased chemical pollution.

(1) The AASHO road test introduced many concepts in pavement engineering, including the load equivalency factor. Unsurprisingly, the heavier vehicles reduced the serviceability in a much shorter time than light vehicles, and the oft-quoted figure, called the generalised fourth power law,[2] that damage caused by vehicles is "related to the 4th power of their axle weight", is derived from this.

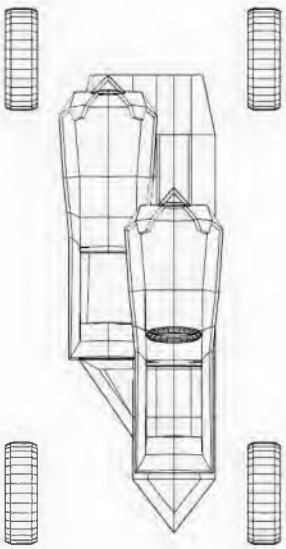
Source: https://en.wikipedia.org/w/index.php?title=AASHO_Road_Test&oldid=1106189485

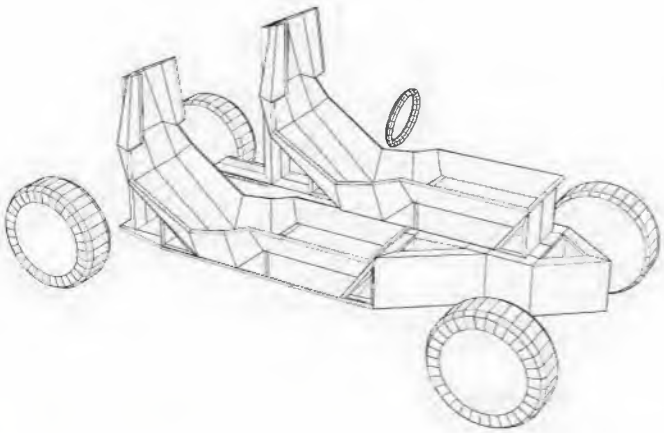
In the **2 seater version**, which body, of an elongated oval shape, is quite narrow, the wheels are outside the car body and are housed in wheel fairings for better air flow.

This offers the ability to have directional rear-wheels, like the rear legs of quadruped animals, for a better agility/road handling. Due to the narrow width of the front and rear area, the principle of hammerhead shark fins is replicated, in order to fit the road and indicator lights on the sides of the car and at the right height. Depending on the car's main usage (city/suburban or road/motorway) these fins will have a varying surface, fixed or adjustable in order to modulate the lift coefficient Cz (downforce) at the level of each wheel. In Formula 1 cars, a big rear spoiler providing high downforce in order to maximise traction in bends and curves can be set flat in straight line in order to reduce Cx (feature known as "DRS"), increase speed and make overtaking easier. Conversely, for a road car, the adjustable spoilers can be set in a minimal Cx position in straight line to reduce energy consumption (and not to increase speed). When necessary, automatically setting 1, 2, 3 or 4 spoilers down increases downforce Cz and improves instantly grip/road handling, while Cx and energy consumption temporarily increases. In "Eco" mode, the spoilers control system would not be activated in bends and energy consumption will be minimal. The spoilers system would also be activated in order to increase downforce Cz in case of lateral wind and would prove an extra tool to increase the electronic stability program (ESP).

This version could be the 21st century's Lotus Super Seven, a quantum technological leap.

Additionally, the 2-seater version can be produced in the frame of the heavy quadricycle category, with a total weight of 450kgs. Its compact and light structure, allowing a very aerodynamical shape, would prove to be for this type of car in the L7e category a significant leap in quality compared to conventional structures.

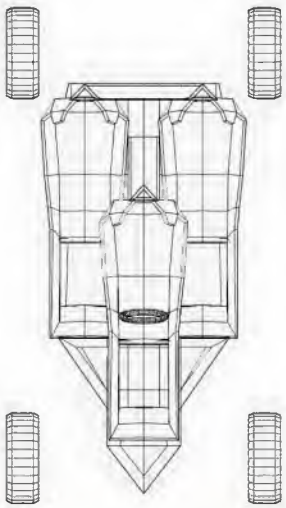


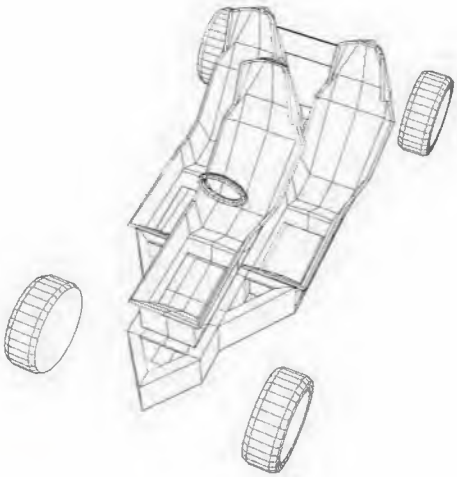


3-seater version: Thanks to the partial slotting of rear seats structures under the driver's cockpit, the total body shell width is equivalent to that of an average conventional saloon car. Moreover the forward placement of the driver's cockpit allows for an exterior body shape that is very faithful to the kingfisher shape for better aerodynamics.

