A Concept Innovation on Urban Personal Mobility

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A Concept Innovation on Urban Personal Mobility

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Abstract: With the urbanization around the world, the automotive industry tries a lot on the challenge of transportation, especially on electric personal mobility. The paper poses a totally new concept that a car is small enough to be contained in a common elevator, which not only makes it possible to get into an apartment house and successfully solve the problems of charging and parking without further request of infrastructure, but also able to extend the range greatly by riding a metro, gives greater freedom for personal mobility. As a combination of a light scooter and a 4-wheeled car, and a house appliance, the concept is hi-tech, high efficiency, comfortable, safe, fashionable, and also has a striking urban styling. During the research, a method called OKARF is developed, which stands for Objective Knockdown and References Filtering. The implementation is to knockdown the objective into tasks, list out the references related to the tasks, filter out the references to generate the concept, which will be the new solution for the objective.

1. Introduction

The urbanization meets a great challenge of transportation around the world. In Asia, the number of urban residents increased from 234 million to 1 billion from 1950 to 1990, and is projected to reach 3.4 billion by 2025[1].

Despite heavy congestion, there is still a desire for personal mobility in urban because no other means of transportation has so far offered the same mix of freedom, comfort, utility and security as the automobile [2]. Cars are well suited for conveying multiple passengers over long distances at high speeds, but inefficient for providing personal mobility within cities [3]. Moreover, congestion is not the only problem, parking, energy and pollution are also serious issues that urge the car companies to try for compact, electric, personal transportation (Table 1).

The 2003 Toyota PM is a one-seat car for personal mobility, also features a wearing concept rather than a driving one [4]. The 2009 GM EN-V (Electric Networked-Vehicle) is a 2-seat urban electric concept with Segway technology features significant autonomous operation [5] [6] [7], and maintains the core principle of personal mobility – freedom [8]. The 2012 Renault Twizy is a completely innovative two-seater design with 4 wheels. On a typical urban journey, it enables a time saving of 25% - including parking [9]. The 2013 Toyota i-Road Concept offers a comfortable, enclosed environment for two occupants seated in tandem, provides a safe, intuitive and enjoyable, helmet-free driving experience [10].

All the designs are interesting and meaningful for research of the future transportation. However, the limits of the electric vehicles are still troublesome. According to a survey in Beijing China, over 50% of the interviewees claim that the biggest worry about electric vehicles lies in insufficient range and

inconvenient charge [11]. So according the specifications of the designs (Table 1), range, charge and parking are still big problems to be solved, especially for big cities.

Table 1. Specifications of the four personal transportations.

	Toyota PM Concept	**GM EN-V Concept Jiao**	**Renault Twizy**	**Toyota i-Road Concept**
				
Length (mm)	1750-2650	1500	2320	2350
Width (mm)	1470	1425	1190	870
Height (mm)	1220-1860	1640	1460	1445
Range (km)	-	40	100	50
Weight (kg)	-	450-500	450	300
Seats	1	2	2	2

2. Material and Methods

2.1 The concept

As the battery technology and charging infrastructures are difficult to be solved in short time, the paper address a new solution to solve these problems. Since the objective is to search for a better transportation, so the idea of designing a more advanced traditional car must be abandoned. However, pick inspirations from current things may still work. For example, a scooter is light and compact, a car is comfortable and safe, charging is never an issue for a household appliance, etc. So how to make all these happen on a single thing becomes the new possible way (Figure 1).

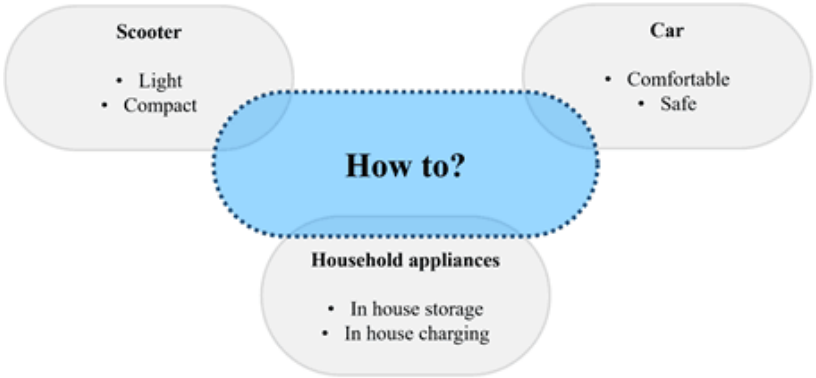

Figure 1. Searching for the concept.

