Industrial Design Project Report 2

Vehicle for Elderly :

Interior Layout and Support System

Project Guide
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APPROVAL SHEET

The Industrial design project 2 entitled " Vehicle for elderly: Interior layout and support system" by Dipesh parmar (07613009) is approved, in partial fulfilment of the requirements for Master of Design degree in Industrial design.

Guide :

Chairman :

Internal Examiner :

External Examiner :

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ACKNOWLEDGMENT

I would like to express my sincere acknowledgements to my guide Prof. G.G.Ray for his constant guidance and motivation.

I would like to thank Dignity Foundation Group for their support during my research and user studies.

Also my sincere thanks to my friends and fellow IDCians who have helped me directly or indirectly during my project work.

ABSTRACT

In India to provide better facility for elderly there are separate colonies dedicated to them. Every elderly person would like to travel independently. Currently, there are many problems in the existing local transport vehicles, such as seating, luggage handling, ingress and egress (entry and exist) and materials used, which makes it difficult for the elders to travel safely and comfortably. The main purpose of the project is to design a proper support system for elderly while travelling. The project also aims to provide a better and safe mode of transportation for the elderly with special reference to their ergonomic needs, better support system and comfort. Special attention is taken to provide and improve the overall look and feel of the layout of the vehicle.

INTRODUCTION

In places like Pune, Mumbai and Delhi few separated colonies are dedicate to elderly people. Every elderly person would like to go out on his own. While travelling in local transfer vehicle they face many problem such as seating, luggage handling, materials used and also ingress and egress (entry and exist). The main purpose of the project is to look for proper support system while travelling and thus helping elderly to meet their daily needs. Provision is made for better and safe mode of transportation for the elderly with special reference to their ergonomic needs and comfort. Special attention is taken to provide and improve the overall look and feel of the interior layout of the vehicle.

Project Constraint:

Considering the project complexity and time frame, the project was restricted to look for an optimum seating layout inside a standard bus for carrying 15 of people who can walk and tow wheel chair bound elderly along with an attendant.

Fig 1: Palki for bidai

Fig 2: palki for Tirth

RESEARCH & DATA COLLECTION

Vehicle: Vehicles are means of transport. Most often they are manufactured
(e.g. *bicycles, cars, motorcycles, trains, ships, boats, and aircraft*)

History:
Palki can be considered as a first vehicle for elderly.
In older days Palki was used by raja and maharajas. It was also used for Bidai in marriage (Fig 1). Now a days it is used for elderly during Tirth yatra (Fig 2). In the history, it was used by Shravan kumar , who carried his parents on his shoulders for Tirth yatra in a basket.

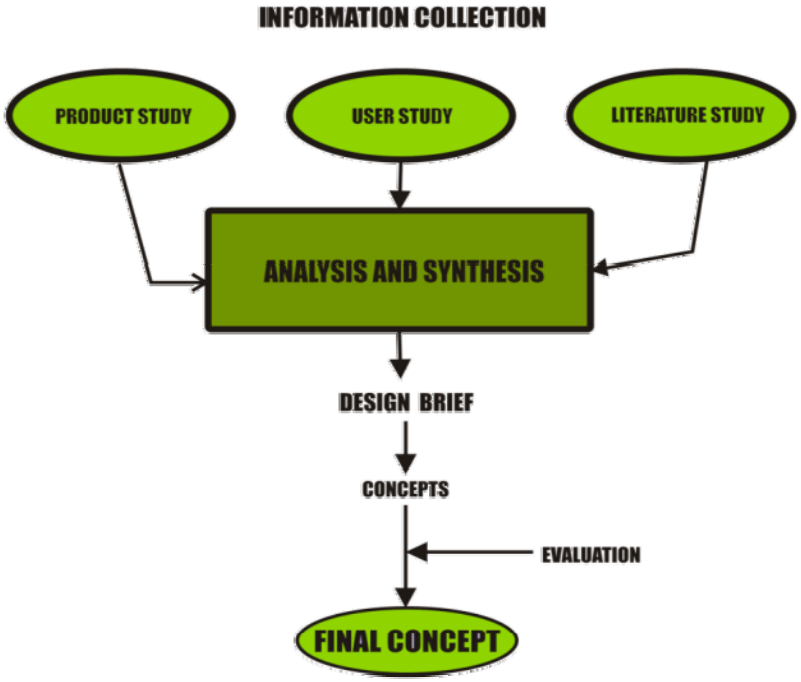

Fig 3 : Design process chart

DESIGN PROCESS

The first step in Design process is Information collection.

Need of product

User Study: to start my project with user study, I have selected Dignity foundation at Karjat which is an old age home. I went there several time to find elderly problems related to transport.

Product study: for user study at Karjat I came to know about the different vehicle used by them for travelling . Then I study all these vehicles in detail.

