2008-01-0262

Interior design and accessibility aspects of the Superbus

Antonia Terzi, Jochem van Deelen, Wubbo Ockels

Delft University of Technology, The Netherlands

ABSTRACT

The Superbus (Fig.1) is a new public transport vehicle designed for comfortable, flexible and sustainable transportation. The Superbus, which drives at 250 km/h cruising speed on its dedicated infrastructures (the supertrack) and at conventional speed on existing roads, is safe, sustainable, and able to transport passengers and goods from point to point.

In this paper the philosophy of the vehicle will be highlighted in terms of the vehicle fundamental concepts. Then, the analysis of the required personal space design will be discussed alongside the design criteria for accessibility. Finally, the layout of the vehicle will be described in its details.

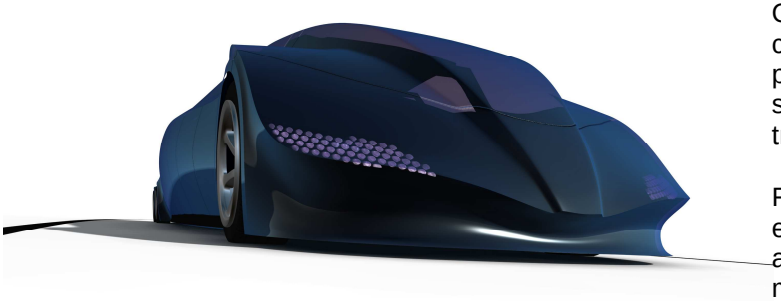

Fig 1: the Superbus

INTRODUCTION

The Superbus [1] is a new concept for public sustainable mobility which consists of a new vehicle, new type of dedicated infrastructure and a new logistics. For this new concept [2], all of the intelligence and innovation is in the vehicle whereas the dedicated infrastructure (where the Superbus runs at 250 km/h) is made of relatively cheap concrete roads. The Superbus does not have a fixed schedule and the logistics allow for the flexibility of high volume transport on demand via a central routing optimization system.

The vehicle transports passengers from destination to arrival without the need to change transport during the journey. The Superbus is 15 meters long and provides seating for 23 passengers. With the aim to improve comfort and to allow for individuality, it has 8 doors per side [3].

One of the primary aims of this new vehicle concept is to create a vehicle for public mobility that enraptures the passenger's desires for flexibility, privacy, comfort and safety with the aim to increment the utilization of public transport.

For that, the Superbus is designed to create an environment that allows passengers to continue their activities, whether recreational or business, whilst moving from one place to another. For that, the personal space is designed to be comfortable and inviting, and fully equipped with a number of devices in a number of personal space layouts.

Another fundamental aspect of the design is the accessibility. Due to the use of a lifting system, the ground clearance of the vehicle can be set at any height from 60mm to 400mm so to align entrances with any platform or road height. In addition, the use of gull-wing doors consent access to people up to 2 m in straight position, although the total height of the vehicle is 1.6m.

The vehicle is also equipped by movable ramps and wheelchairs restraints.

The vehicle has been designed with great attention to safety. For that, the structure of the vehicle has been designed considering a number of crash conditions. Also, the vehicle uses a sophisticated navigation and control system alongside morphing structures and 3 parachutes for emergency braking. With respect to the interiors, a multi-body model has been used to simulate 20g crash conditions and the results have been used to optimize seat design and seat belt attachments. During the vehicle testing, emergency evacuation tests will be performed.

INTERIOR DESIGN

The Superbus is 15.00m long and 2.55m wide, to comply with European regulations. The vehicle height could be up to 4.00m, based on these regulations. However, height has been set at 1.60m. This was mainly due to 3 reasons:

1. to reduce the frontal area with the aim to enhance aerodynamic performance at high speed.

2. to lower the center of gravity to improve handling at high speed.

3. to create a new interior design which emphasizes the realization of an individual environment, as it will be described in this paper.

Clearly this aspect, namely the relatively low height, has had an impact on accessibility with respect to existing and more conventional public transport like trains, trams and buses. Nevertheless, taxis are also public transport and the height for those is comparable to the height of Superbus. However, as it will be described in this paper, the Superbus has been designed to enhance accessibility and is, with respect to this aspect, better than all existing public transportations means.

The Superbus interior has been divided into two parts (Fig. 2): the cockpit and the passenger compartment. The passenger compartment is divided into three cabins by two transparent dividing screens. The first four rows offer individual, forward facing seats in one compartment. The two compartments behind this have two rows of seats that face each other, with a large foldable conference table in the middle.

