design of a passenger-cum-cargo microbus (interior)

based on mahindra tourister platform

Product Design **project 2**

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project guide

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requirements for the degree of
Masters of Design in **Industrial Design**

Industrial Design Center
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approval sheet

The product design project titled
"design of a passenger-cum-cargo microbus (interior)**"** by
Thomas George is approved for the partial fulfilment of the
requirement for the post graduate degree in Industrial Design.

Project Guide

Chairperson

External Examiner

Internal Examiner

acknowledgement

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Last but not the least, thnak you mum, pap, jeecko and lubna for being there for me.

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Abstract

The project aims at understanding the various roles that vehicles play in the context of both passenger and goods transportation either on independent purpose built platforms or hybrid derivatives such multi-utility vehicles, which have been in existence for over twenty years now.

The emergence of a need for a vehicle platform that allows either partial or total convertibility from the passenger mode to cargo mode has been the driving objective.

To bring about a holistic vehicle platform that merges these disparate needs and vehicle characteristics will be the challenge and goal of the project.

1. Introduction

The automobile has become the workhorse of the 21st century, whether it be for transportation of people or goods or both. In a customer oriented market scenario of today multi-utilitarian features that enhance the functionality and usability of the vehicle, more than merely a mule to get from point A to point B, are of paramount importance. The customer wants choice in terms of models, trims, engine specifications and even accessories. 'Customizability' is the buzzword doing rounds in the design departments of automakers big and small alike.

Disparity arises, as the manufacturers want to minimize choice to reduce costs in this capital-intensive industry. Conflicts between capacity and investment, volume and profit, margin and price seem to perpetuate this vicious cycle. Common platform technology and GM's Skateboard Concept are indicators of this trend.

Innovative and efficient design that brings about this change will be crucial in the years to come. This project is a humble exercise in trying to understand the varying requirements of the vehicle between that of a passenger carrier and light cargo transporter and to combine these two contrasting concepts in a single vehicle platform.

2. Methodology

The project was initiated with the purpose of designing a vehicle platform that could adapt itself to the varying needs and functional requirements of a passenger cum cargo vehicle.

On analyzing the ground realities and scenarios in the Indian context, the need for a vehicle platform that caters to both passenger carrying and light goods transportation either independently or simultaneously became evident. At the outset it was required to adequately understand the various vehicle types that are used for passenger transportation and cargo transportation exclusively and those vehicle types which are used in both forms with partial or limited convertibility, such as multi-utility vehicles.

Looking at various attempts to bring about this duality or multi functionality aspect in vehicles seen in the Indian market gave an idea of the existing technology required to create such a flexible interior. Simultaneously similar vehicles from the international market and few concept vehicles such as the Mitsubishi Maia, the Mazda Washu, the Honda Element etc were also studied to gain insights into what the future possibilities in this domain could be.

The next stage involved listing certain possible applications in which this vehicle could operate. A user analysis and profile along with an analysis of the possible cargo carrying potential of the vehicle was also undertaken. Several vehicles from the Indian market were then short-listed and selection criteria based on all the above data was used to narrow down on a single platform on which to initiate the design.

The primary aim and scope of the project was to create an interior space/seating system and layout that could adapt or modify itself to the continuously changing need of the vehicle. Concept generation in terms of various seating systems and layouts were carried out once the product brief was clearly defined. After several iterations and refinements a concept evaluation criteria based on the knowledge and data collected thus far enabled the selection of the final concept.

3. Objective

The objective of this project is to deal with these specific scenarios and design a vehicle that caters to the passenger cum cargo requirement. The emphasis is on the interior design of the selected platform with the focus of creating a seating system/layout that can adapt or modify itself to the varying need of the vehicle. Minimizing the operation time required for convertibility from one mode to another and maximizing flexibility within the platform will also be considered as important parameters.

4. Data Collection

4.1 Passenger cum Cargo Scenes

Ours being a traditionally agrarian economy, the rural landscape provides glimpses of human ingenuity spurned by down to earth everyday needs. The tractor the village workhorse not only does its duty in the field but also when combined with a trailer unit serves in the transportation of farm produce. Come festivities or religious occasions this same vehicle is used by the farmers to carry the family and village folk into neighboring towns or villages.

Small tempo's and motorized rickshaws with just wooden planks as seats are a common site in towns. These vehicles work as efficient little runabouts transporting both passengers and light payloads.

Open top LCV's and trucks which are normally used to transport goods, backup as a people mover. When the occasion calls for it, truckloads of people that are standing or sitting on the cargo bed of the vehicle travel to the mela, the ganapati visarjan and other religious functions or a grand wedding ceremony.

In semi urban environments the local shopkeeper returning from the whole sale market carrying boxes and gunny sacks of merchandise,hawkers and vendors with unwieldy crates and baskets filled to the brim, travelers with large suitcases and luggage returning from the railway station etc usually end up placing their luggage in the aisles of the vehicle, restricting flow of movement, or between opposing benches of the tum tum where there is already a crowd of feet to tend with.

4.2 Problem Identification

The inferences derived from the initial study revealed that there are several situations where both passengers (and their luggage) or cargo are transported on the same vehicle.

In these situations it became evident that the kind of vehicles available could not sufficiently meet the varying requirements of the vehicle, efficiently.

There were impediments with regards to loading and unloading of the cargo. The interior space of the vehicle has a very cluttered appearance, as there are no specific demarcated areas for placement or storage of luggage/ cargo.

Ingress/ egress for the passengers also becomes difficult as a result of this. Movement or circulation through the vehicle is also severely restricted.

The relative non-flexibility of the elements of the interior prevents efficient use of the volume in these circumstances.

4.3 Vehicle Categories

The various problems that were identified required an overview of the contrasting characteristics of passenger and cargo transportation. It was thus necessary to firstly understand the various vehicle categories that are in use today for these separate functions.Barring specialized or military vehicles the average automobile can be broadly categorized as passenger transporters or goods carriers. Even in these two categories there is a wide variation in terms of size, use and overall form among other parameters.

Vehicles designed exclusively for passenger transportation include the 3-wheeler autorikshaw, cars of every conceivable shape and size right from the mini hatchback Maruti 800 to the stretched Mercedes station wagons. Vans and minibuses make up the mid segment in terms of size and the large city buses and intercity coaches with capacities of up to 50-60 passengers top this category.

Cargo transporters have an equally varied range starting with the 3-wheeler goods autorikshaw, small to medium sized delivery vans (Maruti Omni and Mahindra Voyager),
Light commercial vehicles such as the Swaraj Mazda, Eicher Canters and the Tata trucks and the massive 18 and 24-wheeler Volvo truck-trailers that haul tones of freight.

At the center of this wide ranging spectrum lies a category of vehicles termed as multi-utility vehicles (MUV's) or multi purpose vehicles (MPV's) which are extensively used as the name suggests, for both passenger and cargo transportation.

Passenger transporter

Cargo transporter

Multi-utlity vehicles

4.4 Vehicle Characteristics

It was necessary to understand the basic characteristics of these 3 vehicle categories in order to draw design cues that enable a more holistic approach to the design process.

Passenger Vehicles
- § Various body styles hatchback, sedan, coupe, station wagon
- § Closed canopy (to protect from the elements)
- § Hinged doors
- § Windows (to provide ventilation)
- § Comfortable seats for all occupants

Cargo Vehicles
- § Cab/trailer body style
- § Open top
- § No windows/blanked panels
- § Split tail gate (easy loading/unloading of cargo)
- § Flat floor bed
- § Seats for driver and co-passenger
- § Multiple access points

Multi-Utility Vehicles
- § Monovolume
- § Large sliding doors (easy ingress/egress and loading/unloading)
- § Versatile seating layout

4.5 Study of Indian MPV's

Interiors

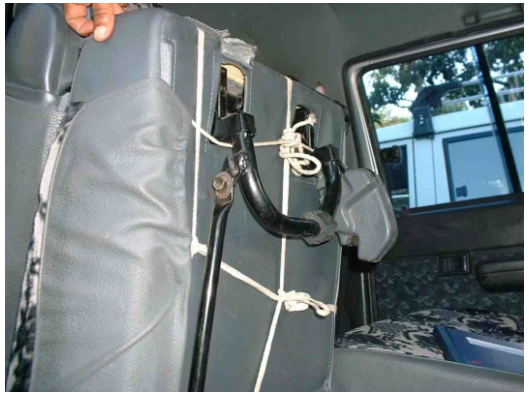
The previous chapter highlighted the existence of the MPV segment as a bridge between the passenger and cargo transporting vehicle categories. It was therefore important to analyze the vehicles in the Indian market that fit into this segment and study the elements of the interior that allow flexibility in the platform.

The vehicles that were studied are the Mahindra Scorpio, Toyota Qualis and Tata Sumo. All of these platforms have some degree of convertibility with respect to the rear seats which can be folded away when the need arises to carry cargo. These jumper seats allow the rear boot portion of the vehicles to be used both either for carrying passengers or cargo. The folding operation, locking and fastening details and clamping details were closely analyzed to gain some knowledge into the existing systems in use in the country.

Mahindra Scorpio

Tata Sumo

The Toyota Qualis has 2 jumpers seats at the rear end which can be folded away and hooked to the side panels. The center bench seat has a 2/3 split, which allows 1 seat unit to be folded forwards and locked behind the front row seat.



Toyota Qualis

4.6 Multi-utility Concepts

Practical 4-person mode

2-person standard mode offers superior ride comfort

2-person conversation mode creates a relaxing lounge space

Mitsubishi Maia

Studying the Indian MPV market gave a fairly good idea of the existing technology and design. A literature survey of the kind of multi functional vehicle concepts that manufacturers are developing abroad gave insights into the futuristic technologies and design innovations in this area.

The Mitsubishi Maia is a concept Recreational Vehicle (RV) that combines sporty performance with full utility. The next generation RV's must offer driving enjoyment regardless of the function required. The Maia meets this uncompromising demand with multi-functional utility incorporated in an unprecedented design concept.

The use of natural materials brightens the interior, creating an environment that gently 'enfolds' the occupants. The overall impression is of one a relaxing living room- like private space.

Front rotating satellite seat

Extending seat backs (satellite seats)

The sliding and reclining seats can be rotated around a central pivot like satellites, and feature seat backs that extend to suit body type. The seat can also be freely configured to offer 2-occupant, 4-occupant, conversation and relaxation modes, as well as to accommodate various luggage items.

Triple action rear gate

Providing the rear gate with multiple functionality greatly simplified the loading and unloading of luggage.

1. opening the mini-gate allows storage of small items in the interior luggage box
2. opening both mini-gate and tailgate enables normal usage
3. removing the detachable bumper creates a large opening for smooth handling of bulky items.

Mazda Washu

Mazda unveiled an innovative six-seat concept car at the 2003 North American International Auto Show. Mazda Washu means "Eagle's Wing" in Japanese. The Mazda Washu concept demonstrates the company's innovative approach to vehicle/passenger interaction in a compelling, modernly proportioned vehicle. The concept vehicle was developed as a calculated experiment into how customers interact with a vehicle's interior space.

Central to the concept are the vehicle's doors, both front and rear. The front two doors, with unique forward hinging, open extremely wide to an angle of nearly 90 degrees presenting the appearance of an eagle, soaring with outstretched wings. The rear sliding doors are also innovative, opening first outward and then sliding rearward much like the doors on a jet liner. Functional too, the doors, when ajar, present a large opening into the vehicle's roofline that greatly assists access to the rear seats.

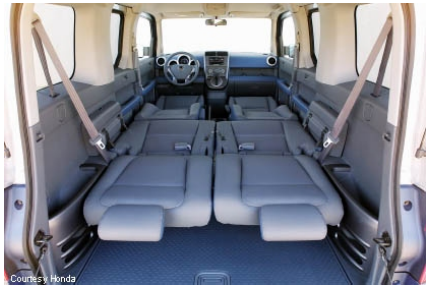
Functional, Flexible Seating

The interior can be modified in a number of ways to meet the needs of changing circumstances and satisfy unique passenger and cargo carrying requirements. The six-seat concept benefits from a low, flat floor and long wheelbase, both of which help to maximize interior space. The three pairs of seats, from front to back, provide ample room for six adults, with space to spare to move around comfortably. The passenger area is completely separated from the cargo area by a partition and tonneau cover. Thus, the interior can accommodate from one to six persons and is suitable for a wide range of applications. Special effort was applied to ensure the seats would be flexible enough to adapt to a variety of circumstances. The aim was to make them extremely comfortable over an extended period of time for long journeys but also make certain they folded neatly out of the way and could move sufficiently to maximize cargo volume. A clamshell design was chosen in order to meet both these requirements, as it allows the chairs to be folded forward flat which makes room for easy stowage of long cargo measuring up to 118.1 inches (3000 mm) in length. The seats in the Washu are captain's chairs. The middle pair of seats is electrically powered and can be independently moved fore-and-aft a full 25.3 inches (645 mm). The seats can also slide to the side to allow easier access to the rearmost pair of seats.

Honda Element

Element, with its straightforward exterior design and functional interior, combines the best features of a pickup truck and a SUV, and is targeted squarely at young, active buyers. The Element delivers on themes featured in the Model X concept vehicle unveiled at the 2001 North American International Auto Show in Detroit. It received a strong response on the auto show circuit, earning a fast track to production.