Literature study: after the product study and user study. I studied the anthropometric data related to Indian standard and started analyzing the comfortable posture for elderly.

Analysis and synthesis: then I did the analysis of user study and the different vehicles, and considering the anthropometric data finally selected bus as focus for my project

Design brief: to redesign layout and support system of bus.

Concept: support system and layouting of the bus.

Evaluation: keeping ergonomic as the main criteria evaluated all the concept and decided the final concept.

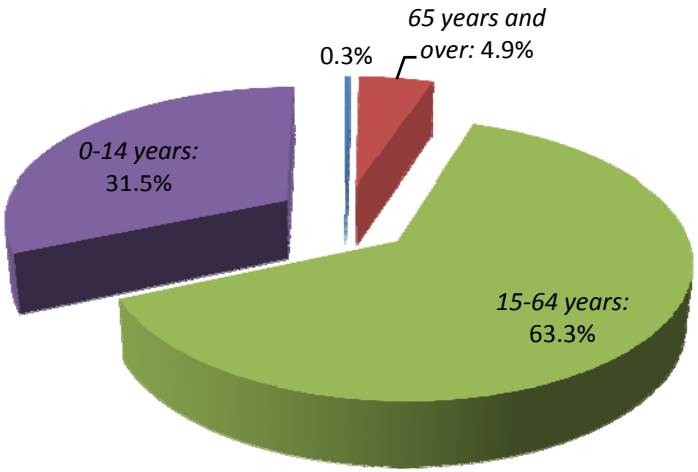

Fig 4 : Indian statistical data

STATISITICAL DATA

Total Population of India: 1,147,995,904 (July 2008 est.)
[Ref. 1 page 74]
Age wise distribution of Indian population as mentioned below: structure:

- 0-14 years: 31.5% (male 189,238,487/female 172,168,306)
- 15-64 years: 63.3% (male 374,157,581/female 352,868,003)
- 65 years and over: 5.2% (male 28,285,796/female 31,277,725) (2008 est.)
- 65< years: 4.9% (urban area population)

TYPES OF ELDERY

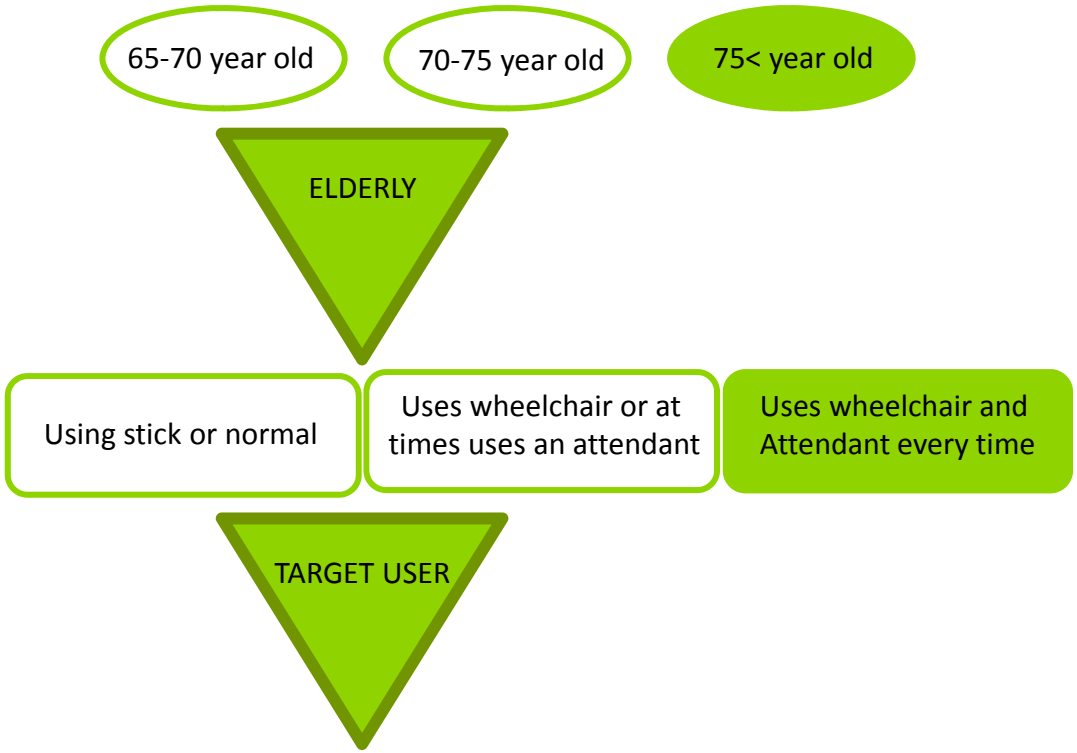

Fig 5: User target

Elderly people means person above 65 year of age, these age group people further classified into three categories of 5 year interval, my user study group for elderly is age 65-75 year old.