There must be plenty of answers, but the easiest one may be this: a household appliance that is big enough to contain a rider inside, and also small enough to be contained in an elevator then go out from the apartment to move around.

The specifications of common elevators are show in Table 2, and the following design target is set according to it. Here the dimensions of the concept is set as 1100×1400×2200 mm (width×depth×height), makes the idea suited for most of the situations.

Table 2. Design targets according to the common elevators.

	Apartment Elevators	**Public Elevators**	**The design target** (Retraced / Stretched)
Width (mm)	1100	1100	Less than 900
Depth / Length (mm)	1400	1400	Less than 1200 / 2000
Height (mm)	2200	2200 / 2300	Less than 2000 / 1600
Load capacity (kg)	400-600	630-1250	100

Weight (kg)	-	-	Less than 200
Top speed (km/h)	-	-	5 / 50
Range (km)	-	-	100 + Metro's travel

This concept should not be confused with a traditional wheel chair, which is usually unclosed and low-speed for physical disabilities, while the new concept will focus on daily mobility for normal persons including the elders. The basic image could be a seat in a wheeled capsule (Figure 2. A). Since the capsule mainly moves around as the speed of a scooter, the wheel-base need to be big enough to keep stable when running, this makes the capsule has a foldable architecture (Figure 2. B), which also makes the center of gravity lowering down greatly for better stability.

However, because of the limit capacity of battery, the range is still a problem. Thanks greatly to the idea of being contained in an elevator, the car could also moves into a metro station elevator, and then carried by the metro for a much longer distance (Figure 3).

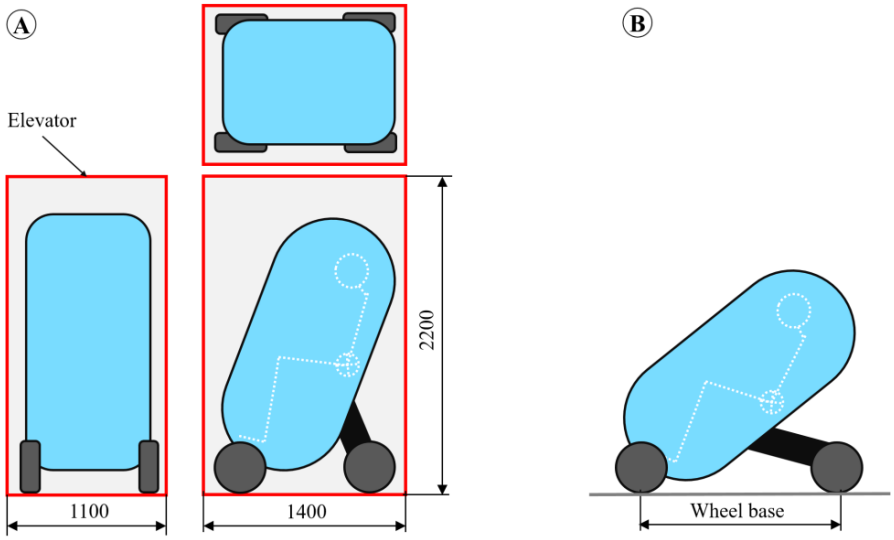

Figure 2. The basic concept and dimensional limits (mm).