It is a very different looking vehicle aimed at young male buyers who need a truck to haul their stuff but want the security of an enclosed cargo area and the performance of a car. A key design feature of the Element is the center-opening "swing-wide" doors that have no B pillar for maximum cargo loading flexibility. Wide-swinging suicide-style doors on either side of the vehicle and a clamshell rear hatch make for impressively unobstructed access to the inside of the box. A totally flat, washable floor and cleverly stowable rear seats - they fold up flat against the walls for 70.1 cubic feet of space, 74.6 cubic feet when taken completely out - give the Element the best and most convenient cargo hold of any small vehicle. The flexible interior hauls four adults and their gear comfortably on road trips; or the rear seats fold away to create a large and open interior capable of hauling just about anything that can be used during the course of a weekend.



5. User Analysis and Platform Selection

5.1 Microbus Category

A vehicle class can be determined by the physical attributes of the vehicle such as number of axles and/or tyres, dimensions (height, length, wheelbase, height over first axle), weight of the vehicle and the purpose for which the vehicle is used. The microbus category of vehicles is formed by considering the number of occupants in the vehicle.

The Microbus class itself is not clearly defined in the vehicle market. If introduced it will lie between MPV's and minibuses. An MPV typically seats anywhere between 6 – 8 passengers and has a more car like appearance. The minibus accommodates between 14 – 25 persons. Usually serves as a commuter vehicle for small groups over short to medium distances.

5.2 Possible Applications of a passenger cum cargo microbus

§ As a privately operated commuter service vehicle operating in the vicinity of railway stations, bus stations and airports on short circuits, connecting these transit hubs with nearby suburbs.

§ Used by a group of traders to pick up and supply goods from the wholesale market. It can also be used by semi urban traders to bring their wares into the central market district.

§ As part of company owned fleets. Used to carry people as well as equipment within the premises. Can also be used as a pick up vehicle for the company staff.

§ In educational campuses to transport students, staff, faculty and visitors around the campus. Can be used to transport light payloads of furniture, exam papers to various centers and even equipment such as lab machinery or computers from one department to another.

5.3 User Analysis

This class of vehicles is most suited for short to medium distance commuting. Analysis of the various roles that such a platform could play it was found that the vehicle would cater to a diverse user group. Along with varying parameters such as the environment of use - semi-urban, city, campus etc and utilitarian functions the vehicle would need to have optimal flexibility.

User Profile

In the case of passenger vehicles, it is commonly seen that it is the owner who is the user of the vehicle. For him parameters like comfort, looks, milage etc are some of the factors that influence his choice.

Contrary to this, in cargo vehicles the owner is seldom the user. Issues such as load carrying capacity, maintenance, operating cost etc are more relevant in this case. The owner intends to extract maximum profits from his investment, sometimes even at the expense of passenger(driver/co-driver) comfort.

The MPV segment has a mix of both. Self owned MPV users are most likely to be middle-aged men who use the vehicle as a family vehicle for everything from everyday trips, shopping and even short holiday drives. Leased MPV's are commonly seen as tourist vans, courier service vehicles etc. In this case both users take advantage of the flexibility of the vehicle to perform several tasks. Here too operating cost is a more important factor than looks or luxury.

The kinds of likely users would be working class who are traveling to and from their workplaces. They seek uncluttered seating with minimal frills as opposed to the executive class which would require higher levels of comfort and luxury.The users were categorized on the basis of the amount of luggage carried into 3 basic categories

Minimal luggage carriers

Consisting of office goers or factory workers who carry small briefcases or satchels. Students with their school/college bags.

Medium luggage carriers

Consisting of travelers with small hand luggage.

Heavy luggage carriers

Consisting of traders with their wares. Travelers with large suitcases and baggage.

User Behavior

Being in the tropics, the Indian climate greatly dictates the behavior and psychology of the user. In hot and humid conditions it is unlikely that people will travel with the windows shut. Rather he will prefer to have large windows which offer good ventilation with the added advantage of being able to know the progress of the journey by watching the route through the window.

5.4. Cargo carrying potential

Luggage

The kinds of goods that could be potentially transported by this vehicle concept were analyzed based on the possible applications envisioned. The scenarios in which such a passenger cum cargo vehicle would operate require that minimal specialization in terms of the body interiors be carried out (the cargo loading space would essentially need to be a flat bed free of obstructions). This would allow a varied cross section of non-specialized goods such as luggage, small to medium sized parcels, crates/baskets, paper and stationery items, lightweight electronic equipment such as computers, TV monitors etc and also light collapsible or stackable furniture etc, to be transported.

Computers

Baskets/crates

Stackable furniture

Cartons

5.5 Platform selection

Several possible vehicle platforms were short-listed based on which the design could be carried out. The selection criteria laid down for evaluating these vehicles were drawn from the previous studies and also from the analysis of various vehicle parameters and specifications. These included overall dimensions (length, width and height), the number of doors (entry/exit points), rear door if present (cargo loading/unloading points), seating capacity, engine specifications, type of body and chassis construction.

Vikram 410 Petrol version

Based on Italian design. Improved with enhanced technology to suit rough roads and driving conditions. The vehicle is equipped with a welded steel cabin, electronic ignition, turn indicators etc. Popular as a public carrier in semi urban areas for up to 7 persons or a small sized good carrier.

Maruti Omni

Maruti Omni is a 5 door, rear wheel driven MPV, which was originally conceived as a delivery van. But it has done wonders as a practical little runabout in Indian cities. The sliding doors are a boon when it comes to loading the car with either people or goods. It is available in 2 versions standard with a seating capacity of 5 persons and a - tourist version with a capacity of 8 persons. Besides its use as a city runabout it is also used for equipment transport, as an ambulance and delivery vehicle.

Mahindra Voyager

Has a spacious and comfortable interior in contrast to its compact external dimensions but has a low roof like MPV's. Provides seating in multiple configurations for up to 9 persons. Large sliding doors and a rear hatch are its plus points. However its flat panels and dated looks are a big negative.

Bajaj Tempo Traveler

The Temp Traveler is a top of the line vehicle identical to the one currently manufactured abroad by Mercedes Benz under the name 'Mercedes Transporter'. Its monocoque body offers a high standard of safety and treated with advanced anti corrosion techniques to give lifelong protection against corrosion. Driving the Temp Traveler is a pleasure with its spacious interiors and extraordinary handling. Powered by the proven 72 BHP Mercedes OM 616 diesel engine, rear wheel driven, offers excellent pick up, high fuel efficiency and silent trouble free performance.

Telco LP 407

On the same wheelbase as the Telco SF 407. This minibus has a larger seating capacity of up to 24 persons. It is more popular as a company transport for its employees. Also used as a tourist vehicle for small groups. Similar vehicles are also made by Swaraj Mazda, Eicher, Mitsubishi etc which are popular in different parts of the country.

Mahindra Tourister

Touted as the most rugged minibus on the road. Has a powerful yet fuel efficient 2.5 lit DI engine. A spacious and comfortable passenger saloon which offers excellent visibility. Corrosion free, long life and light weight aluminum body. Attractive and long life polyvinyl interior panels with an optional rear luggage compartment. Available in various seating configurations 11, 12, 13, 14 and 15 seaters.

Platform Selection Parameters

PLATFORMS	OVERALL DIMENSIONS (all in mm)				NO. OF DOORS		REAR DOOR	NO. OF SEATS	BUILT UP BODY	ENG. SPECS.
	LENGTH	WIDTH	HEIGHT	WHEELBASE	HINGED	SLIDE				
VIKRAM	3179	1200	1885	1864	-	-	NO	8	NO	198cc P
MARUTI OMIN	3370	1410	1640	1840	2	2	YES	5-8	NO	800cc P
MAHINDRA VOYAGER	4040	1700	1800	1700	2	1	YES	9	NO	2.5l D
BAJAJ TEMPO	4755	1600	2545	3050	2	-	YES	7-15	NO	2.4l D
MAHINDRA TOURISTER	5274	2020	2613	2654	3	-	YES	11-15	YES	2.5l P
TATA 407	5975	1800	2730	3100	3	-	YES	14-20	YES	2.9l D

Desirable Features

- Standing Height Interior : Ease of ingress/egress
- Rear Door : Separate passenger entry/exit point & cargo loading/unloading point
- Built up Body : Ease of modification

5.6 Final Platform Selected

Mahindra Tourister : Platform Specifications

External Dimensions

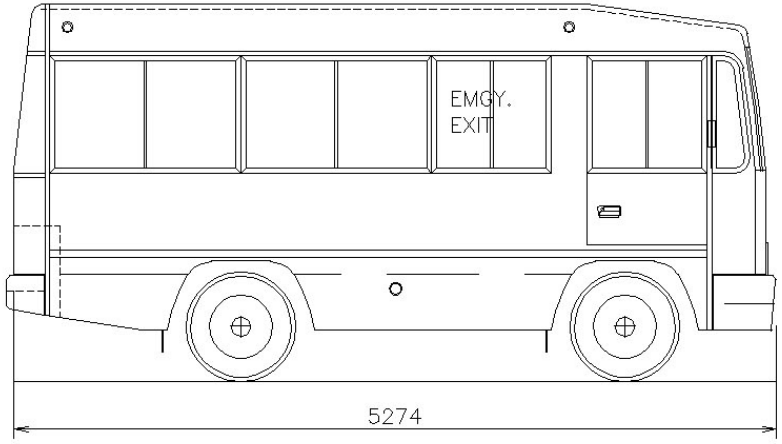
Overall length	= 5724mm
Overall width	= 2020mm
Overall height	= 2613mm

Internal Dimensions

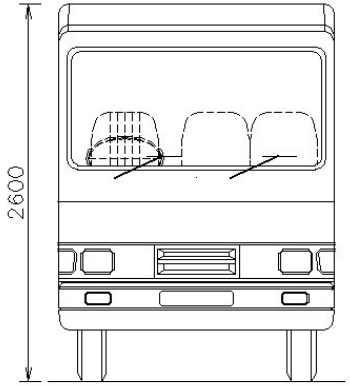
Interior Width	= 1940mm
Interior Height	= 1830mm

Engine specification

Type	:	MDI 3200B, 4 Stroke DI, 4 cylinder
Displacement	:	2523 cu.cm
Max. Eng. Output	:	53.6 +/- 2% HP @ 3200 rpm
Max Torque	:	16.5 kgm @ 1500 rpm
Tyres		
Type	:	front 2, rear 2
Size	:	7.00*16-14 PR
Fuel Tank		
Capacity	:	58 litres
Weights		
Max. GVW	:	4450 kg
Max Permissible FAW	:	1800 kg
Max Permissible RAW	:	2650 kg



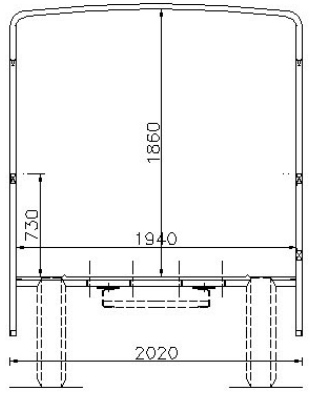
DR'S SIDE VIEW



FRONT VIEW

SPECIFICATION

1.	STRUCTURE.	:– M.S.
2.	EXTERIOR PANELLING.	:– ALUMINIUM
3.	INTERIOR PANELLING.	:– P.V.C. COATED ALUMINIUM.
4.	FLOORING.	:– ALUMINIUM CHEQ. PLATES.
5.	WINDOW GLASSES.	:– CLEAR
6.	RUBBER PROFILES.	:– E.P.D.M.
7.	Dr. PARTITION.	:– FULL PARTITION M.S. STR.
8.	INSULATION.	:– GLASS WOOL (ROOF)
9.	PASSANGER SEAT.	:– SEMI LUXURY SEAT 14+2+DR'S



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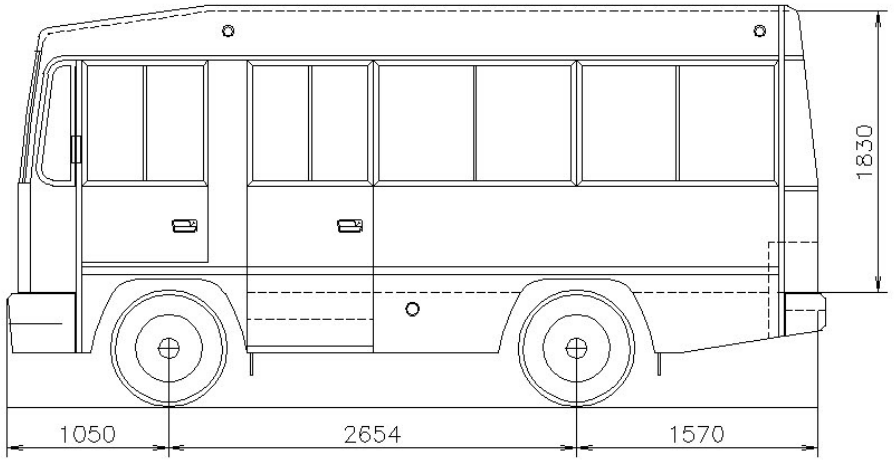
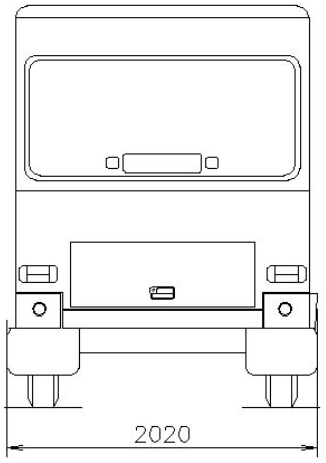
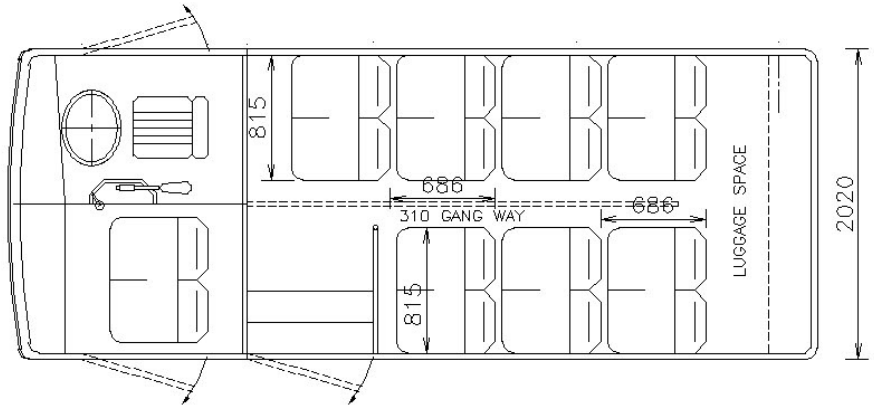


PASS. SIDE VIEW



REAR VIEW



SEATING CAPACITY 14 + 2 + DR

OPTIONAL ITEMS

1. LUGGAGE CARRIER ON ROOF
2. REAR DICKY ON FLOOR–UNDER REAR SEAT.
3. PIPE HATRACK.
4. TINTED GLASSES
5. SPEAKERS.
6. FANS.
7. LETTERS & LOGO PAINTINGS.