In Fig 5- on the 1st row, white color is my user group study in which Green circle above 75 year is not considered.

Elderly people generally defines normally as he/she using walking stick , or using wheelchair or at sometimes uses an attendant , excluding elderly who uses attendant for full time for any disability which is not considered in this study.
white circle in Fig 5- 3rd row is my user target.

Fig 6: (A)

Fig 6: (B)

Fig 6: (A),(B),(C)The Dignity lifestyle township for elderly

USER STUDY

To get acquainted with the life style and physical disability of the elderly field study was educated at the dignity lifestyle township Fig 6: (A)(B)(C)

Accordingly three residential members of the township were interviewed from the view point of their lifestyle, disabilities and difficulties while the traveling the community bus for shopping or outing the individual questionnaires are gives in two follow up pages.

Fig7: Mr.Dennis Carpenter

EXTRACTS FROM INTERVIEW

Mr. Dennis Carpenter

- 70 yrs Old.
- Approximately, he goes 4 times outside in a month.
  - 2 days in a month for shopping.
  - 2 days in a month for a picnics.
  - Once in every 2 month for routine check up.

Medical Problems:

- Visual Problem (*20% visibility in right eye*).
- Other Problem (A*sthma, breathing problem*).

Walking Problems:

- Steps - Comfortable.
- Ramp or Slope - walking Problem (*Breathing Problem*).

Luggage Carrying

- Walking Stick
- Umbrella
- Bags

Ingress and egress problems while using vehicles provided by dignity town ship

- Golf Car
- Dignity Auto
- Local Auto
- Dignity Qualis
- Local Bus

Fig 8: Mr.M.J. Ropani

EXTRACTS FROM INTERVIEW

Mr. M.J.Ropani

- 96 yrs old.
- Approximately, he goes 5 times outside in a month.
  - 1 day in a month for shopping.
  - 2 days in a month for a picnic.
  - 2 days in a month for routine check up.

Medical Problems:

- Visual Problem
- Arthritis (*joint pain- knee join*)
- Other Problems (*Back pain*).

Walking Problems:

- Steps – Little Problem.
- Ramp or Slope – Less Problem.

Luggage Carrying :

- Walking Stick.
- Umbrella.
- Bags.

Ingress and egress problems while using vehicles provided by Dignity town ship

- Golf Car
- Dignity Auto
- Local Auto
- Dignity Qualis
- Local Bus

Fig 9: Mrs. khanna

EXTRACTS FROM INTERVIEW

Mrs. Khanna

o 65 yrs old.

o Approximately, she goes 3 times outside in a month.

1 day in a month for shopping.

2 days in a month for a routine check up.

Medical Problems:

- Visual Problem.
- *Arthritis (Advance Stage- hand and leg).*
- Other Problem (*One Attendant's Help*) supported by attendant while.

Walking Problems:

- Steps – Big Problem.
- Ramp or Slope – Less Problem.

Luggage Carrying :

- Walking Stick.

Ingress and egress problems while using vehicles provided by Dignity town ship

- Golf Car
- Dignity Auto
- Local Auto
- Dignity Qualis
- Local Bus

Fig 10: Dignity Auto

Fig 11: front seat side

Fig 12: back seat side

DIGNITY AUTO

To understand the problem with the vehicle used by the elderly resident, attempts were made to study the vehicle provided by Dignity township. The sole purpose is to serve elderly for small work outside the Colony, each user has given a 5 point ranking scale, according to their use for acceptance of particular vehicle. The capacity of vehicle is 3 person.

Problem: Egress and ingress problem: step height is high, front seat height is 19”(Fig 11)which is too high and on the back side two steps are provided, given one more step for easy entrance(ingress). the height of first step from the ground is 11”(Fig12). Egress (Exit) is more difficult, step height is too high and also first step is not visible. Wrong placing of first step.

Egress time - Knee joint problem because of step height

Handle grip is not in proper place , not in proper size and slippery

Name	Score	Reason
Mr. Dennis Carpenter	OK (no problem in climbing)	High floor height
Mr. M.J. Ropani	Bad (Difficulty in climbing)	High floor height
Mrs. Khanna	Very bad (other person help)	Too high floor height

Fig 13: Dignity Golf Car

Fig 14: front seat side

Fig 15: back seat side

DIGNITY GOLF CAR

To understand the problem with the vehicle used by the elderly resident. Attempts were made to study the vehicle provided by Dignity township. It is purpose is to serve elderly for work inside the Colony, each user has given a 5 point ranking scale, according to their use for acceptance of particular vehicle. The capacity of vehicle is 3 person

Problem:

Egress and ingress problem: step height is high, front seat height is 13”(Fig 14)which is high and back side step height is 13.5”(Fig15)

Egress (Exit) is difficult, step height is high and not proper support system. then whole body weight hand and hip portion, hip portion touch seat and slip according to video analysis. knee joint problem.