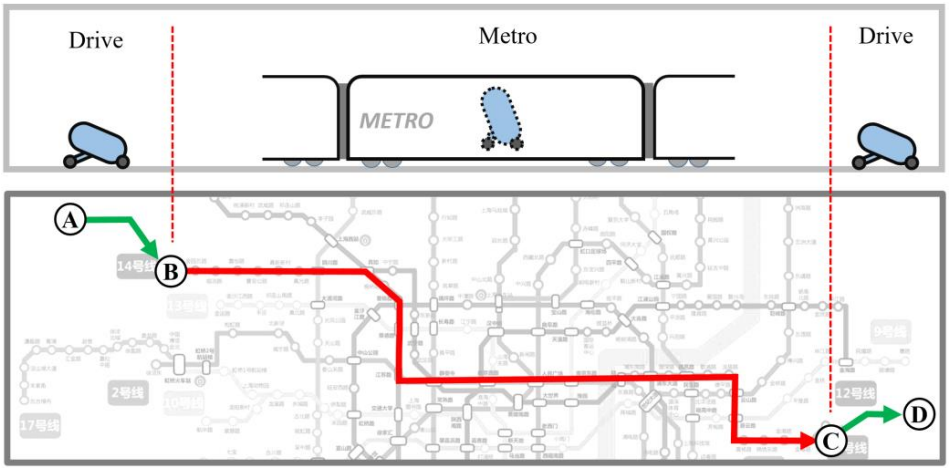

Figure 3. The extension of range: driving + metro riding.

2.2 The design

In order to represent the totally new concept for future consumers, some key elements are concerned to express the sense of clean, electric, fashion, light, hi-tech and colourful life. The design image is shown in Figure 4.

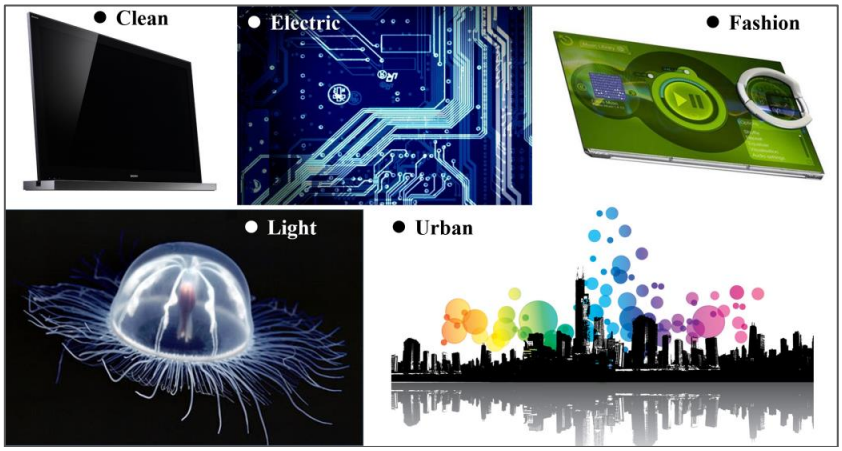

Figure 4. The design image.

The design features are shown in Figure 5. The wraped glass A gives a panorama vision and bright cabin; the front lamps B, rear lamps O, and the turning flash E are all of LED, which gives an elaborate look; the front hatch C can rotate up around the pivot N, and the pivot H implies the function of zooming the wheelbase; the lines M shown in red color represent the sense of electric, gives a strong hi-tech feeling; the flush body D could be painted in different colors to make the car stylish and fashionable; the front wheel F is smaller for better package of feet space and steering room, while the rear wheel I is bigger for better driving performance; part of the side body is mesh G and is benefit of ventilation; the battery J stores the energy for range of 100 km and top speed of 50/km; the carbon-fiber K gives a light and strong structure for the whole car; the camera L is used as a rear view mirror and is also helpful during reversing.