6. Product Brief

Product Brief

To design a flexible multi-utility vehicle, keeping in mind the various environments it will operate in and the services it will undertake. The product brief was categorized into three broad segments passenger requirements, cargo requirements and seating system/layout.

Passenger requirements

- Should provide wide openings for ease of ingress/egress
- There must be sufficient aisle space to allow free movement within the interior.
- Suitable features such as grab rails to provide requisite support when entering or exiting the vehicle or while making way through vehicle.
- Good ventilation should be provided during travel to make journey comfortable
- Sufficient visibility should be provided to enable passenger to check progress of the route
- Adjustable components such a windows and seats should be easy to use and simple in operation

Cargo requirements

· Should provide wide doors which are as free of intrusions as possible to enable easy loading / unloading of cargo.
· Floor of the vehicle must be as flat as possible to allow even loading of cargo
· Elements that enhance the cargo transportation requirements of the vehicle could be provided.
· Construction and materials used must be tough and sturdy to with stand the abuse.

Seating system and layout

· Should provide flexibility for the transport of both passenger and goods simultaneously or in separate modes (partial convert ability or total convertibility)
· Conversion from one mode to another must be quick and easy to achieve.
· Should provide optimal flexibility and reconfigurability of the interior space]
· Minimizing intrusion of seating elements or fixture so as to open up maximum floor space for cargo loading.
· Choice of materials used for construction should be such that they can adequately take the stress of both modes of operation.
· Operation to achieve convertibility should be kept simple so as to enhance its usability
· Should provide sufficient comfort to the passenger during travel.

7. Concept Generation

7. Concept Generation

The concept generation phase was initiated keeping the product brief in mind as an overall framework within which to work but yet not constraining oneself. Emphasis was on clearing up the floor space to create a homogenous volume that could be used for non specific cargo transportation, as in a flat-bed delivery van.

Ceratin key criterion were kept in mind as the process progressed such as finding an appropriate seating system that enables either partial or total convertibility from one mode of transportation to another.

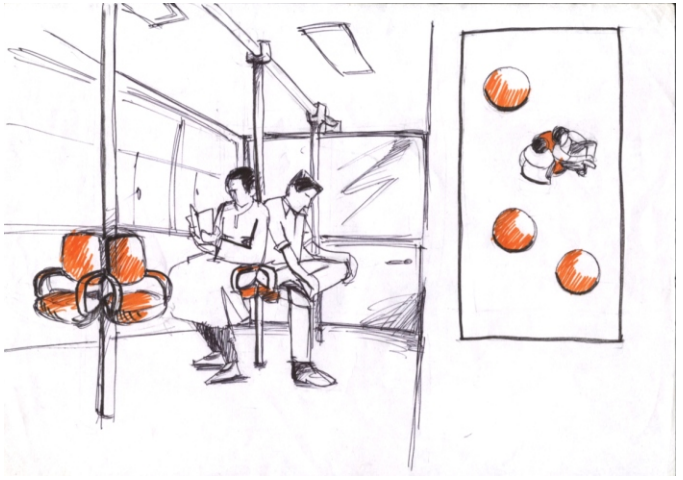
Mahindra Tourister, the selected platform has a layout which includes 2 doors in the drivers area and a passenger entry/exit door in the passenger area. A wide rear cargo door was opted for to enhance the cargo loading/unloading characteristics and also to create separate zones within the vehicle for passengers and cargo. This would serve to allow separate movement of both people and cargo into and out of the vehicle.

The working volume was based on the internal dimensions of the standard platform and focus was on the passenger area exclusively.

7.1 Ideation Stage and Concepts

One of the initial concepts, which consists of two rows of back to back benches along the center of the vehicle interior. The passengers would be seated directly facing the windows with sufficient aisle space all around to allow for movement through the vehicle. The benches could be folded creating a partition that clears up space on either side for loading goods. With benches in the normal position on one side of the vehicle and folded up on the other, the vehicle could be used as a passenger carrier and goods transporter at the same time.

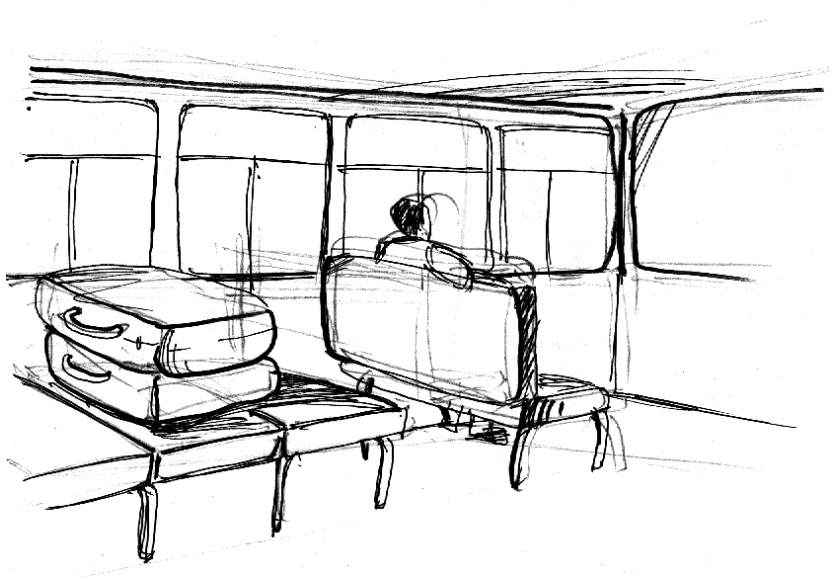
The flower type layout, an attempt to break away from the usual monotony of parallel and perpendicular lines seen in boring abundance in vehicle layouts. The idea was to have a set of vertical pillars around which a circular array of seats are placed. The seats would be cantilevered on the pillar and could be folded up on to the pillar to open up the area underneath and around. The biggest drawback of this layout was its lack of space efficiency. Added to this was that it resulted in an interior volume that had several vertical beams that would inhibit the space utilization in terms of cargo loading capacity.



Concept 1

Fixed seats placed laterally

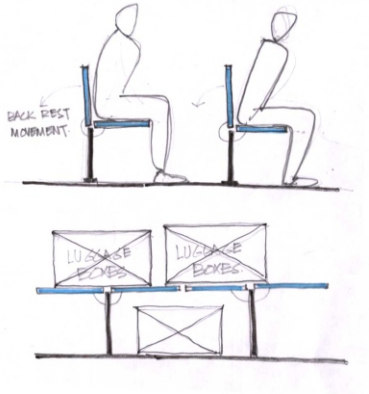
Concept 1a : Backrest folding backwards

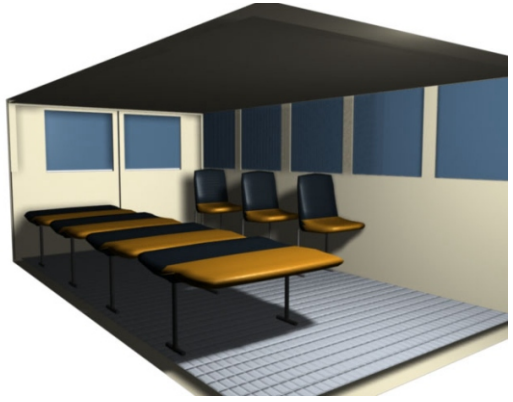


The layout included rows of double seats along one side of the vehicle and single seats on the other, facing the front.

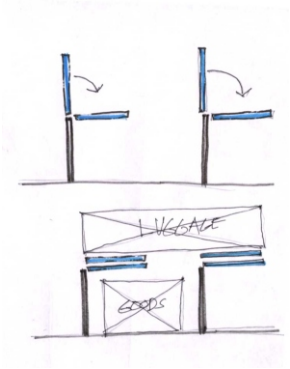
The idea was to design the seat pan and backrest such that when the seats folded back, the backrest of the seat in front would lock with the seat pan of the rear seat. This would create a kind of platform, above and below which goods could be stacked.

The disadvantage here being that the goods would come into direct contact with the seat elements and upholstery(if present). This would in the long run lead to excessive wear and tear on the seats, psychologically dissuading passengers from using the damaged seats.





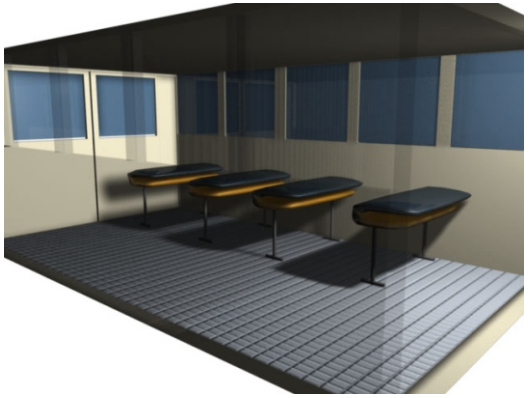
Concept 1b : Backrest folding over seat



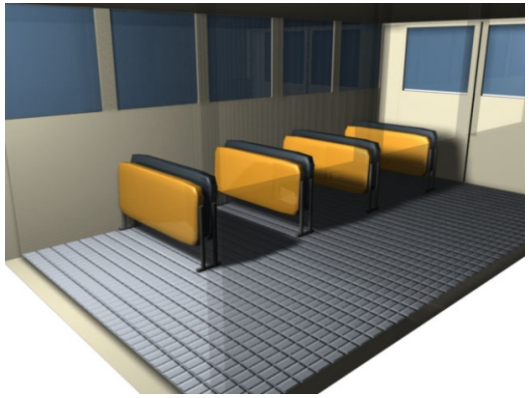
In this concept the seat backrest were folded directly over the seats so as to reduce the surface area coming into contact with goods in the cargo mode. A series of elevated platforms are created as against a single continuous one in the previous concept. Goods can be stacked on these platforms as well as in the spaces between the seats

Here there are several negative spaces created in the voids between the benches which may or may not get fully utilized.

In the picture the other row of seats have not been shown so as to prevent blocking of a clear view.



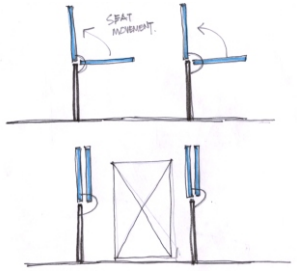
Concept 1c : Both backrest and seat fold upwards



This concept involved having a kind of seat design which could be folded totally upright. Both the seat pan and backrest are independently mounted on 2 sets of guides which allow it to be hinged and then slid down onwards the floor of the vehicle. The advantage in this case was that the goods are not placed directly on the seat elements, thereby reducing chances

of damage and prolonging the life of the seats itself.

The goods can be placed directly on the floor of the vehicle in the spaces created between the upright seats.



