

Smart vehicles.A design contribution for the changing urban mobility

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Abstract

Digital technologies nowadays invade every dimension of human life, manifesting themselves both in space and in objects, transforming our habitat into an intelligent place (smart city) with intelligent products (internet of things).

Albeit technological advances are progressing with remarkable speed, offering new scenarios for the future use of cities, globalization 3.0 and knowledge economy have led to a phenomenon of wealth concentration in large cities, on one side, and increasingly weak peripheries on the other, making urban mobility a theme of interest. Italy, despite having significant physical characteristics such as the territorial extension of the nation which logically reduce geographical distances between cities (compared to the great metropolises of the world), shows the symptoms of a few areas of prosperity surrounded by suburbs that struggle to keep the step.

In this scenario, we are wondering how design research can contribute to the mobility of the future, in particular to the changing concepts of cars, and what new challenges are awaiting. Almost a hundred years ago, Le Corbusier wrote that “automobile has completely overturned all our ideas on urban planning”(1). Today, it seems that this condition has returned, the new mobility systems could redefine the urban space, as these objects might no longer be called automobiles. In this design research, in fact, the term automobile disappears in reason of its definition: "Four-wheeled motor vehicle with a generally petrol engine, used to transport a limited number of people on ordinary roads"(2).

We can now intend as a matter of fact, that artificial intelligence in everyday things, vehicle automation, the evolution of machine learning and computer vision technologies will make vehicles lose their distinguishing elements: indicators for direction, light sources, the necessary four wheels and the position of the passengers sitting in two or more rows with their eyes facing forward.

Hence, the aim of this paper is to present an applied research dedicated to experimentation on the morphological aspects of future vehicles for urban mobility intended as connecting elements between large infrastructure networks and, consequently, as a part of an integrated transport system that can help in bring the suburbs “closer” to the centers.

Through the description of some micro-vehicle concepts, that try to completely overturn the common ideas of vehicles, the objective is to propose a design experiment that aims at identifying new forms of mobility that are inclusive and sustainable from an energetic, urban and social environmental point of view.

Keywords

smart vehicles; urban mobility; vehicle automation;

1. Introduction

Smart mobility plays a pivotal role in the broad field of *Smart City*, it represents one of the six cornerstones on which the concept of *Smart City* is based (see in this regard the founding research conducted by the Universities of Vienna, Delft and Ljubljana, Giffinger et al., 2007). It is a theme of interest also for the European strategy launched in 2011 "Smart cities and communities", welcomed by the Italian government in the MISE (Ministry for Infrastructures and Transport) and MIUR (Ministry for University and Research) institutions in the sixteen-axis program called "Smart City, Communities and Social Innovation". This program envisages the *Smart Mobility* and, in particular, it focuses on the "last mile logistic" as a driving force to reach the *Smart City*, to achieve the objective of a socio-economical growth and to improve quality of life for the city users.

In this respect it should be underlined that the global transport landscape is generally experiencing a time of important changes, likely due to a combination of new technologies and society driven innovations. These shifts are gradually converting the meaning of products and services related to mobility and transforming expectations for the consumer involved in the process.

It is possible to claim that we are now experiencing a digital revolution that probably originates in a five factors convergence for which a noticeable number of technologies, known as "enabling technologies" (Broy, 2011; Ackerman, 2015), have become quantitatively widespread (Padula, 2013) as they become simultaneously easy in use, not invasive, mature in performances, economically advantageous, and most of all potentially combinable with each other.

The rapid development of digital technologies, the Internet of Things (IoT) and Artificial Intelligence (AI) have made the topic of autonomous vehicles a vital business for enterprises, and the discussion around it represents a thriving research topic for academia and research centers. Some scholars have observed how these phenomena will change the transport landscape substantially: in May 2013, the McKinsey Global Institute published a detailed study of a dozen new technologies called "disruptive" because of their potential repercussions; autonomous or semi-autonomous vehicles appear among the most significant innovations.

In particular, for disruptive technologies we mean a technological solution that completely replaces a previous one. Even though disruptive technologies are nothing new, as we can trace them back in time in cars, radio, TV, cellphones and so on, in the last decades we have experienced countless examples of this phenomenon and this continues to happen at ever-increasing speeds.

Hence, the aim of this paper is to present an applied research dedicated to experimentation on the morphological aspects of future vehicles for urban mobility. Through the description of some micro-vehicle concepts, that try to completely overturn the common ideas of vehicles, the objective is to propose a design experiment that aims at identifying new forms of mobility that are inclusive and sustainable from an environmental, urban and social point of view.