Handle grip is not in proper place, ingress is okay but egress is problem because of handle positioning.

Name	Score	Reason
Mr. Dennis Carpenter	Good (no problem in climbing)	High floor height
Mr. M.J. Ropani	Bad (Difficulty in climbing)	High floor height
Mrs. Khanna	Very bad (Extra table used)	High floor height

Fig 16: Dignity Qualis

Fig 17: front or back seat side

DIGNITY QUALIS

To understand the problem with the vehicle used by the elderly resident. Attempts were made to study the vehicle provided by Dignity township. It is working for elderly serving purpose of Picnics or shopping outside the Colony, each user has given a 5 point ranking scale, according to their use for acceptance of particular vehicle. The capacity of vehicle is 7 person

Problem: Egress and ingress problem: step height is high 21.5”(Fig 17)which is too high and step divided in two part, given one more step for easy entrance(ingress).extra step height is 12.5”(Fig17) Egress (Exit) is difficult, step height is high, at time of use extra step is not visible. Placing of step is wrong. Handle grip is not in proper size ,not in proper place Egress time - knee joint problem, step height is to high. There the no room behind the seat, lack of Leg space.

Name	Score	Reason
Mr. Dennis Carpenter	OK (no problem in climbing)	High floor height
Mr. M.J. Ropani	Bad (Difficulty in climbing)	High floor height
Mrs. Khanna	Very bad (other person help)	Too high floor height

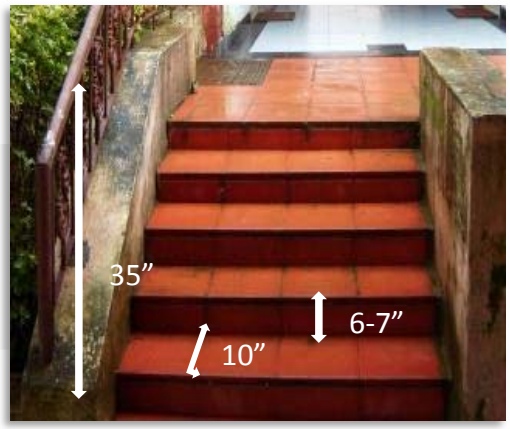

Fig 18: Dignity standard follow step

Fig 19: Dignity standard follow slop

DIGNITY FOLLOWING

In addition to the vehicle ingress/egress attempts were also made to study the local steps or ramps in terms of ease in climbing or walking. This will lead to determine the step height / ramp slope to be provided in the vehicle

- Normally Dignity Colonies follow Ramp (Slope) System though there are some areas were steps are used.
- Slope angle 10 to 12* degree
- Steps height 6-7”
- Step Trade 10”

Name	Step Score	Slope Score
Mr. Dennis Carpenter	Good	OK
Mr. M.J. Ropani	OK	OK (Using stick)
Mrs. Khanna	Very bad	Ok(Using stick)

Summary from the User study in relation to different types of to be emphasized problems

Personal problem

- Everyone prefer front seat because of more leg space.
- Long journey is painful (40-60 min)
- They cannot go out together.
- Person on a wheel chair, cannot accompany them.

Vehicle problem

- Door handle problem.
- Roof handle
- Handle bar thickness problem.
- Seating arrangement.
- Pitch of a seat.
- Luggage problem.
- First step in the vehicle is high (ingress and egress)..
- Getting up and getting down problem from the seat.

Requirements

- Wheel chair should go inside the vehicle.
- Group travel (13-elderly person, 2-wheel chair person, 1 attended)
- Playful environment for long journey.
- Steps height should be 7-8” (ingress and egress).
- Slope angle should be 10-12* degree
- Comfortable Handle.
- Layout of vehicle (Seating arrangement).
- Space for luggage.

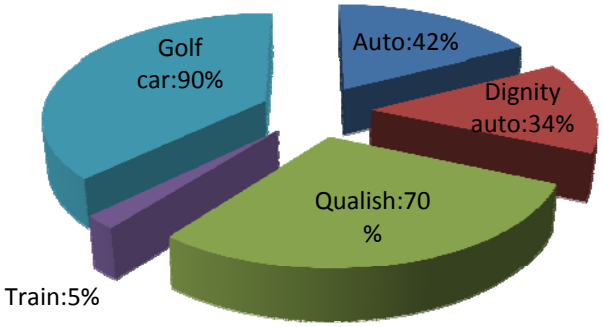

Fig 20: Dignity elderly vehicles used

FOCUS AREA

- Wheel chair should go inside.
- Group travel (13-elderly person, 2-wheel chair person, 2 attended)
- Steps height should be 7-8” (ingress and egress).
- Slop angle should be 10-12* degree for wheelchair
- 20-30* degree for walking
- Comfortable Handle.
- Layout of vehicle (Seating arrangement).
- Space for luggage.
- Getting up and getting down from the seat.