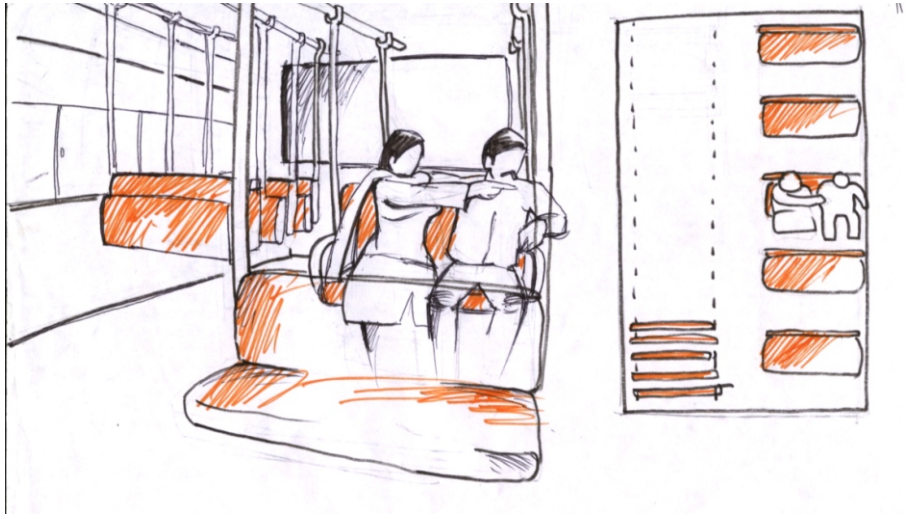
Concept 2

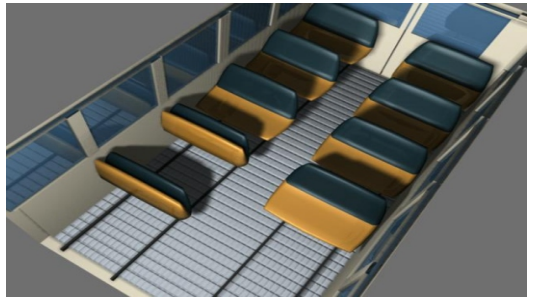
Foldable seat on guide rails

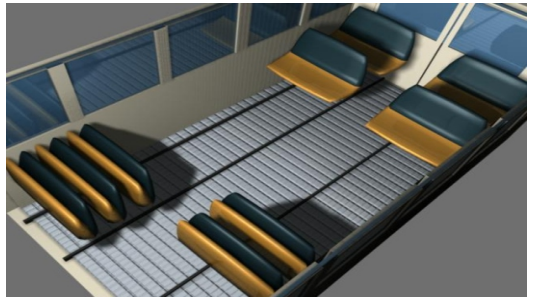
Here the approach was to have conventional bench seats which are mounted on guide rails fixed to the floor and side walls of the vehicle. The seat pan and backrest are hinged so they can be folded and the entire unit can then pushed over the rails and stacked at the front of the passenger area.

The benches could be selectively stacked thereby giving a certain degree of flexibility in terms of the amount of passenger or cargo space that can be created.

The other advantage is that there is minimal intrusion on the floor which opens up a large, flat, free space which can be used for cargo loading.



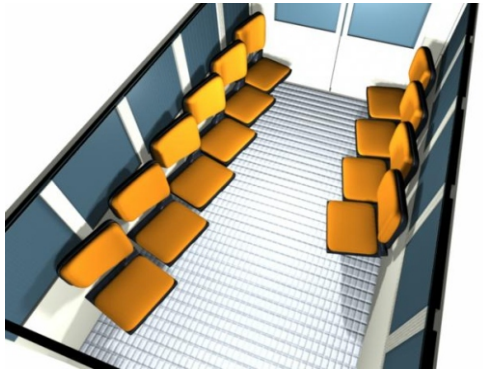




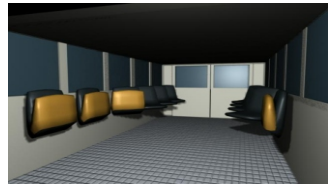
Concept 3

Jump Seat

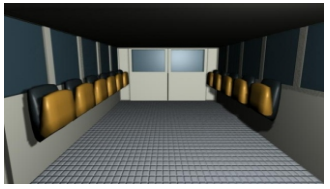
Concept 3a : Independent Seat Unit



A series of independently mounted seats which are positioned in an angular orientation along the length of the vehicle, facing towards the front diagonally.

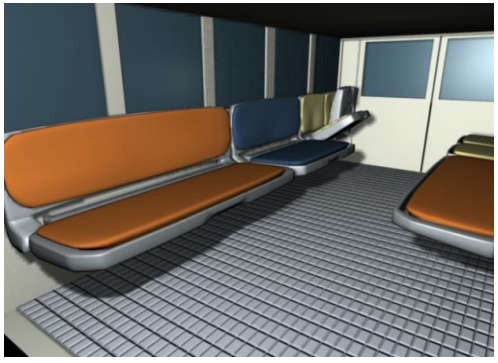


Passenger mode

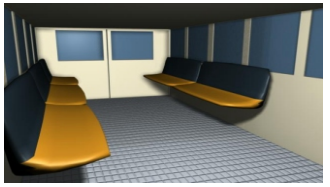


Cargo mode

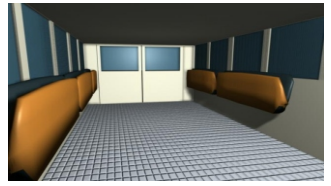
Concept 3b : Bench Seat



This concept involved using a modular kind of bench seat which is placed along the length of the vehicle perpendicular to the direction of motion. There are 2 rows of bench seats facing each other on either sides of the vehicle. The benches can be folded upright towards the side walls of the vehicle thereby opening up a generous area of floor which is totally clear of all intrusions.



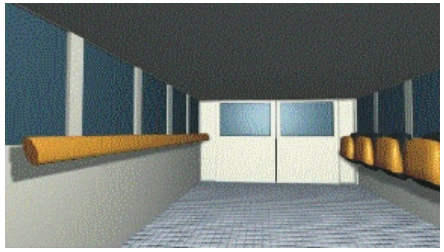
Passenger mode



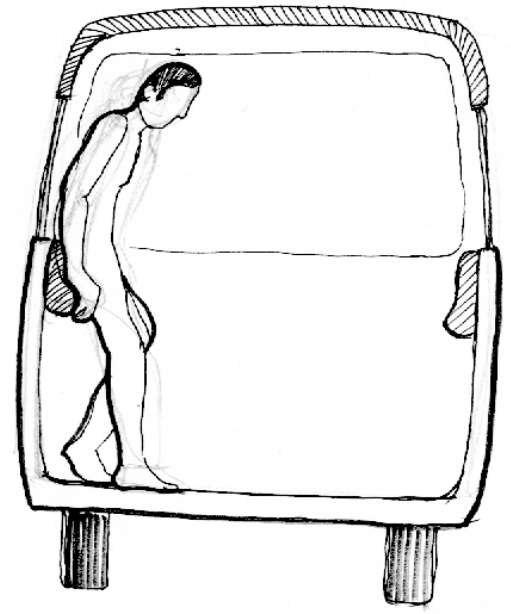
Cargo mode

Concept 4

Lean-to beam

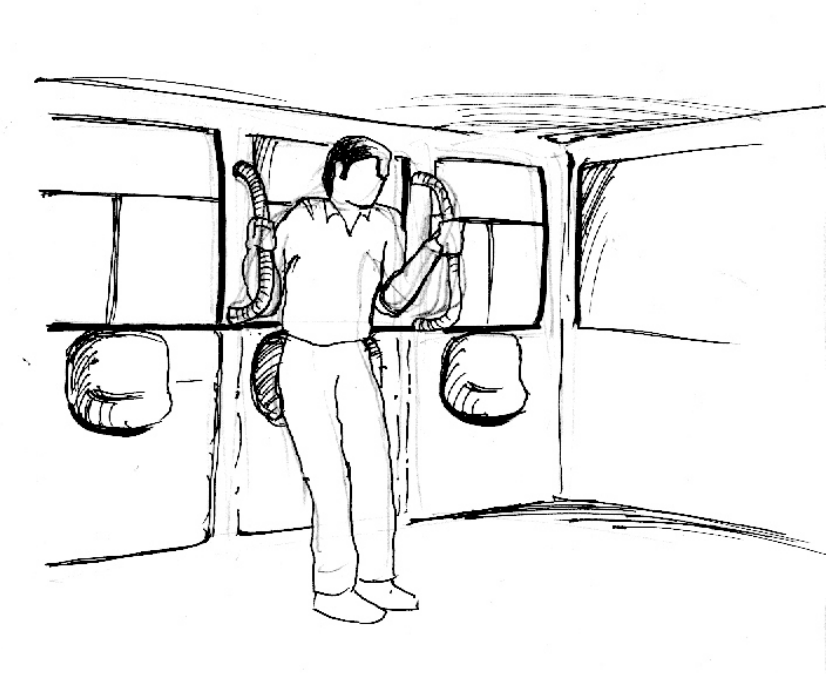


A simple beam mounted along the length of the vehicle which serves as a lean to. The opposite side of the vehicle would have a series of jump Seats which when folded would open up a space of considerable dimensions which can be effectively used to load cargo.

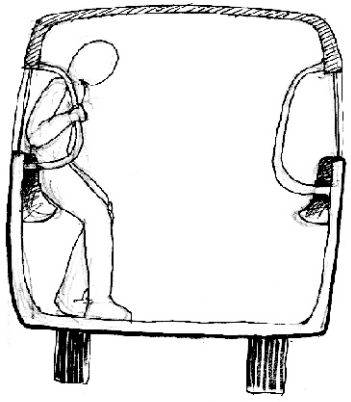


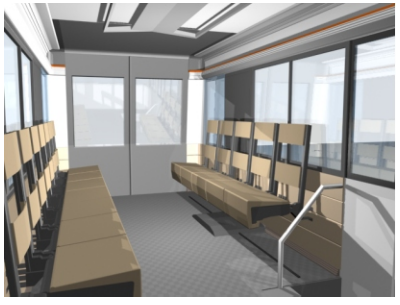
Concept 5

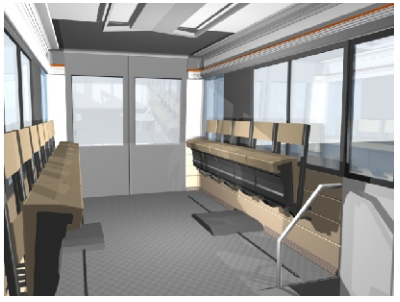
Semi Seat



This concept was evolved combining the jump seat concept with the lean to beam. It was realized that since this vehicle platform would operate on short commutes the travel time would be anywhere between 10-45 minutes. It could be possible be to provide a kind of seating system that allows for a person to remain semi-seated rather like the lean to.
The design incorporates a normal jump seat with a thick front edged seat pan, which upon folding doubles as a support on which the buttocks can be rested. The concept tries to address the issue of both multi-utility as well as overcrowding. In the semi seated position the floor of the vehicle can be opened up significantly for cargo loading, also if the need arises this same configuration can be used to accommodate more people by clearing up the aisle space. This would allow a greater number of standees.







7.2 Passenger Ingress/Egress

The entry/exit point is the first area at which there is interaction between the passenger and the vehicle. It is therefore critical to make sure that adequate attention is paid to the selection of this element. Due to the constraints in the selected platform it is possible to incorporate only certain types of doors. The entry/exit points must be as wide as the platform allows to ease ingree/egress. It is desirable that the type of door and elements have minimum protrusion both into and outside the vehicle at the same time not sacrificing on the available width of the door frame.

Several types of doors and their mechanisms were studied in this endeavor.

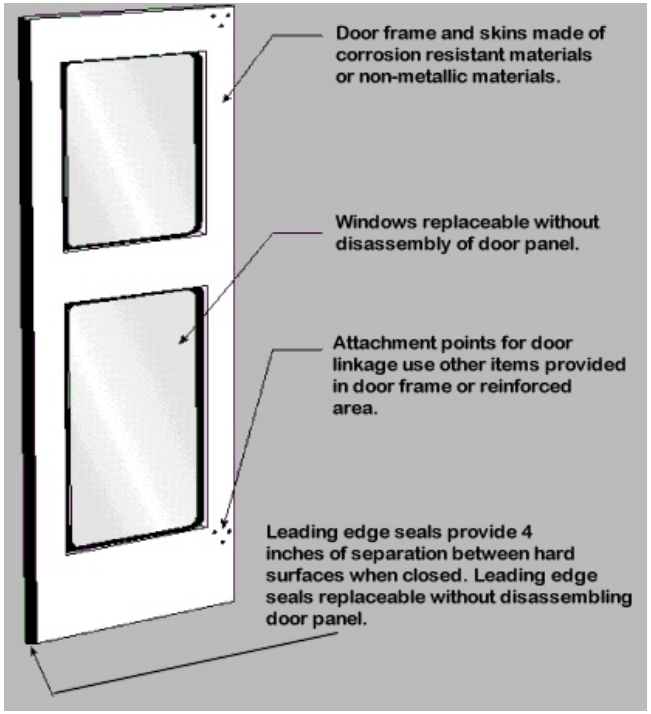
Swing door

Bi-fold door

Slide Glide door

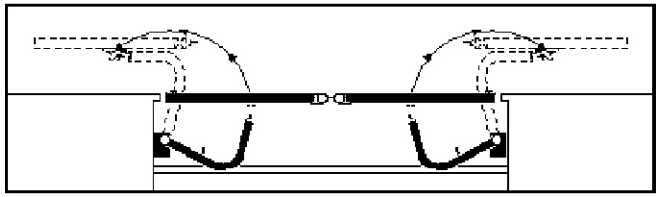
Parallelogram Plug door

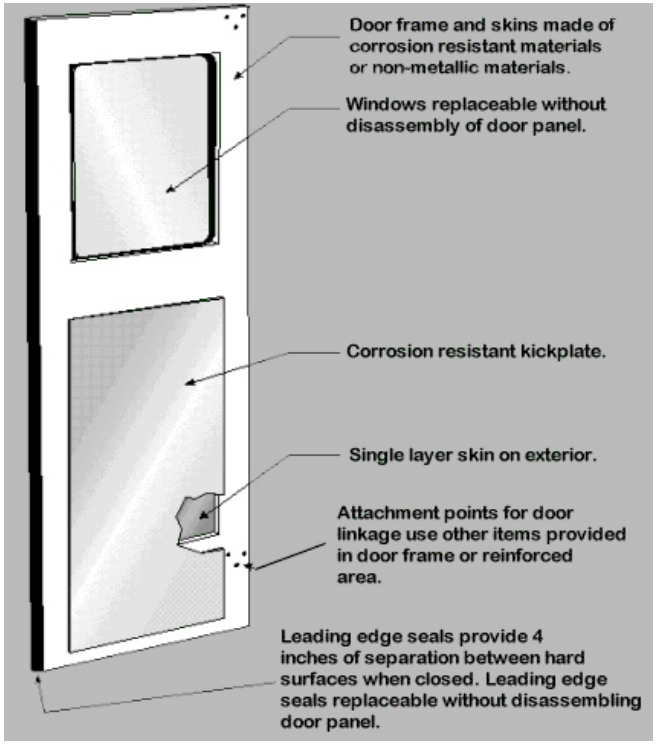
After careful consideration it was found that the most suitable door would be a parallelogram plug door.