2. Design discipline and smart vehicles

The advent of autonomous vehicles is often associated with a number of positive social impacts as a safer transportation system, at a lower cost and certainly it would allow access to people with limited or no mobility.

Some researchers predict that autonomous vehicle will be affordable to displace any human-driving vehicles and sufficiently convenient by 2030. They should provide independent mobility to non-drivers, reduce stress, city traffic, accidents and pollution problems (Johnston and Walker 2017; Keeney 2017; Kok, et al. 2017) surely spurring a fundamental shift in users behavior. Thus, autonomous cars will likely accelerate the trend away from personally owned vehicles fostering the development and dissemination of sharing services, consolidating the mobility as a service (MaaS) phenomenon.

However, it is also worth mentioning that Autonomous Vehicles should be approached through a “wide-angle lens”, as they are a technology, or more precisely an aggregate of technologies that moves in a multidisciplinary environment. In fact, this topic is or has been subject of extensive researches in various fields, and could, therefore, be considered at the crossroads of many disciplines such as Transport Sciences, Electrical Engineering, Computer Science, Software and Hardware Engineering, Law, Ethics, Philosophy and last but not least Design.

The reason why the Design discipline fits fully into what could and should deal with Autonomous Vehicles could fundamentally be in the change of scenario that this aggregate of technologies offers: since the vehicles will become totally autonomous, there will be a huge work to be done, studying these changes that undoubtedly hint at a large revolution in terms of morphological aspects and meanings of both the automobile vehicle and the whole system in which it moves.

2.1 The physical context

Le Corbusier wrote, about a hundred years ago, "automobile has completely overturned all our ideas on urban planning" (Le Corbusier, 1923). This was certainly true as it is still valid today thanks to the changes that will bring about the advent of autonomous vehicles. As it was for the recent past, the urban and interurban roads that we know today are likely to change as they will no longer be used by human users but only by autonomous vehicles, hence, all communications, information etc. will be transmitted digitally.

However, Maldonado reminds us, in his interesting essay "Criticism of Computer Reason" of 1996, as historically happened in urban development, new infrastructures have overlapped the previous ones; reappropriating, with slight modifications, of the underlying system (T. Maldonado 1996). This path could be problematic and full of challenges, one of which is probably the appearance and perception of the landscape.

Although the roads may undergo milder changes, the external appearance of an Autonomous Vehicle can be subjected to an overwhelming design. Despite at present most of the prototypes of Autonomous Vehicles are morphologically similar, if not the same as traditional vehicles (fig.1), they lead to a substantial revolution in how the interior space is organized and how it communicates with the outside and with other vehicles, which will no longer have any reason to remain faithful to the same language.

From a morphological point of view, the introduction of completely autonomous vehicles opens interesting scenarios of change and great opportunities for design research, primarily because the absence of a driver puts all users of the vehicle at the same level of passengers.

The automobile as we know it is destined to disappear as the Autonomous Vehicle embraces unprecedented possibilities and allows to completely overturn the traditional car vehicle structure: many of the features that are fundamental today in the design of a vehicle such as a front and a back, passengers facing forward, layout, direction indicators, headlights, windowed parts, four wheels etc. will no longer be necessary.

Vehicles of the future will certainly have to be equipped with lighting systems but only to indicate their presence to pedestrians, or to make certain activities within the vehicle, certainly no longer to communicate their presence to other vehicles or to drive at night.

It is clear at this point that we can no longer call those vehicles "cars" according to their traditional definition of "Four-wheeled motor vehicle with a generally petrol engine"(2) as in the advent of the autonomous vehicle each one of these characteristics will fail.

2.2 The behavioral context

Nevertheless, in addition to the radical shift in the morphological aspect of the vehicles, considerable changes can also be attended with regard to user behavior and expectations, their accessibility to the vehicle, and the way the vehicle is used.

As part of the discussion on autonomous vehicles, we often read about the near future in which, to encourage safety, the use of human-driven vehicles will be prohibited. Removing pedals and



steering wheel from the driver's availability, makes him/her a simple spectator of the journeys made.

Figure 1: GM's Cruise Automation vehicles (via GM/Cruise Automation)

In this vision, as previously mentioned, the space of the passenger compartment is transformed into a space to be designed, just as the activities that the vehicle user can carry out during his/her trip need to be designed.