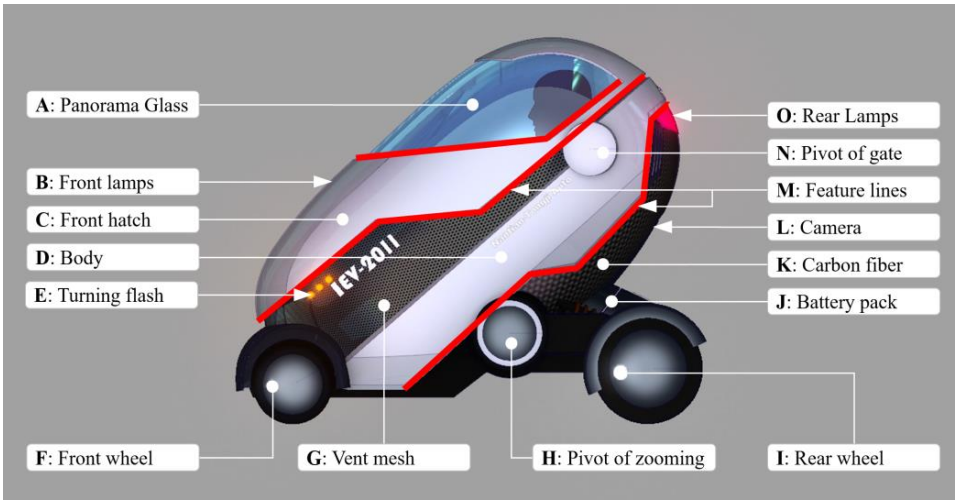

Figure 5. The design features.

The final design is show in Figure 6 with miscellaneous body colors presented.

Figure 6. The final design.

2.3 The functions

There are two basic modes of the car, one is fold-up and the other one is stretched.

According to the concept, the car could be contained into an elevator, hence the length of the fold-up mode and the width are set 100mm smaller on each side of the elevator, shown with A and B in Figure 7, and B also shows the opened helmet for the passenger could operate the elevator from inside of the car. C is the stretched mode and D is shows the front hatch opened for the passenger's ingress and egress.

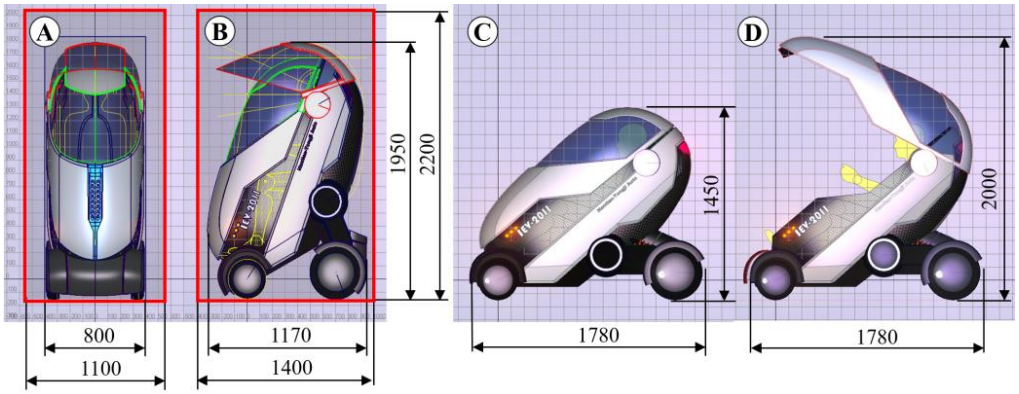

Figure 7. The two modes and four status.

Notice that the footprint is only 800×1170mm (0.936m^2), takes less than 1m^2 when parking, this is very space-saving comparing with a common compact car whose foot print is over 8 m^2.

When at the fold-up mode, the car can climb through the slope (Figure 8. A) at low speed of 5 km/h (similar to walking speed), reverses into the elevator (Figure 8. B) with the assistance of rear view camera and intelligence technology, and then moves into the room for parking and charging with standard household power. (Figure 8. C).

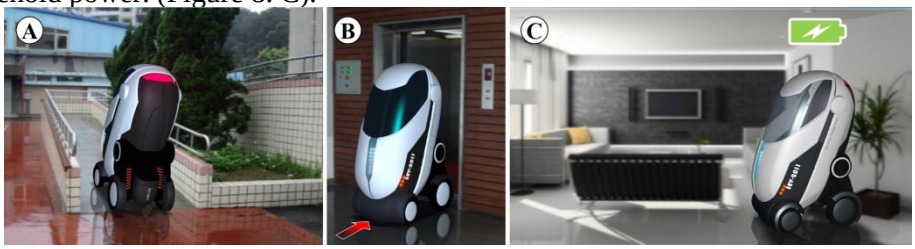

Figure 8. Entering into an apartment house.

Also when folds up, the car could get onto the metro platform (Figure 9. A) through the elevator and ride the metro for a much longer trip (Figure 9. B).