CONSTRUCTION FEATURES — TYPICAL ENTRANCE DOOR

PARALLELOGRAM PLUG DOOR





CONSTRUCTION FEATURES — TYPICAL EXIT DOOR

Description of Geometry

Each door panel is suspended near its top and bottom by curved (boomerang) arms attached to a rotating door shaft mounted inside the vehicle body. A third guide arm is attached to a point near the leading edge of the door and to a point on the vehicle body. When the door shaft is rotated, the door panel moves out of the opening and follows a circular trajectory to a point adjacent to the vehicle body and clear of the door opening. Parallelogram Plug Doors may be used in either single panel or bi-parting configurations.

Applications

Principal uses are on intercity and tour coaches.
Vehicles where a flush door and/or no protrusion into body is desired.
Shuttle vehicles where smooth sides are desired.

Application Considerations

Door panels may be flat or curved to match vehicle body contour.
In open position, entire door panel is on exterior of vehicle.
Door linkages must be designed to withstand forces associated with cantilevered door panel mass.
Leading edge of door panel overlaps door opening when in fully open position.
Latching devices may be required to prevent door panel "lift-out" caused by aerodynamic effects at higher speeds.

Implications for Door Panel Design

Attachment points must be provided for boomerang arms and guide arm.

7.3 Cargo Loading/Unloading

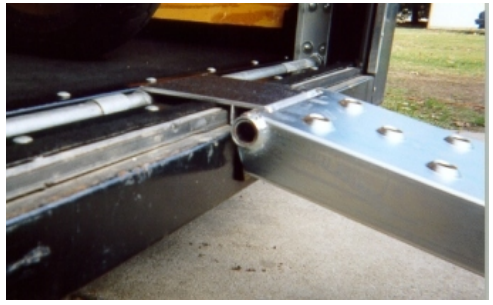
Position the ramps anywhere along the slide tube- they can even move to the center creating one large loading surface.

The cargo loading unloading point is also an important element because of the dual nature of this vehicle. It is necessary to provide wide access doors to ease movement of cargo out of the loading area. The cargo door is located at the rear of the vehicle so as to create separate zones within the vehicle for the accommodation and movement of both cargo and passengers. It is intended to have two large single hinged doors with wide opening angles to create a loading area, which is free of intrusions.

In order to enhance the cargo transportation characteristics of the platform, loading ramps can be provided which can be stowed under the floorboard or folded upright

As shown in the accompanying images.

The ramps slide along a tube inside the trailer eliminating any kick up and offer a raised tread that is actually formed into the ramp design for excellent traction.



When the ramps are not in use they fold up into the trailer locking into place out of the way- still permitting passage through the rear doors.

Windows, Flooring, Sidewall & Ceiling

Windows

The windows of the vehicle serve two purposes in the passenger mode; (1) Provide sufficient ventilation to the occupants (2) Provide good visibility so that passengers can check the progress can check the progress of their route.The windows are sliding type, which allow opening up of the glass area so as to enable movement of air into the cabin.Construction would entail slidable safety glass panels mounted in extruded aluminum channels.

Flooring

The floor area of the vehicle has been kept free of intrusions or projections so as to prevent injury to passengers and to create a flat loading bay that can be used to stack cargo. The floor should posses characteristics such as anti skid nature, durability etc. The flooring panels would be made of standard aluminum checkered plates that are riveted to the structural members of the chassis.

Sidewall & Ceiling

The sidewalls and ceiling make up the largest visual elements of the interior of the vehicle. Frame members and/or reinforced fastener attachment points should be provided for attaching fixtures such as lights, grab rails etc. Appropriate use of materials,color and graphics will enhance the appearance of the interiors.

Safety Features

Due to the dual characteristics of the vehicle it is essential that the safety aspect of transporting passengers along with goods is analyzed. By creating separate zones within the interiors of the vehicle for passengers and cargo we can minimize the risk factor in the event of a collision. The layouts will have been to be designed in such a way that the cargo area opens up from the rear of the vehicle. Features such as floor/wall mounted cargo restraints can be incorporated that can be used to tie down the cargo. Additional features such as a net barrier can also be used to protect the passenger area.

7.4 Concept Evaluation

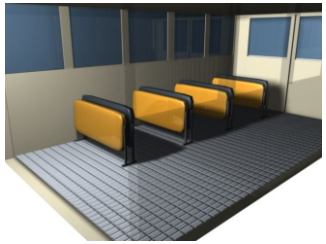
Concept Evaluation Parameters

After the initial phase of concept generation, the ideas were carefully studied and analyzed in terms of feasibility, complexity, suitability and practicality among other issues. Some of the concepts that seemed more down to earth and direct proved to be better alternatives for further exploration as these had a very high degree of implement ability in terms of construction and use.

Once the choices were narrowed down, the product brief came into play in deciding on one final concept in terms of seating system and layout. The parameters for evaluation were further given weightage points (given in brackets) according to priority, which I gave myself in achieving the end goals

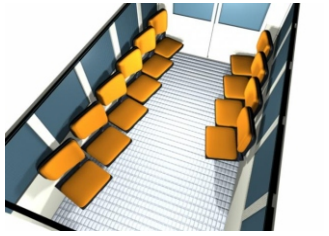
The parameters used for evaluation were

1. Adaptability/reconfigurability to changing needs of vehicle (10)
2. Minimizing contact between seat elements and cargo (8)
3. Minimizing negative spaces (8)
4. Number of components-ease of manufacture (6)
5. Maintainability/cleanliness (6)
6. Ease of use/operation (6)
7. Psychological Impact (10)

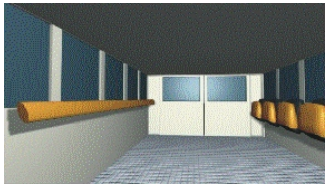


Fixed Seat

Guide Rails



Jump Seat



Lean to

Semi Seat

Concept Evaluation Table

CONCEPTS	1 (10)	2 (8)	3 (8)	4 (6)	5 (6)	6 (6)	7 (10)	TOTAL SCORE
FIXED SEATS	4	0	1	4	2	3	1	15
GUIDE RAILS	5	5	3	1	1	1	6	22
JUMPER SEAT	8	7	7	4	4	5	10 ■	45
LEAN TO	8	7	7	6 ■	5	6 ■	1	40
SEMI SEAT	10 ■	7	7	4	4	5	9	46 ■

■ TOP SCORE IN A CATEGORY

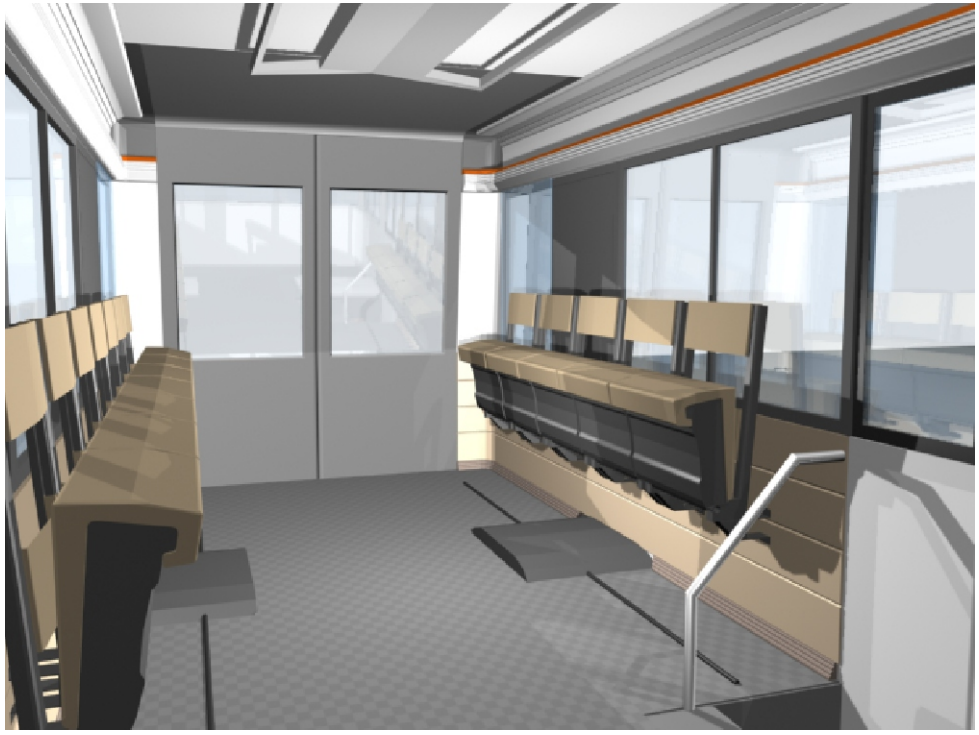
■ OVERALL TOP SCORE

Evaluation Criteria

1. Adaptability/reconfigurability to changing needs of vehicle (10)
2. Minimizing contact between seat elements and cargo (8)
3. Minimizing negative spaces (8)
4. Number of components-ease of manufacture (6)
5. Maintainability/cleanliness (6)
6. Ease of use/operation (6)
7. Psychological Impact (10)

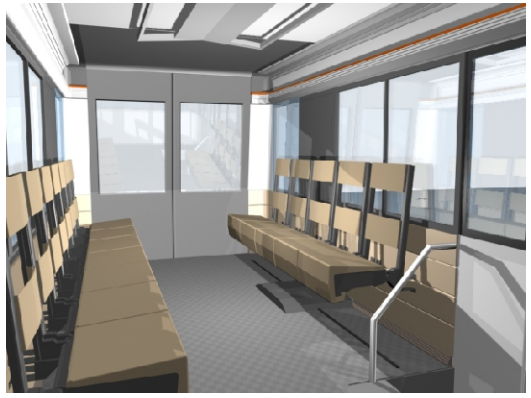
7.5 Final Concept : Layout, Elevation and Section