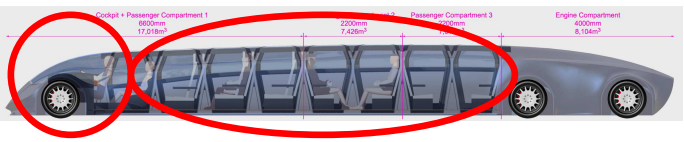

Figure 2: division of Superbus interior: the cockpit and the passengers' compartment.

DESIGN TARGET- The interior of the Superbus is designed to be a comfortable and pleasant space to travel quickly and effortlessly to your destination. It is kept light and open, by putting as many transparent surfaces in the doors and roof as possible within the limits posed by structural requirements. The Superbus will provide seating with a higher level of comfort and privacy than currently available in public transport to a maximum of 23 passengers. Passengers can travel alone, in privacy, or in groups of up to 6 people. Indeed, the shape and layout of the vehicle, combined with the new design style, are aimed at creating a new solution which is unprecedented in public transport vehicles. The level of individuality, comfort and luxury present in Superbus will change people's perspective on public transport.

Based on the above design target, the most important elements of the interior design have been designed as follows.

ENTRANCE - The shape, size, position, type of door and number of doors all have their influence on accessibility. To enable quick and easy access to the seats, each row of seats in Superbus has its own gull-wing doors on each side of the vehicle. So there are 16 doors for the 23 passengers and the driver. By eliminating the center aisle and creating a specific entrance for each row, the individuality aspect of the interior is emphasized.

SEATING LAYOUT - Not having a center aisle, unlike in trains, buses and trams, creates the space for wider and more comfortable seats. The Superbus has three 680mm wide seats, while a city bus or coach usually has four seats and a center aisle within the same width. Besides offering more space in a lateral direction, the Superbus has a seat pitch of 1100mm which is comparable to the back seat of a Rolls Royce Phantom. Finally, in the front passenger compartment, extra privacy is created by shifting the middle seat in each row 200mm forward. In this way, passengers are not seated directly next to their neighbors, as shown if Figure 3 were P95 mannequins were used.

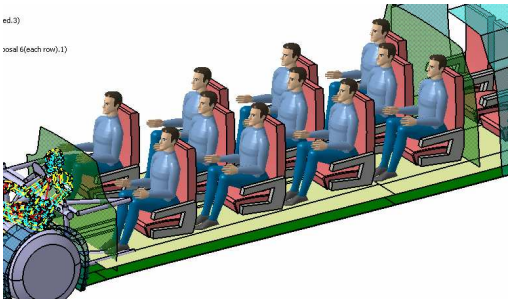

Figure 3: front cabin

SEAT -The seat is being specifically designed for Superbus and has to be comfortable as well as extremely lightweight to keep the total vehicle weight under 9000kg (including passengers and driver). The Superbus seat is significantly bigger than existing public transport seats. Also, it is being designed in order to achieve a high level of safety due to the high cruising speed (250 km/h) of Superbus. The seat will be made of a composite shell similar to those used for racing seats. The seat cushions will move within this shell to offer passengers adjustability of the backrest angle. To give the seats the desired luxury appearance they will be covered with high quality leather.

TABLES - The first four rows of seats will feature individual foldable tables. The folding mechanism for the table will also include a 8,4" touch screen monitor that will offer passengers a number of multimedia options.

LIGHTS - Just as any other part of the Superbus the lights for the interior have to be lightweight, consume as little energy as possible and be durable. On top of this, the interior lights have to fit and enhance the desired interior atmosphere. LED's provide a fitting solution to all of these issues and will therefore be used throughout the interior of Superbus.

STYLE – The Superbus interior style will be light, open, calm, comfortable, and luxurious. Traveling in it will be like being driven in a spacious, luxury sedan. For the realization of the latter, beige leather will be used for the seats and part of the interior bodywork, Australian beach wood will be used for the flooring and part of the doors interior, and large transparent surfaces in blue polycarbonate will be used for the glazing. These materials and colors will be combined with the carbon fiber structure of Superbus of which large parts will be visible in the interior. Finally, orange leather accents will be used in the trimming of the seats. The resulting color panel of the Superbus is shown in Figure 4.

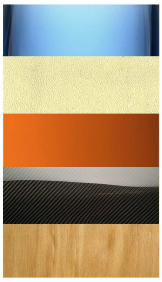

Figure 4: colors in the Superbus interior

SEAT CONFIGURATION – Many different seat configurations have been tried and tested using 1:1 mock-ups of the interior (Figure 5) and 3D CAD models.

Figure 5: the mock-up

The aim has been to create an interior that allows the passengers to travel alone, in privacy and undisturbed as well as creating space for people traveling together. The demonstration vehicle that is currently under construction will have the layout shown in the Figure 6: eight rows of three seats per row, except for the front row which will have two Recaro sports seats to allow space for the driver to slide in and out of the cockpit.