TYPES OF VEHICLES USED BY ELDERLY

According to data collection elderly generally uses vehicle like Auto , Dignity auto, Golf car, Qualis car, Bus and Train. Elderly use different vehicles for different types of journeys like they use Golf car inside the campus, Dignity auto to roam out of campus and use Qualis car for going out for picnics and shopping in groups and also at times they prefer Local train.(Fig 20)

FOCUSED VEHICLE

After user study , analyzing the user demands and needs, which is basically for a vehicle for group travelling and also keeping in mind the demands of the physically challenged people, to travel along with others for picnics and for shopping, I selected **Bus** as the target vehicle for modifying it to suite the needs of elderly and provide them with a vehicle for group travelling.

PRODUCT BRIEF

From user study point, the area which need for major improvement was ingress ,egress and step height . Knee pain started during egress and wheelchair person also join a group, for which layout used is of maximum usability and comfortable support system for inside of bus

Thus this was the main focus for improvement

PRODUCT BRIEF STATEMENT.
To design an support system for elderly to get in and out with minimum afford, comfortable and walk inside a bus easily. It is component decided by considering the ergonomic principals of human comfort ability.

Entrance step should be effective than existing bus or car By providing slope initially to reduce space between level of bus and ground for the comfort of elderly

LOW FLOOR BUS DETAILS

In India there are many buses available, but there is no bus for specifically designed for elderly. Basic requirement of the bus requirement is 18 sitter, low floor bus, gang way and leg room with proper space, and important point is two wheelchair in side of vehicle is focus area [Ref: 3 page 74]

Low Floor Buses manufacturing company's in India:

- Ashok Lyland
- Tata Motors ltd
- Tata Marcopolo motors
- Tata Hispono
- Marcopolo corporation –Brazil

Low floor buses are generally big, capacity of bus is above 37 sitter which is not matching with above requirements. We require 18 sitter bus which can run easily in colony as well as outside, then searched some small bus manufacturing company's in India.

Small Buses manufacturing company's in India:

- Ashok Leyland.
- Tata Motors Ltd.
- Force Motors Ltd.
- Hindustan Motors Ltd.
- Mahindra & Mahindra Ltd.

Fig 21: Force Traveler

Fig 22: RTV Passenger(HM)

Fig 23: Tata Starbus

SMALL BUS MANUFACTURING COMPANYS

It should have 18 sitter ,small bus, and easy wheelchair movement inside the bus, small bus manufacturing company's in India [Ref: 3 page 74]

Force Motors Ltd.
- Force Citiline
- Force luxury
- Force Traveller (Fig: 21)

Eicher Motors Ltd.
- Eicher Skyline Bus

Hindustan Motors Ltd.
- RTV Passenger (Fig :22)

Tata Motors Ltd.(Starbus Standard)
- Starbus 16
- Starbus 18 CNG(Fig: 23)
- Starbus 20
- Starbus Dlx 18
- Starbus Dlx 20
- Globus18
- Globus 20

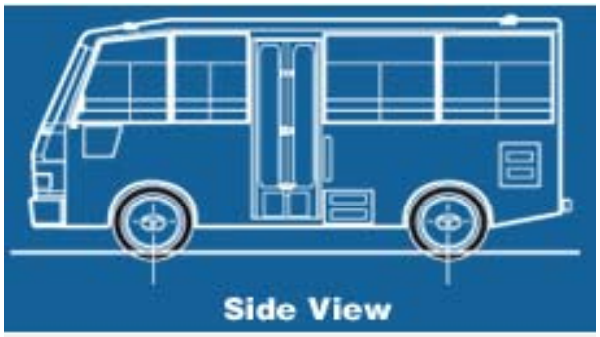

Fig:24 side view of bus

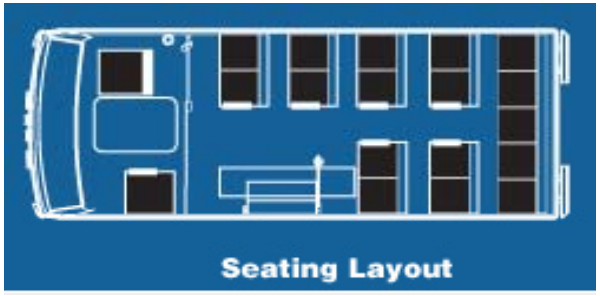

Fig:25 seating layout

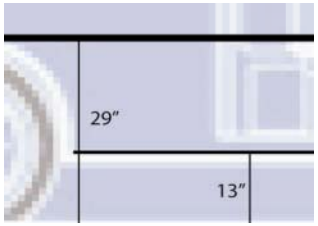

Fig: 26 Chassis height

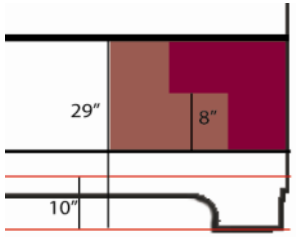

Fig:27 Road clearance

DETAILS OF VEHICLE CHOSEN FOR THE PROJECT

According to Company standards, general arrangement is given side view (Fig24) and seating layout (Fig25) and floor height is 29" (Fig 26) and first step height 13" and staircase height is 8"(Fig 27)