Final Concept : Semi Seat



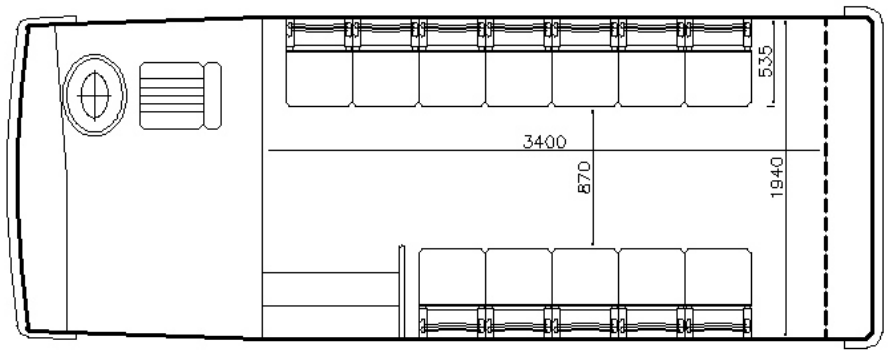
Semi-seated/Cargo Mode

Fully-seated Passenger Mode



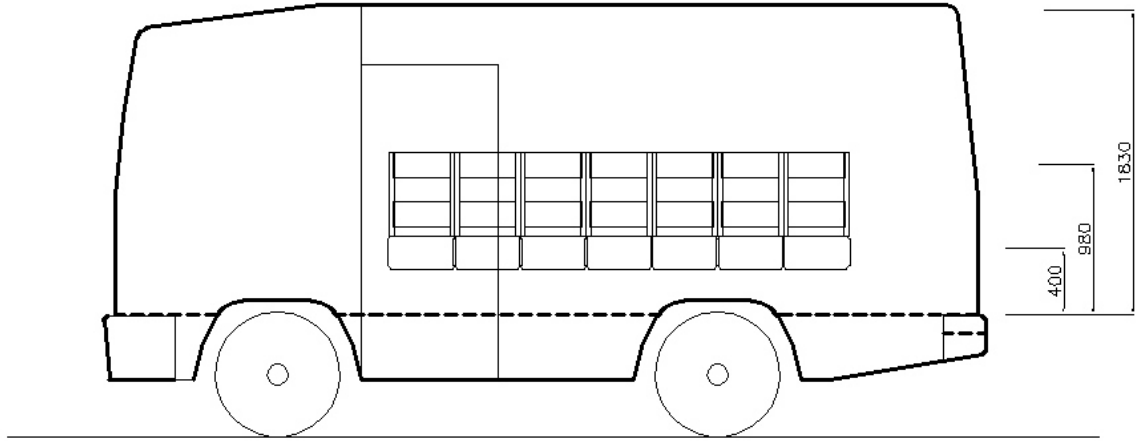
PLAN

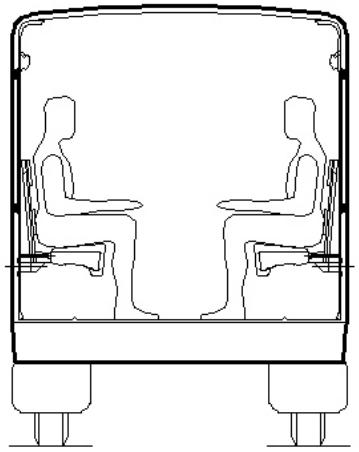
PASSENGER MODE



LONGITUDINAL SECTION

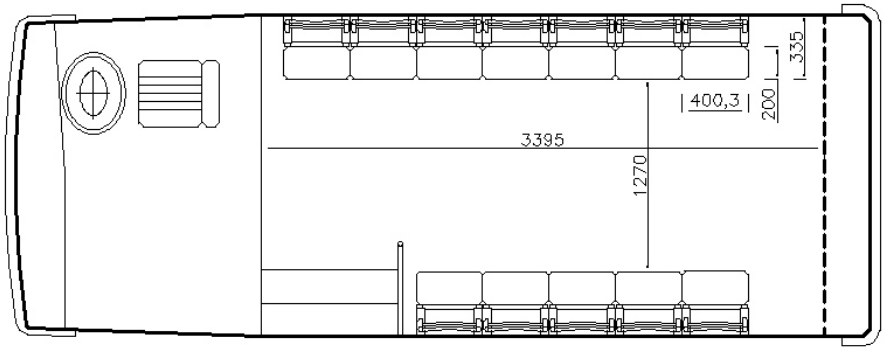
COSS SECTION





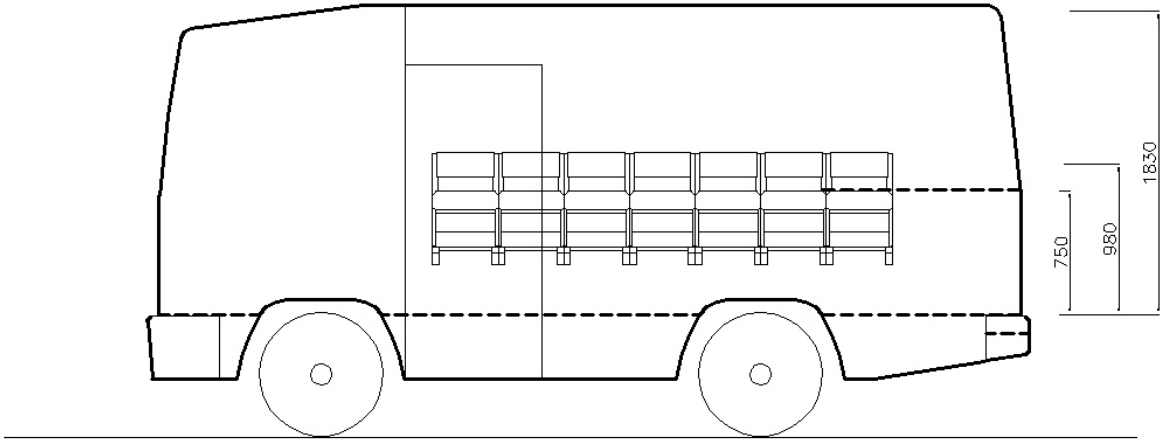
Seating Capacity : 12 + 2 + DRV

PLAN

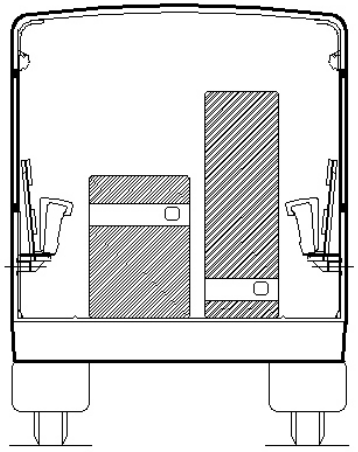


CARGO MODE

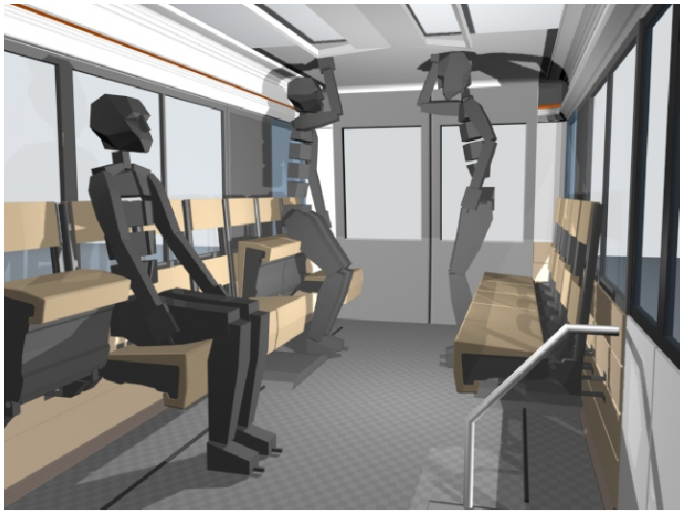
LONGITUDINAL SECTION



COSS SECTION



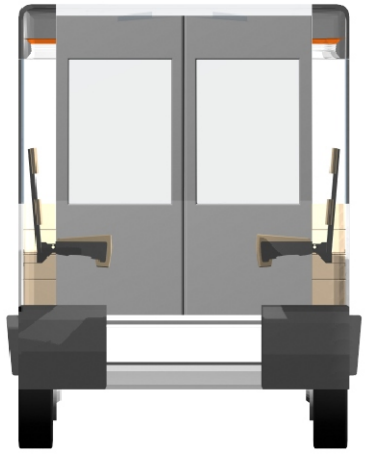
Modes of operation and various scenarios



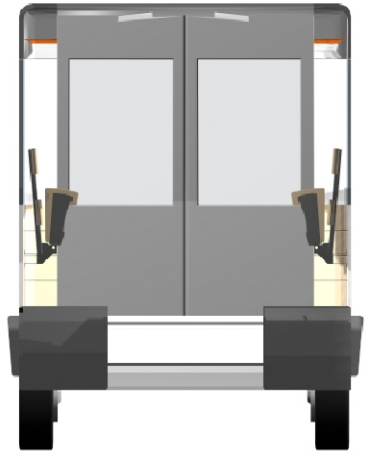
Passengers can travel either fully seated or in a semi seated position

The passenger cum cargo microbus as the name suggests is an effort to create a platform that changes with the varying need of the vehicle. This concept allows for 2 exclusive modes of transportation - passenger mode or cargo mode. Coupled with a seating system which mates the traditional jump seat concept with a semi-seated position, the vehicle increases its adaptability by offering either 'total convertibility' or 'partial convertibility'.

In passenger mode the seats can be used in the full seated position to allow 12 passengers to sit comfortably and travel. When the need arises to increase capacity the seats maybe folded into the semi-seat position. This clears up significant aisle space which enables more standees to also travel on short commutes.

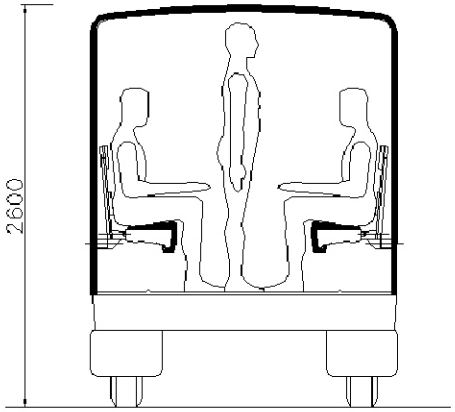


Passenger Mode

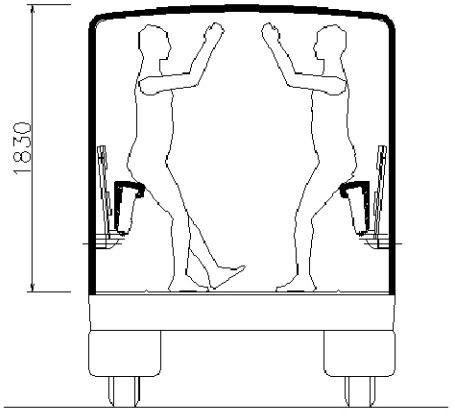


Semi seated or Cargo Mode

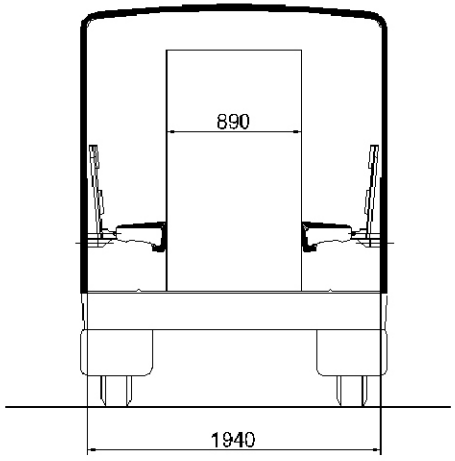
Seating Configuration

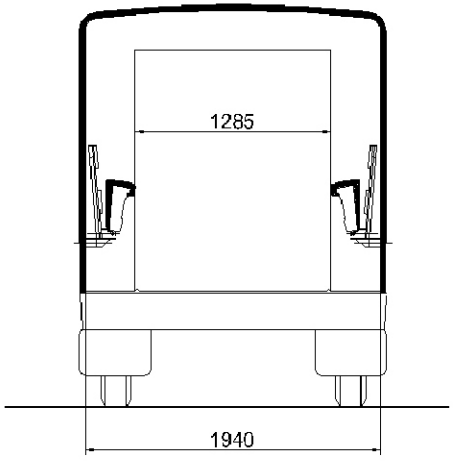


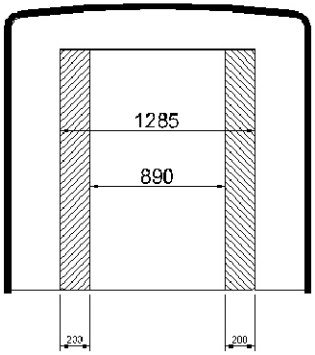
Full Seated



Semi Seated

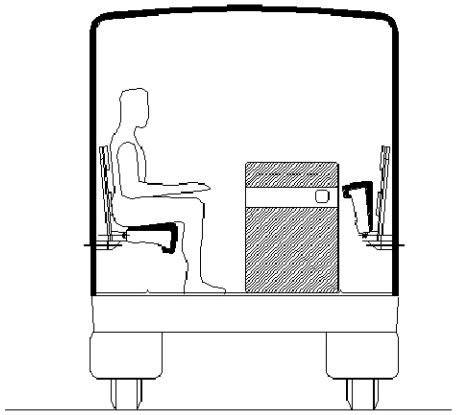


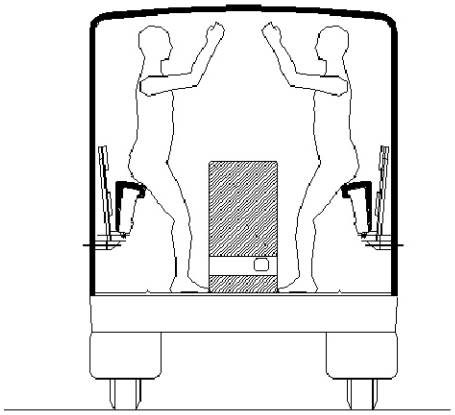




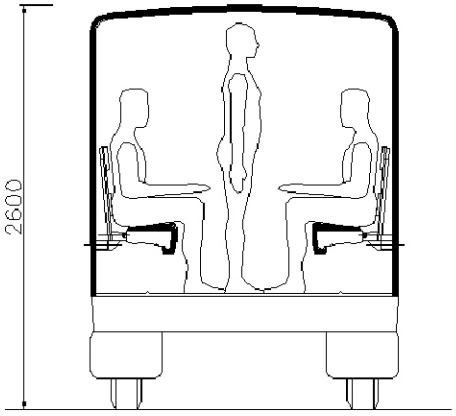
Volume Increase

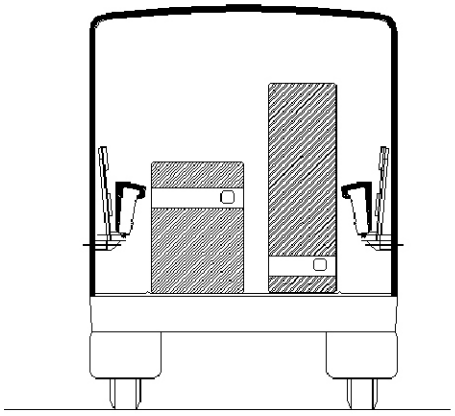
Vehicle Modes





Partial Convertibility





Total Convertibility

Passenger Mode

Cargo Mode

7.6 Seat Conceptualization and Design

Having arrived at a seating system that is most suited for the application at hand, jump seat concept combined with a semi-seated lean-to option, it was necessary to refresh oneself of the user analysis and the various environmental factors that will affect the vehicle before going into the conceptualization and design stage. The microbus platform is intended to travel over short to medium distances with a duration lasting anywhere between a few minutes upto about 45 minutes.