Another interesting aspect to consider is the one related to accessibility: there will be no obstacles for any type of disability, both motor and sensory; the new imaginable vehicles are

configured as spaces able to accommodate everyone, even elderly or unaccompanied children.

The autonomous vehicle makes it possible to bring the suburbs closer to the center, allowing a more fluid, efficient and shared mobility. The fact that the autonomous vehicle is likely to have high costs at the early beginning will deter users from owning a private vehicle, encouraging collaborative and sharing relationships. Those vehicles will be particularly well suited to leisurely or productive activities, as passengers will be fully dis-engaged from vehicle operation like they are during train travels. (Halden, 2003; Flockling et al., 2009; Lyons and Urry, 2005; Lyons et al., 2007; Pawlak et al., 2012)

It is therefore desirable to reach what Norman defines as "over-automation", one of the most recognized problems studied by engineering psychologists and human factors experts, that is what happens when a device works so well that people no longer show the need to pay attention to it (D.A. Norman, 2008).

3. Experimenting Design concepts and proposals

In this section of the paper we present a part of the results of the research dedicated to micro vehicles for urban mobility, whose design is based on the previous considerations.

The description of three concept will follow: MoveUs, Autonoma and Rapture. All three of those concepts have been developed within the product design and product advanced design course of the University of Florence DesignCampus.

3.1 MoveUs

This project is proposed as a car sharing service accessible to all and propose a concept of a self-driving electric vehicle. The exterior and interior of the vehicle were designed, with a focus on spaces for accessibility and use. The vehicle has two seats positioned *vis à vis* and the interior space can be configured according to the user needs (fig.2).

The configurations can be:

- _two people;
- _two people with wheelchairs;
- _two people, one with a wheelchair;
- _A seating space plus space for a stroller or bulky baggage.

The vehicle is mirrored, has neither a front nor a back (fig.3), this indicates the possibility of being able to travel in both directions, making immediate the restart from the stops and maneuvers. The direction is indicated by the necessary position lights that take red or white tint according to the direction.

The interesting aspect of the project lies in the possibility to set the internal cabin configuration according to the need, deciding the amount and type of users that will use the vehicle; the choice of the type of configuration occurs at the time of booking through a smartphone application specially designed (fig. 4). After the configuration is confirmed and the vehicle is ready to reach the user thanks to autonomous driving and geolocation that allow it to arrive in the right direction and with the required configuration.

In the case of the configuration for a seat and a space for a wheelchair, the vehicle will accompany the user to get on board in all its steps (fig. 5). The vehicle, through a damper system for adjusting the position, is lowered to allow the ramp to lean so as to facilitate access. Subsequently the vehicle will autonomously modify the dashboard according

to the configuration preferences, with the aim to position itself to interact with the user. Once the passengers leave and the doors have been closed, the vehicle resumes its set-up.

The dashboard consists of an elastic textured element covered with a water-repellent leather positioned on a mobile structure driven by automatic servomechanisms (fig. 6) . This solution allows the car to change its internal shape by adapting the configuration to the required needs. An oled screen is positioned on the dashboard and follows the movements of its configuration.