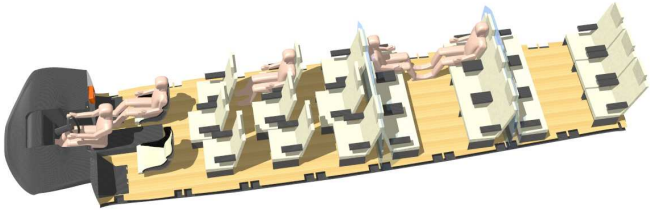

Figure 6: seat configuration

As mentioned above, the first four rows face forward with the middle seats shifted forward for added privacy. The next four rows face each other in a conference setup that will have a conference table in the middle formed by six individual tables. Besides this layout, there is an alternative seat configuration which will be realized by removing the dividing walls and mounting all the seats in a forward facing position as shown in Figure 7. This alternative solution has been designed to show the flexible layout of the vehicle.

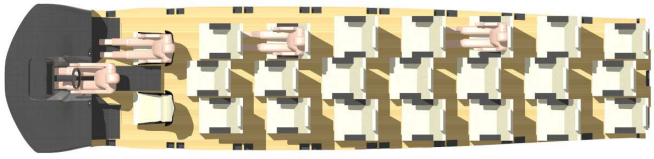

Figure 7: second seat configuration

COCKPIT - The same colors and materials are used for the cockpit as for the passenger compartment. The driver is seated in the same Recaro seat as the front row

passengers and is enclosed by the front sub-frame and the driver-house that covers this sub-frame as shown in Figure 8 and 9.

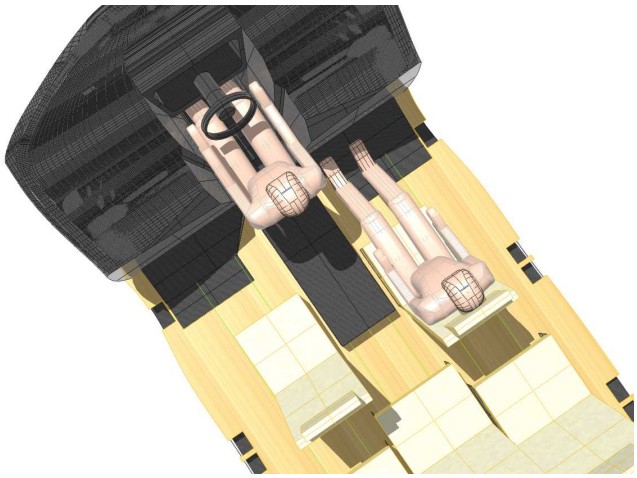

Fig 8: Cockpit

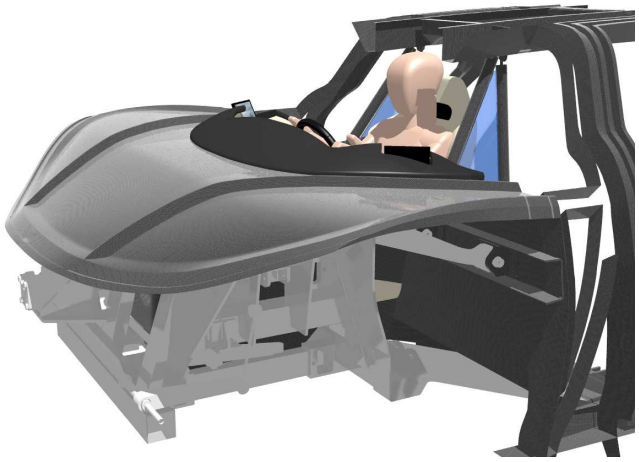

Figure 9: driver enclosed in the cockpit

ACCESSIBILITY

In existing public transport vehicles, passengers have to access their seat trough a limited number of doors after having passed a gap between platform/sidewalk and the door, then walk up steps, and then into a narrow center aisle. Also, the seats are usually small and during peak hours the seating capacity is not enough to accommodate all passengers.

When designing the Superbus great attention has been put on accessibility, which has resulted in the utilization of gull-wing doors, adjustable vehicle height, accommodations for passengers in wheelchairs, dedicated small children's seats attachments and handles on the side of the entrances.

GULL-WING DOORS – Due to vehicle height (1.60m) it is not possible to stand up straight inside the vehicle when the doors are closed, much like in any normal car. However, the gull-wing doors enable even tall passengers to enter and exit without having to bend. Indeed, when opened they stand at 2.00m from the vehicle bottom, as shown in Figure 10. The opening strategy of the doors will not require more space than existing transportation vehicles.