Environments of use

Company owned fleets. Transporting people and / or cargo around large plants / factory sites

Semi urban transport vehicle

Educational Campus Vehicle. Transporting faculty, students and visitors in the campus. Also carrying light payloads such as stationery. Collapsible furniture, workshop/lab equipment, models, exam papers etc.

Function of Automotive Seating

The function of an automotive seat is to support the body comfortably under both static and dynamic conditions. To achieve this, conventional seat designs have combined a number of separate mechanical suspension systems in the seat base. These systems are used to a degree in seat backs and other trim parts, but they are less sophisticated as the loads carried are significantly lower.

Riding comfort / Passenger comfort: Comfort experienced within the vehicle
The factors that affect this riding comfort / passenger comfort are

Leg room
Seat width
Seat shape
Seat adjustments
Firmness
Reclining angle
Layout

Auxiliary factors such as

Duration of travel
Route terrain (smooth metalled roads, unsurfaced roads, hilly regions etc.)
Ambient temperature

Material of seat upholstery etc. can also have varying influences over the riding comfort of the passengers.

Conventional Seat Design

The conventional seat base uses a steel (or other metal) frame that acts as a chassis to support a series of springs and a PU foam layer or 'topper pad', which sits on top of the springs. To produce such a seat, expensive and time consuming multi-stage fabrication techniques have to be used.

Seat Evolution

Over recent years, vehicle manufacturers have focused on reducing production costs, and have initiated programmes to reduce the weight of the seat, while improving its ride, comfort and durability. To complement these programmes research aimed at reducing the foam density and cushion thickness used in production, and the understanding of factors affecting both long-term and short-term seating comfort are also being undertaken.

Polyurethane Development

Implementation of the Montreal Protocol in 1989 banned the use of CFC11 as an auxiliary blowing agent, which was used to improve processability and reduce foam densities. It was then necessary to increase foam densities to 55-6O kg.m-3 to meet vehicle manufacturers' seating specifications. ICI Polyurethanes has now developed special PU systems with enhanced performance characteristics, which meet or exceed the demands of vehicle manufacturers at significantly reduced foam thicknesses, at densities of around 40 kg m-3.

The Full Foam Seat

Despite these advances, the conventional seat design remains relatively expensive to produce and places restrictions on the optimisation of comfort and durability. 'Full foam' seating techniques, on the other hand, offer vehicle manufacturers the opportunity to fully exploit the advances made in PU technology. It is this technique that is being used in the development of the 'concept seat'.

The Design

In a full foam seat, the metal frame or chassis is replaced by a cradle or pan, which is often manufactured from impact modified glass-filled nylon, ABS or lightweight metal. The springs and topper pad are all replaced by a single PU foam core.
As the foam core now has to provide both vibration dampening and comfort, it has to be considerably thicker than foam used in a conventional seat. To give an equivalent performance, the first generation of full foam seats generally needed a foam core thickness of approximately 13 cm. However, to achieve maximum design freedom and reduce the cost impact of the increased material usage, volumes need to be significantly reduced. The target for the concept seat is to reduce the foam core thickness by 46%, to 7 cm.

Dynamic Creep

Dynamic creep testing allows the physical change that occurs to the foam under driving conditions to be determined. Energy generated from prolonged vibrations of the occupant results in the foam losing height and hardness. Under certain conditions, this deformation can result in permanent damage to the foam structure.
Tests have shown that minimising the elastic modulus change and creep rate over time and a range of climatic conditions improves comfort, reduces fatigue and can allow a reduction in foam thickness. These findings have been confirmed by a number of global seat manufacturers, who have conducted subjective laboratory tests using real people.

The 'concept seat' combines many aspects of automotive design that are critical to vehicle manufacturers. It embraces the continuing need for reducing production costs, the need to increase the durability of the vehicle and the need to meet the demands of an increasingly sophisticated customer. This however, is not purely a notion around which production costs and speed to market times can be reduced. It embraces wide concerns on recycling and reducing the environmental impact of manufacturing processes.

7.7 Ergonomic Data

Ergonomic Data is used in design standards for new systems and in evaluation of existing systems in which there is a human equipment interface. The purpose of this data is to ensure that the human being is comfortable in using the equipment.

The passenger-cum-cargo microbus is required to operate on short to medium distances with travel times that may vary from a few minutes to about forty minutes at the most. Therefore it was required to analyze what could be the possible factors that could make the seating system ergonomically optimal for the requisite time of use by the passenger. Height and inclination of the seat pan, combined with the position, shape and inclination of the backrest influences the resulting seat posture. Low back stresses can be reduced with the use of back supports or full seat backs. Leaning the back against an inclined backrest reduces the physical load on the in-vertebral discs and the static strain of the back and shoulder muscles. This is due to the loads on the spine being greater when one is seated as compared to when one is standing.

Fig. 1

Balanced Seating

J.J.Keegan, an American Orthopedic surgeon, made in 1953 a series of x-rays of people lying on their sides which documented the large movements that took place in the lumbar section of the spinal column as the position changed from standing, to right angle sitting and bent-over positions. He reported that the disc seems more evenly distributed when the legs are approximately 135 degrees from the torso. This is the natural resting position, as when you lie on your side while sleeping. The lumbar curve is retained and the muscles are relaxed and well balanced. (Fig.1)

Fig.2

Fig.3

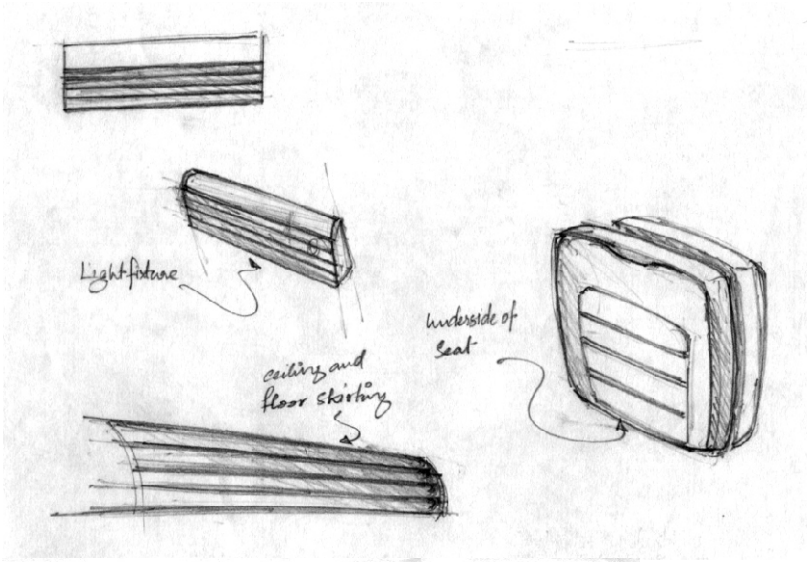
A sitting posture that approaches the natural resting position is a more suitable position and allows the spine to carry the body weight in a more comfortable way. This is "Balanced Seating".

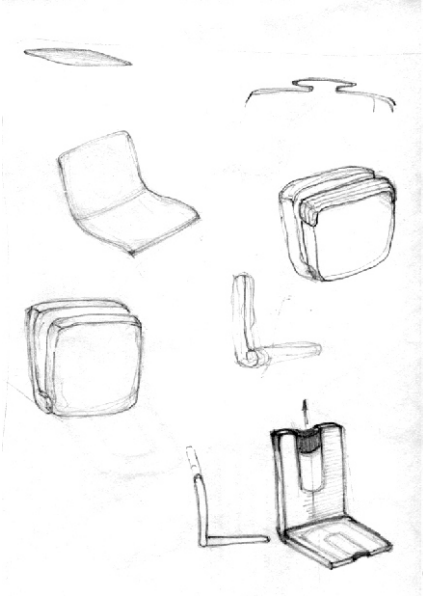
The semi-seated concept creates this natural posture. Opposing muscle groups are balanced and the lumbar curve is preserved producing balanced seating in which the back is straight, the joint angles are open and the muscles are relaxed. This position provides greater mobility and relieves pressure on the lungs and stomach. Children will often tilt forward on the legs of their chair to relieve backpressure. By tilting their chairs forward they avoid bending their backs, allowing the front and back muscles to relax, and thereby sitting in a more comfortable position with a straight back. (Fig.2)

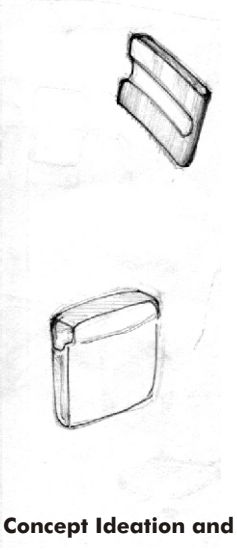
While riding a horse, the rider sits upright, yet maintains a lumbar lordosis because the thighs are sloping downwards. This is exactly the same position as the neutral resting position, or sitting on a chair seat that tilts forward. This means the rider is in the perfect position for "Balanced Seating". (Fig.3)