Figure 9. Riding the metro.

3. Results

1) The concept is a combination of the advantages of a scooter, a car and a house appliance, and comes out as a hi-tech, high efficiency, comfortable, safe, fashionable personal mobility solution, and also a striking urban styling.

2) One of the highlights of the concept is that the size is compact enough for being contained in a common elevator, which effectively solves the problems of parking and charging with standard household power while without the further request of infrastructure. The foot print is only 1/8 of a common compact car.

3) The concept of being contained in an elevator also result in a very effective solution for expanding the range of 100km by riding a metro when necessary, while despite the bottleneck of current battery technology. This gives greater freedom for personal mobility, and also is an innovative combination of personal mobility and public transportation.

4. Discussion

Comparing with a common car, the concept is much lighter, greener, and more environmental friendly, so it is possible for the government to set a preferential policy to promote, just like the bus priority lane for public transportation. This will greatly encourage the whole green mobility trend.

This concept can also be used in small cities and towns, where the daily activity region is not so big and the driving range is enough regardless of no metro lines there, saving a lot of road and parking resources.

Beside the private mode, the concept can also be used for car-sharing, which also could be much high-efficient than traditional cars.

With the development of network and intelligence technology, the concept can run in formation, communicate with the other road users for better active safety, and linked to the infrastructures as well. In a word, it can be a new highlight of the traffic ecosystem.

5. Conclusions

1) A good conceptual idea could speak louder than technology. Usually the capacity of battery is the key factor for the long range of an electric car, however, it is difficult to achieve a breakthrough on battery technology in short time. Furthermore, the charging points and other facilities are also limited greatly by the traditional infrastructures. In this case, a car that is small enough of being accessible into an elevator is the key idea, which avoids the challenges of battery technology and limits of infrastructure, and makes a small electric car possible to run a long range, easy to park, and easy to charge as well.

2) For a typical objective, there are always different ways to deal with. Here a method called *Objective Knockdown and References Filtering* (OKARF for short) is presented. The route map is shown below, also shown in Figure 10.

Get start: determine the objective. In this case the objective is urban personal transportation.

Proceed: Knockdown the objective into tasks as A, B, C, etc. Here the tasks are range, charging, parking, riding experience, etc.

Essential: List out the References. Here the references of range are car, scooters, etc., and references for charging are charging pile, lots, etc. There could be a lot of references for more choices later.

Key step: Filter out the references and generate the concept, hence the concept is the new solution for the objective. In this case, a concept of mobile capsule is the solution for the personal transportation.

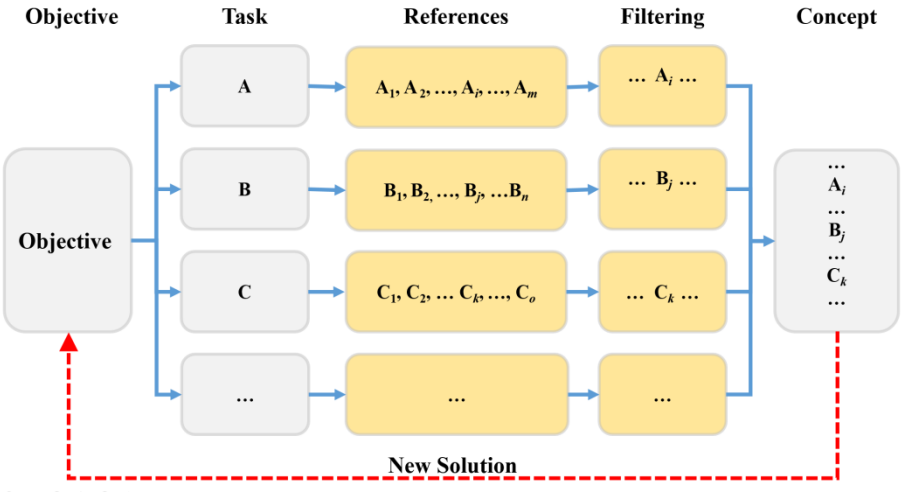

Figure 10. The OKARF method.

Acknowledgements

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