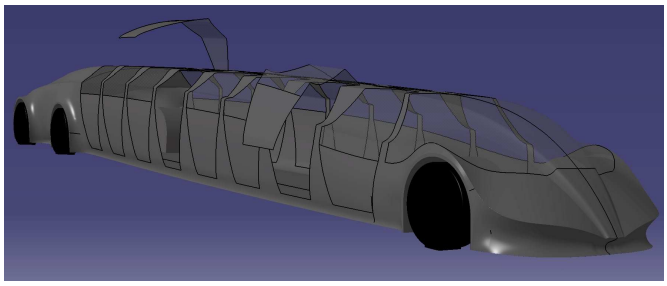

Figure 10: gull-wing doors on Superbus

VARIABLE VEHICLE HEIGHT – A combination of air-springs and a hydraulic lift system makes the vehicle height adjustable from 60mm ground clearance up to 400mm. This not only enables the Superbus to drive over bumps and obstacles, but also makes it possible to level the floor of the vehicle with any platform or sidewalk. The vehicle will be driven at its maximum height in city centers and highways to give the passengers a feeling of safety. The vehicle will drive close to the ground only at high speeds on the dedicated Supertrack, where there is no other traffic other than Superbuses.

WHEELCHAIR ACCOMMODATIONS – The Superbus has a dedicated wheelchair position (Fig. 11). On request, the conventional seat in this position is removed by a quick release mechanism. The wheelchair is then placed in position by the driver and rapidly secured with a wheelchair restraint system (Fig, 12), tying it down at all four corners. The wheelchair is positioned with the back against the dividing wall of the rear conference compartment. On this wall there is a dedicated headrest for the passenger in the wheelchair and there is a three-point seatbelt provided specifically for wheelchair users.

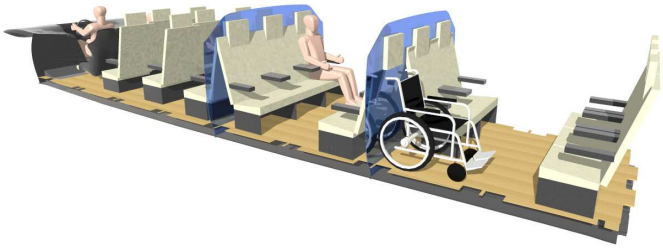

Figure 11: wheelchair position in Superbus

Figure 12: wheelchair attachments

RAMPS – If a gap between a platform and Superbus should be too big to cross comfortably, a ramp will be used.

CHILDREN'S SEATS – Each passenger will have a three-point seatbelt. To ensure that passengers will wear them, Superbus will not be able to drive unless the control system has cleared that all passengers are wearing their seatbelt. To ensure the same level of safety for small children, all seats will be equipped with the ISOFIX child seat fixation system (Fig.13). With this system, child seats (provided by the driver) can be fixed securely to two hooks located between the seat and backrest cushions.

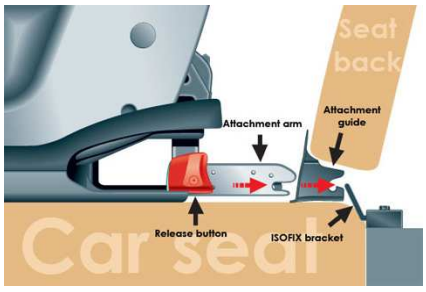

Fig 13: ISOFIX child seat fixation system

CONCLUSION

As described in this paper, the seat layout has been defined in a main and an alternative option in order to show that, if in production, the Superbus will be able to be set up in a number of different configurations (amongst which a fully open and empty interior to transport goods)

The finalization of the seat design is currently undergoing as are the design of the interior side panels and driver cockpit instrumentation layout. These parts of the design will be finalized in November 2007 in order to be produced and assembled into the vehicle.

As described, accessibility will be enhanced by the utilization of the gull-wing doors, the variable vehicle height, wheelchair accommodations, ramps and children's seats.

The vehicle will be ready for testing in February 2008 and will be officially launched at the 2008 Beijing Olympic Games.

ACKNOWLEDGMENTS

We wish to thank our sponsors, The Ministry of Transport and Water Management, Connexxion, TUDelft, Koning and Hartman, SABIC, Vredestein, DOW, and all our suppliers.

REFERENCES

1. W.J. Ockels, Superbus Dossier, Conceptual Feasibility Study, TU Delft Report, in Dutch (2004)
2. W.J. Ockels, A. Terzi, J. Melkert, Superbus development Program, TU Delft report, in Dutch (2006)
3. V. Antonelli, A. Terzi, W.J. Ockels, A. Beukers, Preliminary Design of the Superbus, SAMPE Europe (2007)