7.8 Seat Concepts

Concept Seat 1 : Jumper Seat

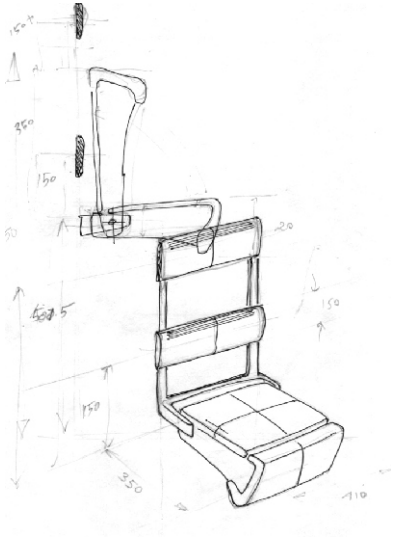


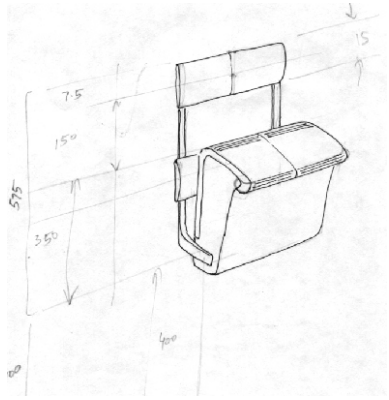


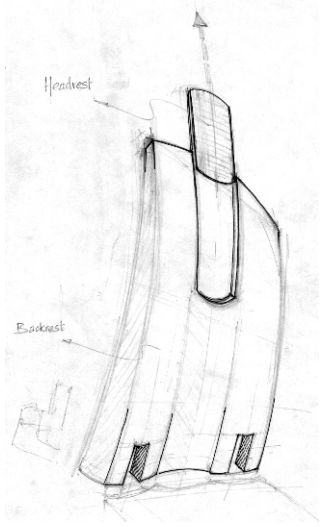


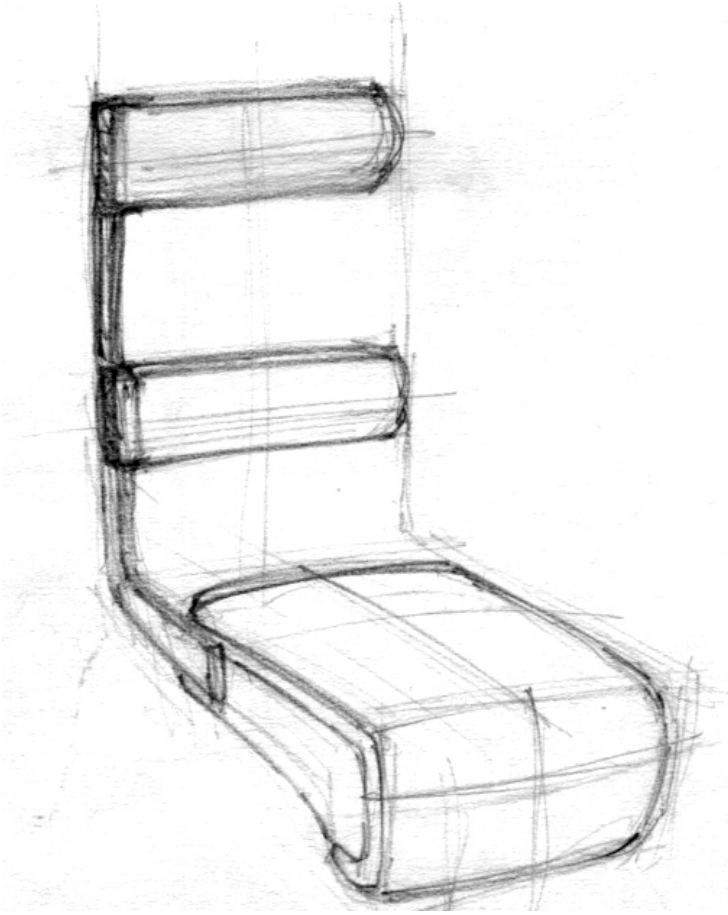
Concept Ideation and sketches

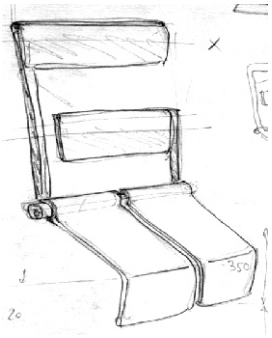
Concept Seat 2a : Semi Seat

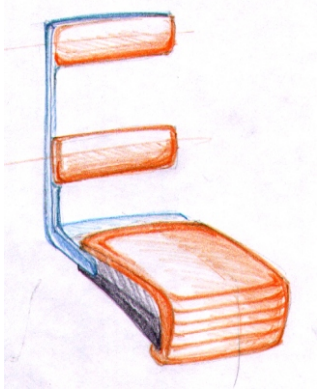






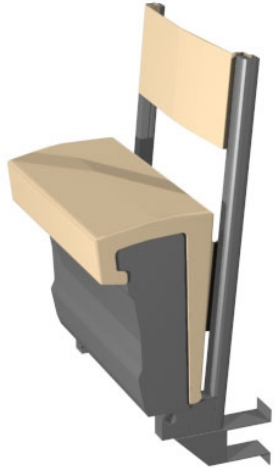




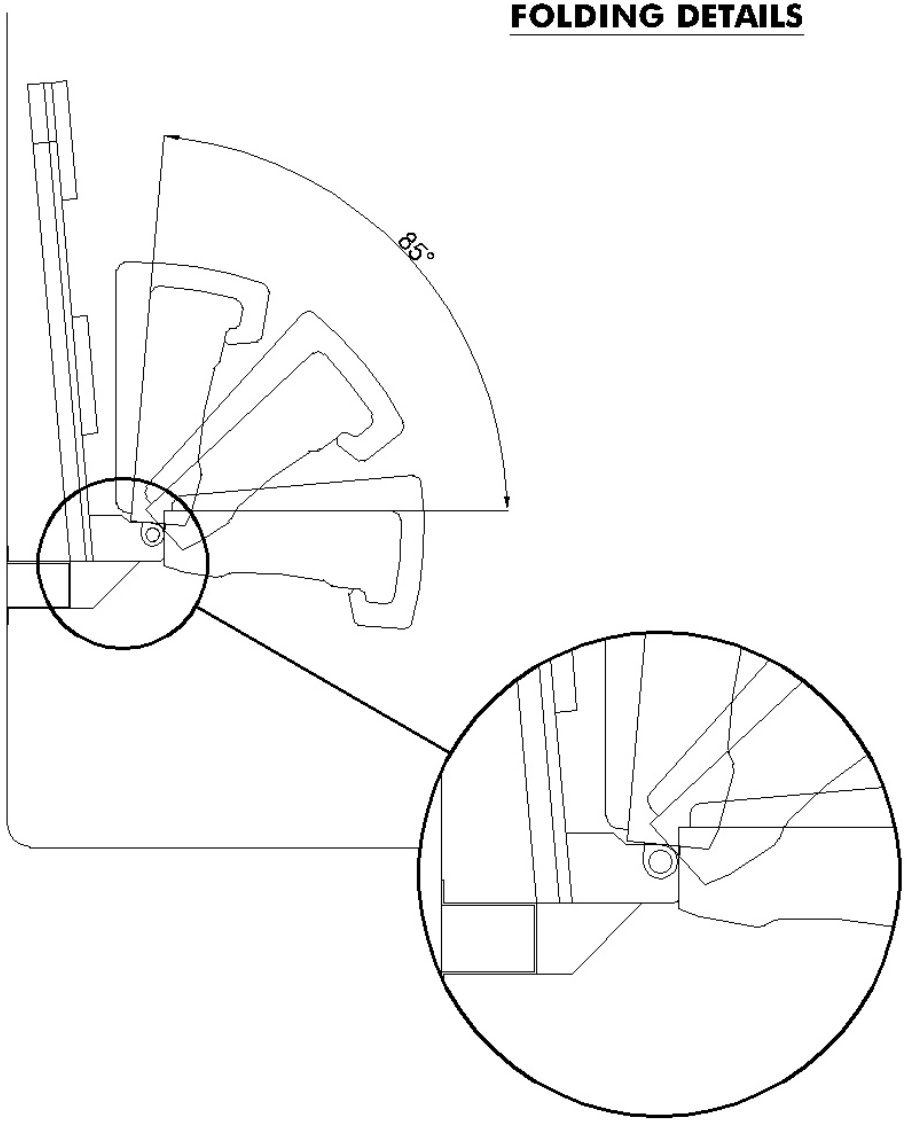


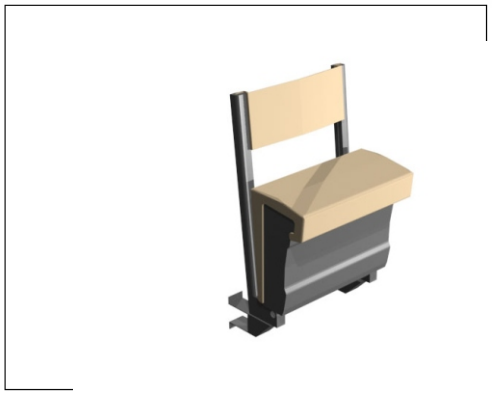
Concept Ideation and sketches

Semi Seat 3d Model

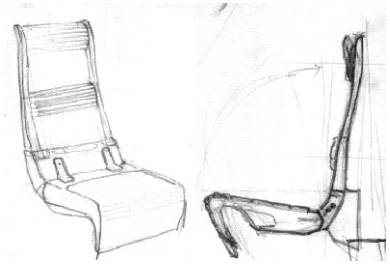


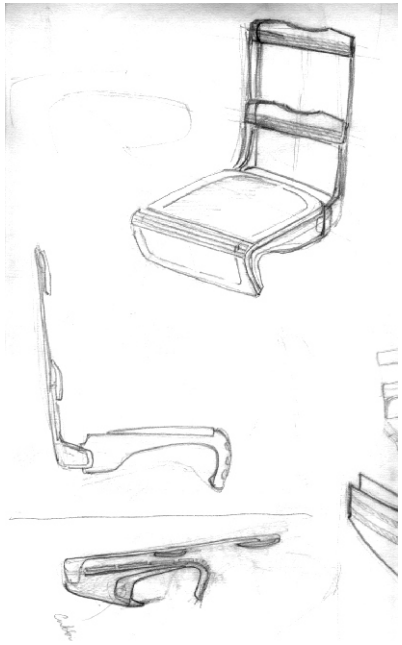
FOLDING DETAILS



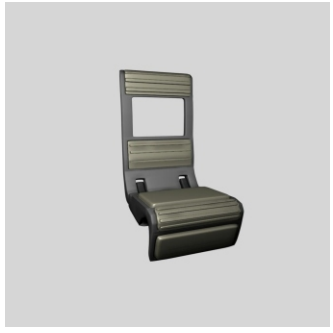


Concept Seat 2b : Semi Seat



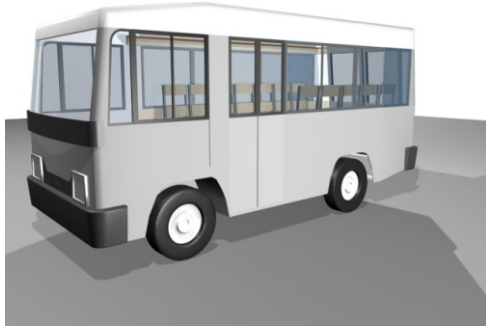


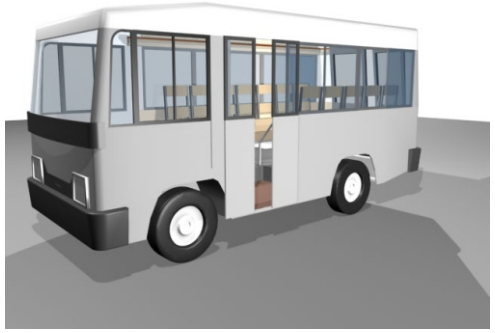
Concept Ideation and sketches



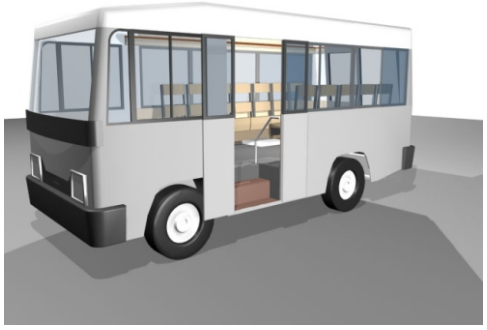
Concept Seat 2c : Semi Seat

Passenger and Cargo Handling Features

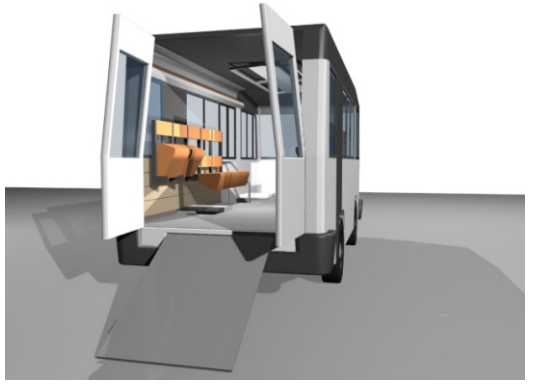




The final concept has passenger doors which are parallelogram plug type that open out and slide along the body of the vehicle. This creates a wide, unobstructed clearing in the door passage that enhances ingress/egress for the passengers.



The rear of the vehicle has been provided with wide opening hinged double cargo doors. This feature along with the retractable ramp that is stowed under the floor of the vehicle greatly enhance the cargo loading/unloading capabilities of the vehicle.



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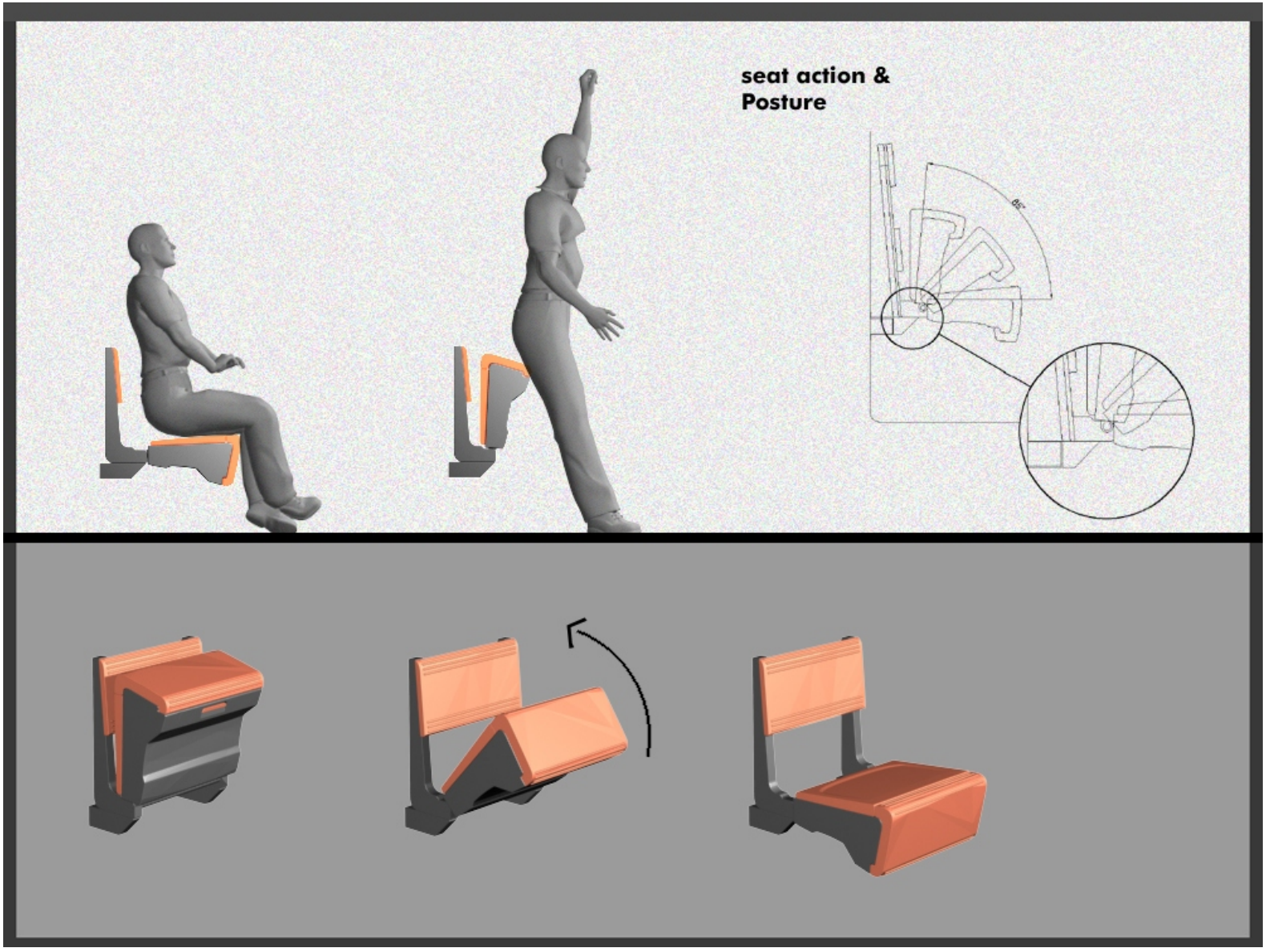
9. Appendix

Final Concept 3D Model and Photograps

Semi Seat

Final concept


seat action &
Posture