TATA STARBUS 18 CNG (as shown in [Ref: 8 page74])

Door Type	- single door
Chassis Platform	- LP 407/31 CNG
Engine Power (Kw)	- 49.5 Kw @3200 RPM
Engine Torque (Nm)	- 190Nm @ 1200 – 1700 RPM
Clutch Diameter (mm)	- 240
Gear Box Type	- GBS 18
Rear Axle Ratio	- 37/8
Steering	- Mechanical
No. of Tyre	- 4+1
Tyre Size	- 7.5" X 16", 16 PR
Fuel Tank Capacity (liters)	- 3 cylinder 47kgs gas @ 200 bar
Gross Vehicle Weight (kg)	- 5560
Basic Dimension (mm)	
Wheel Base	- 3100
Front Over Hang	- 1415
Rear Over Hang	- 1290
Overall Length	- 5705
Seat Pitch	- 720
Gangway	- 350
Internal height	- 1815
Overall height	- 2620

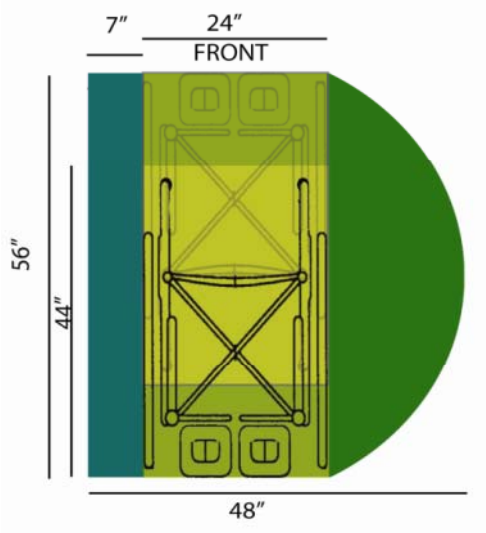

Fig:28 wheelchair space require

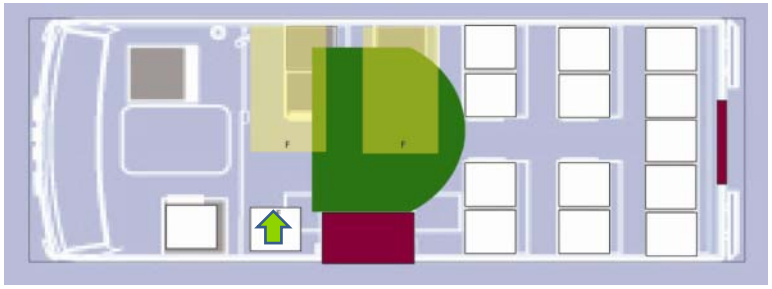

Fig: 29 Layout 1

SEATING LAYOUT

Common Entrance

Giving a common door for both, for physically challenged elderly to climb the bus with the help of a wheel chair and for normal elderly to climb through a staircase or slope. Door size of a bus is 30” and wheelchair width is 24”, which is adequate for wheelchair to go inside from the same door.

Space consumed by wheelchair

Wheelchair dimension are 24 x 44”. If wheelchair is rotated to 180 degree or given a U-turn then space consumed is 56 X 48” with an attendant consider(width is 7” for the attendant)

Keeping the wheelchair space constant different interior layouts were tried out to accommodate maximum no. of elderly on foot, 2 wheelchair bound persons and one attendant .

Layout 1 : (Fig 29) when given a common entrance for wheelchair and walking staircase then **11** elderly person and **2** persons on wheelchair can seat inside the bus. In this case there will be a direction problem for 3 persons, one person seating on the side and the two on the wheelchair.

ENTRANCE SAME

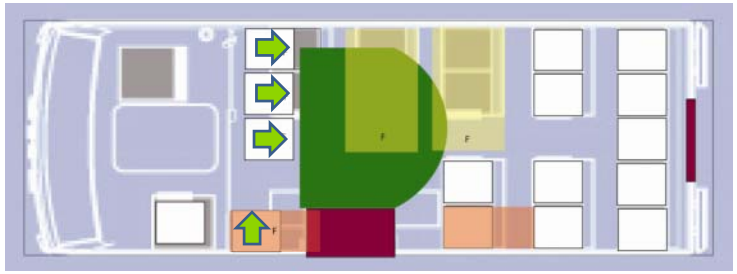

Fig: 30 (Layout 2)

Layout 2: When given a common entrance for wheelchair and walking staircase then **14** elderly person and **2** persons on wheelchair can seat inside the bus. As shown in Fig 30 in this case there will be a direction problem for 6 persons, four person seating on the side and the two on the wheelchair. In this layout the entrance is blocked , because of the wheelchair, and no one can come inside and go outside without moving the wheelchair.