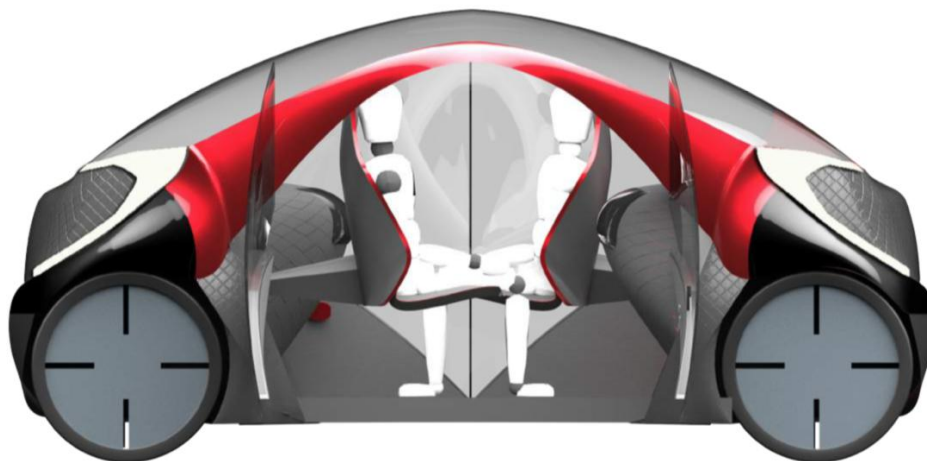


Figure 2: two seats positioned vis à vis

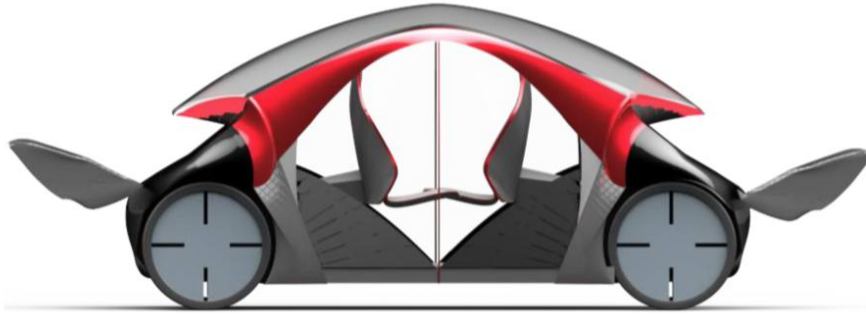


Figure 3: the vehicle is mirrored, it has neither a front nor a back

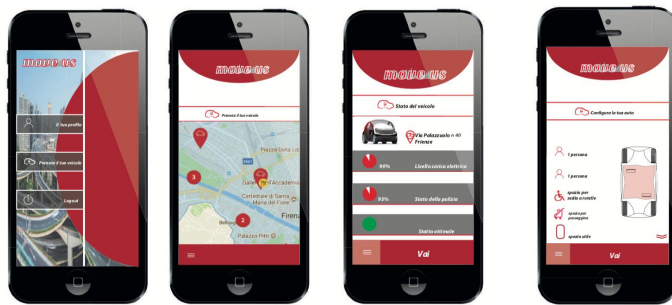


Figure 4: the smartphone application

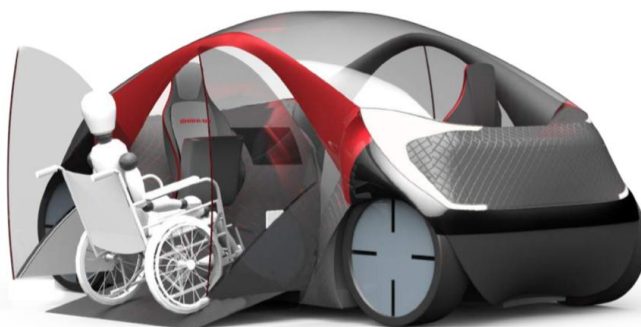


Figure 5: the vehicle will accompany the user to get on board in all its steps

3.1 Autonoma

Autonoma is conceived as a sort of "companion" of urban life, which leads people to work, the children at school and tourists around the city, making them discover every wonder.

Considering its main characteristics, the concept has been linked to Fiat for its great history of utilitarian cars and the focus that the company has always had on the relationship between vehicles and people (fig.6).

This was the idea that guided the design of the "Fiat Autonoma", an electric vehicle with autonomous driving for urban mobility, which considers the occupants, their life and needs as an objective to achieve. Thus, the body of the vehicle presents a *Figure 6: Fiat Autonoma concept.*

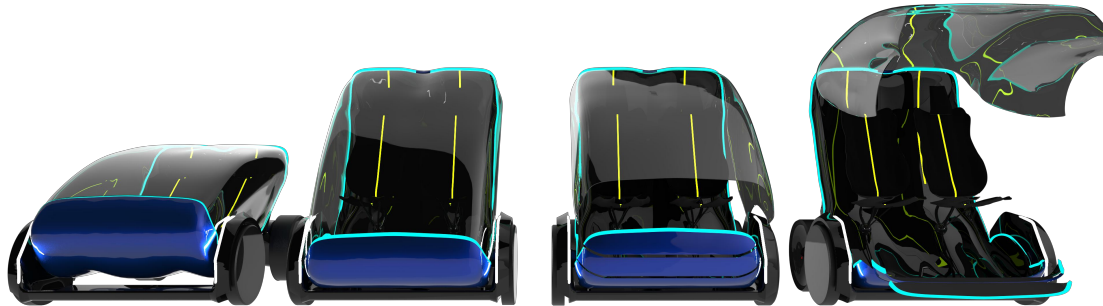


Figure 7: Fiat Autonoma interiors

Figure 8: Different positions of the rapture micro-vehicle

"nice" and reassuring style, easily interpretable and recognizable, with the aim of overcoming the distrust of users towards autonomous driving.