The 3-seater version provides maximal visibility to the driver, with a lateral visual field and the best view point to position the car on the road, like in a one-seater, as opposed to the very eccentric lateral position on conventional cars. It is more biomimetic to have the eyes in the median axis of the car body. This ideal central position is currently found only on "supercars" such as the McLaren GT F1 and Gordon Murray T.50, which are million Euro cars, while the patent allows to bring this unique advantage to affordable cars.

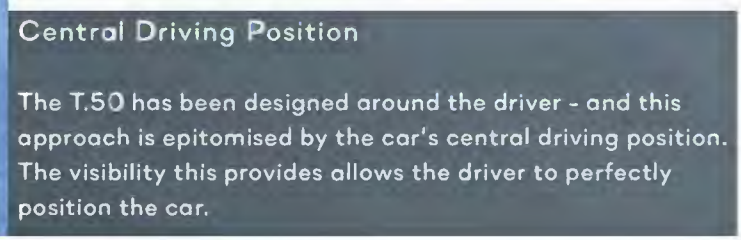
This GT version can be made in a form that is more compact, lighter, even more economical to manufacture and to use, under a 1+2 format, with lateral seats slightly reduced in size and more slotted under the driver seat.





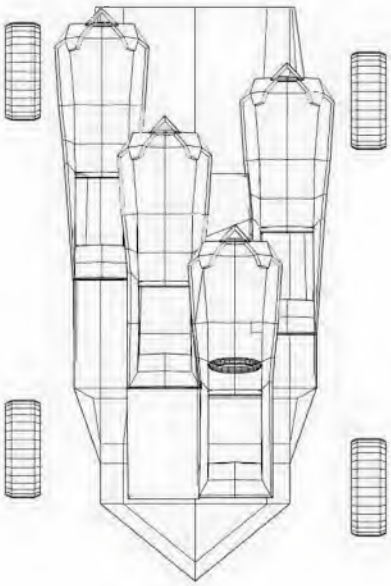
GT 3-seater

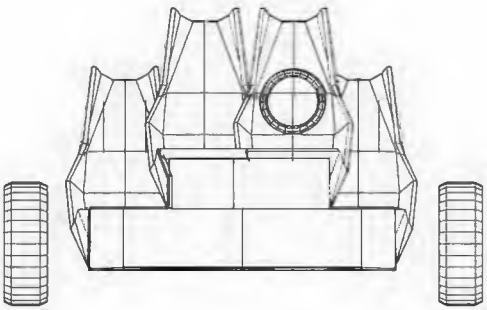
(Apropos the 3 seater hyper-car Gordon Murray T.50)
https://www.gordonmurrayautomotive.com/automotive/t50?limit=12



City 3-seater, length 2.99m

4-seater version: amongst possible versions, minimal width and increased length, shorter length and increased width, an intermediate version (in terms of width and length) is a further link with biomimicry: there is an internal dissymmetry — like in the human body — so as to make the skeleton more compact. The driver and front passenger spaces are slightly staggered with respect to each other, on longitudinal and lateral planes. This consequently determines the position of rear passengers, with a similar staggered placement. This allows to logically stagger the front and rear wheels of the right side with respect to the left side, while keeping the same wheelbase on the right and left, so as to optimise comfort when driving over speed bumps by spreading the move over the obstacles in four vertical moves instead of two. The car body won't show any visible dissymmetry since the front wheel arches are positioned differently but are not visible simultaneously by an outside observer.





This type of 2, 3, or 4-seater cars could be named "***SideCars***" since they can be viewed as single seater cars slotted side by side, with an optimised staggered placement on the 3 dimensional planes.

The world needs, for all the pre-cited reasons, and especially ecological ones, this new generation of very evolved cars, as a complement to current conventional shapes, which are polyvalent or adapted to specific needs but that require much more energy to run!