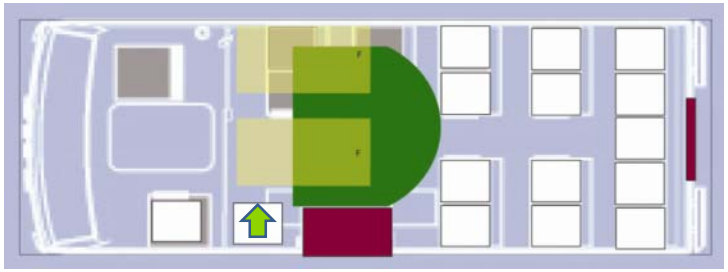

Fig: 31 (Layout 3)

Layout 3 : When given a common entrance for wheelchair and walking staircase then **15** elderly person and **2** persons on wheelchair can seat inside the bus. As shown in Fig 31 in this case there will be a direction problem for 3 persons, one person seating on the side and the two on the wheelchair. In this layout the entrance is blocked , because of the wheelchair, and no one can come and go without moving the wheelchair.

LOAD CARRYING CALCULATION

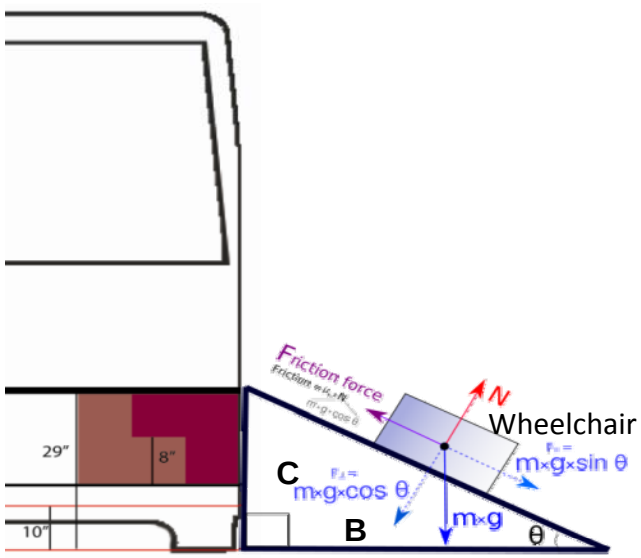

Fig: 32 horizontal and vertical force component

Angle	Load carrnying	m= Mass	70+10
	.= m*g*sin A/10	g= Gravity	10
12	16		
15	20		
17	23.5		
20	27.2		
22	29.6		
24	32		
25	33.6		
30	40		

Fig: 33 wheelchair load calculation (Table)

The standard slope angle for carrying wheelchair is 10 to 12 degree. While lifting the wheelchair, horizontal and vertical forces work together. As show in Fig 32, and all calculation as show in Fig 33 (table 1)

- In case of 12 degree slope, the attendant carrying the wheelchair, have to apply force of 16 kg.
- In this case 70kg is considered as the weight of the person and 10 kg is considered as the weight of the wheelchair and 10 N is considered as the force of gravity.

According to ergonomics calculations the angle of slope, for staircase climbing is 22 Degree [Ref: 2 page 74] for humans to climb is 16 to 25 degree. And the required angle for carrying the wheelchair is 12 degree, so if we combine both, staircase and slope, then the person carrying the wheelchair will have to apply more force. So giving a common entrance for slope and staircase is not possible.

SLOPE ANGLE CALCULATION

Step Height	Step Depth	Step Width	Ground Clearence	Slope angle	Slope base
H	**D**	**W**	**C**	**Ang***	**B**
7"	9"	28"	15"	15*	57"
8"	9"	28"	13"	15*	50"
7"	9"	28"	15"	17*	50"
8"	9"	28"	13"	17*	43"
7"	9"	28"	15"	20*	41.5"
8"	9"	28"	13"	20*	36"
7"	9"	28"	15"	22*	37.5"
8"	9"	28"	13"	22*	32.5"
7"	9"	28"	15"	24*	34"
8"	9"	28"	13"	24*	29.5"
7"	9"	28"	15"	25*	32"
8"	9"	28"	13"	25*	22.8"
7"	9"	28"	15"	30*	22"
8"	9"	28"	13"	30*	18.4"
29"	0	28"	o	15*	111"
29"	0	28"	o	17*	96"
29"	0	28"	o	20*	80.5"
29"	0	28"	o	22*	72"
29"	0	28"	o	24*	65.5"
29"	0	28"	o	25*	63"
29"	0	28"	o	30*	46.5"

Fig: 34 slope base length calculation(Table)

According to ergonomic data(Ref) the standard step height(**H**) is 7" and the in this condition the first step height(**C**) is 15 inches and the slope angle is 22 (**Ang***) degree and the slope base(**B**) is 37.5 inches.
Fig 35 direct slop for wheelchair and walking.
Fig 36 first step in slope.