This vehicle is also mirrored, which means that it can move in both directions, eliminating any



need for maneuvering and resulting in better traffic flow. The design of the internal cabin was based on the maximization of the interior spaces, with seats adaptable to the needs of the occupants and a livable and bright space, thanks to the large windows.

The intention was to design a vehicle that could be integrated within a system of urban and interurban mobility, with extreme ease of use; such as from being able to book, for example, the car together with the train ticket. Once boarded, the passenger can obtain information about the places and the various commercial realities that he/she will meet during the journey, through large OLED screens placed on the doors (fig.7).

In addition to tourism facilitation, the vehicle has the task of making urban life simpler, through a shared mobility system, with which anyone can book a vehicle, that will arrive autonomously and pick up the passenger to take him/her to the destination desired, acting as a alternative to taxis or public transport.

3.3 Rapture

The concept of this micro-vehicle was inspired by folding bicycles, hence, with the aim of saving space; the design process concentrated on reducing the occupied spaces for parking, a problem that is truly relevant for Italian cities.

Two people can be hosted on board; the main feature of the vehicle is that it changes its layout according to the phase of use, in fact it relaxes when it is traveling and folds away when it is parked (fig. 8).

In fact, thanks to the hydraulic system imagined for the rear wheels, the vehicle takes different positions according to the conditions of use: stretched in gear, to allow a relaxing "chaise longue" position, while at the time of descent it takes a more vertical position that accompanies people with reduced mobility during the ascent and descent phases.

In this concept it is interesting to underline how the lying down allows users to sleep during the long journey, optimizing travel time (fig.9).



Figure 9: Rapture micro-vehicle in side view

5. Discussion and Conclusions

Urban mobility have become a theme of interest, not only for the new opportunities arising from technological advances, which are certainly offering new scenarios for the future use of our cities; globalization 3.0 and knowledge economy have led to a phenomenon of wealth concentration in large cities, on one side, and increasingly weak peripheries on the other, bringing up the importance of urban mobility as well.

In this scenario, we are wondering how design research can contribute to the mobility of the future, in particular to the changing concepts of cars, and what new challenges are awaiting. Surely technological advances are enabler of new product meanings for the customer and allow manufacturers to change product technologies quickly and experiment with new technologies. (Dell'Era, Marchesi, Verganti, 2010)

However, this technology-push kind of innovation that we are experiencing nowadays, arises mainly from the exploration and investigation of new technological possibilities, and that typically leads to radical innovations on the technical level. In this research, we believe that this kind of approach should be together with a design-driven innovation approach (Verganti 2009), that arises from the exploration and understanding of social and cultural trends, with the aim of giving answers to questions not yet asked, to pursue a radical innovation of meanings in the use of autonomous vehicles, to produce visions, concepts and senses. That typically leads to innovations not explicitly requested by clients.

Hence, according to the definition of design given by the International Council of Societies of Industrial Design (3), in this research we are experimenting how to connect technology with people in the context of Autonomous vehicle, considering what Roberto Verganti calls “the second dimension of the product”, which is the symbolic-linguistic one, and which constitutes a central and unavoidable aspect when examining the dynamics of design innovation, especially in the case of Italian design.

Trying to Innovate the product-system therefore also implies defining new messages, new meanings and sense that could better meet the needs of the users or that enriches the semantic and pragmatic contents of his world (Dell’Era, Marchesi, Verganti, 2010). With the aim of realize these messages, we should work on design research and design activity that leads to the definition of new morphological languages.

It would be misleading to assume that all current problems in cities can be solved only with the help of technology (T. Maldonado, 1996); The development of technology is accelerating, and Design is considered a key differentiator in creating innovative solutions and understanding future needs.

Notes

(1) Le Corbusier, *Verso una architettura*, 1923 (2003) ed. Longanesi

(2) Definition of Treccani dictionary Treccani www.treccani.it

(3) Design definition by ICSID: «Design is a creative activity whose purpose is to define the multiple qualities of objects, processes, services and their systems throughout the entire life cycle. Design is therefore the central factor for the humanization of technologies and the crucial factor for cultural and economic exchanges »

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