>>>

Maquette of an example of 3-seater Grand Tourer version type

3D scan of a half maquette at FABLAB ROANNAIS AGGLOMÉRATION for digital imagery work and 3D printing of the full maquette at 1:8 scale for wind tunnel tests after full car body finish

Examples of aerodynamic performances : Cx and SCx :

Modèle	Coefficient Cx	Surface m² S	Résistance SCx	Poids Kg	Batterie Kwh
ALPINE A110	0,32	2,17	0,62	1 114	
VW ID.3 58Kwh	0,267	2,217	0,592	1 730	58
TESLA Model 3 2023	0,23	2,17	0,50	1 645	60
RENAULT Megane E-Tech EV60 220ch			0,713	1 636	60
MERCEDES EQS AWD AMG 53	0,20	2,475	0,495	2 655	120
MERCEDES EQXX	**0,17**	**2,12**	**0,36**	**1 755**	**100**
APTERA 60 Kwh 3 roues 2 places	0,13	1,86	0,24	800	60
McLAREN GTR F1 3 places *	0,32	1,78	0,57		
Patent application - GT 3 places	*0,17*	*1,67*	*0,28*	*800 à 900*	*30 à 40*

At cruising speed on dual-carriage ways or motorways, the power (and therefore the energy consumption) required are predominantly proportional to the SCx... and consequently a very low SCx provides a huge advantage in terms of reduction of energy consumption, driving range, low running noise - both aerodynamic and mechanical -.

As an example, the implementation of the patent to a 3-seater car would allow it to consume 2 times less electric power, for the same speed, compared to the electric cars the most sold currently! A 3-seater car based on this structure, equipped with a 30 kWh battery, would achieve, thanks to its very low SCx and very light weight, the driving range of a current electric car equipped with a 60kWh battery. This was verified with a maquette test thanks to Mr Bernard SEROL's wind tunnel which is of Eiffel-type.

Test of a 1:8 maquette of an application from the patent for automotive structure as a 3-seater version.

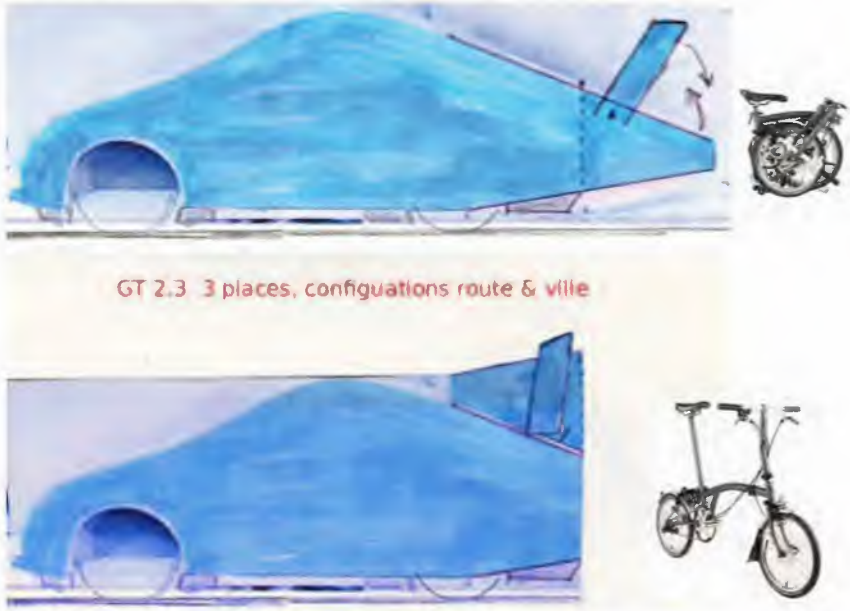
This maquette made by myself (neither engineer nor aerodynamicist) and finished by a professional body-maker, applies the biomimicry taken from the kingfisher. The Cx and SCx measured on maquette No.2 at 0.17 and 0.28 respectively can be improved by professional aerodynamicists, in particular with a 1+2 seat structure instead of this more spacious 3-seater version.

Jean CELLE

(*) https://www.motorsdb.com/fiche-technique/auto/141/McLaren-F1-1993-1998.html

A 3-seater GT made as a maquette on the base of this patent can be stretched to 5.15m in order to reduce the rear part to 0.80m wide x 0.15m high, while adding an additional 1m-long trunk to the 4.15m base car. This trunk can contain a Brompton foldable electric bike with its accessories so as to allow the driver to be able to carry on his urban trip by bike (in 80% of cases, there's only one car occupant according to studies on road trips). When arriving in urban areas, this trunk can tilt down fully over the main trunk, just like a small roof gallery, in order to shorten the car in the city and make its parking easier. The GT's maximum height goes then from 1.35m to 1.55m, and its length is trimmed down to 4.15m.

Considering how narrow the rear part of the car is, as it is reduced to the registration plate and a red light on each side of it, it is necessary to come up with a rear lights system that materialises the actual car width and that are placed at an appropriate height. This is allowed by thin and curved spoilers that improve the air flow behind the vehicle by reducing turbulence. The increased car body length caused by this "aerodynamic trunk" has a double trade off: it allows the transport of a city bike and it very significant improves the Cx! In city mode, the spoilers rotate in the opposite way from the trunk.



http://www.jc43.fr/