According to ergonomic standard 10 to 12 degree is for perfect angle for wheelchair and 16 to 25 degree slope angle for walking[Ref:2 page74].

When selected 15 degree that time slope length 57"which is long, cannot possible that match ramp

So because of this I selected separate door for wheelchair and separate for walking.

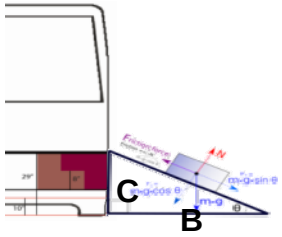

Fig: 35 direct slop

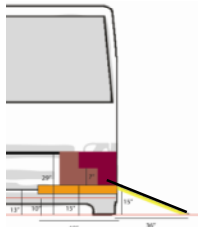

Fig: 36 slope with steps

Fig: 37 Arm lever mechanism

Fig: 38 Hydraulic cylinder

LIFTING MECHANISM USED

There are many Wheelchair lifting mechanisms available in the market, so the one which selected one out of them, which suites. the best according to the bus selected [Ref.4 page 74]

Fig 37 arm and lever mechanism. It is consumed lots space it is using for big or high floor buses in used.

Fig 38 In these mechanism is special for two hydraulic cylinder and foldable base, and base guide in guiding slide ways.

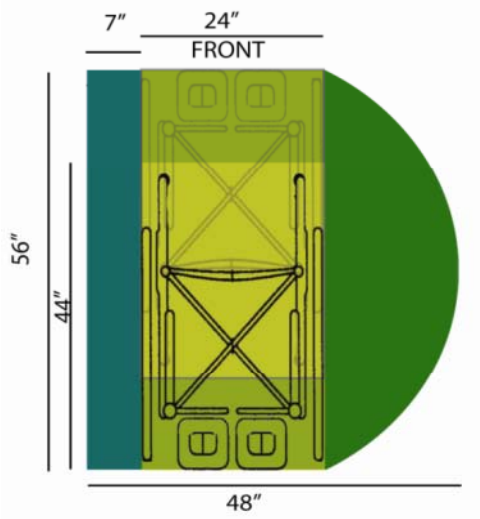

Fig: 39 wheelchair U-turn space consumed

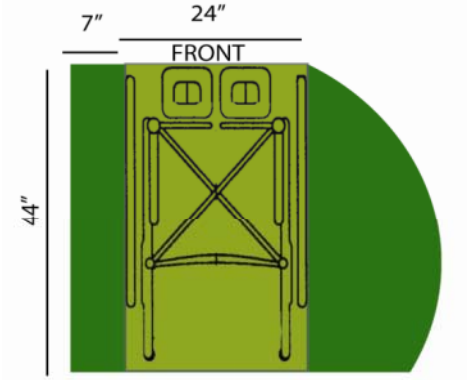

Fig: 40 wheelchair shift in space consumed

SPACE REQUIRED FOR WHEELCHAIR (LIFTING MECHANISM USED)

As shown in Fig 39, Dimension of wheelchair is 24 x 44”. Space consumed by wheelchair when rotated 180 degree or given a U turn is 56 X 48” including attendant. Width of the attendant considered is 7”.

As shown in Fig 40, Dimension of wheelchair is 24 x 44”. Space consumed by wheelchair when rotated 90 degree is 44 X 48” including attendant. Width of the attendant considered is 7”.

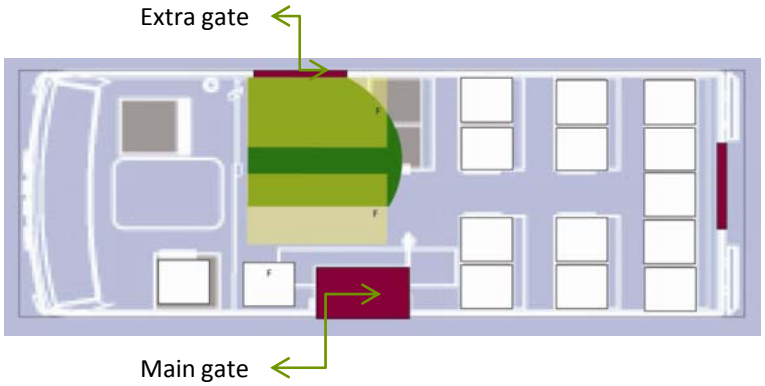

Fig: 41 (Layout 4)

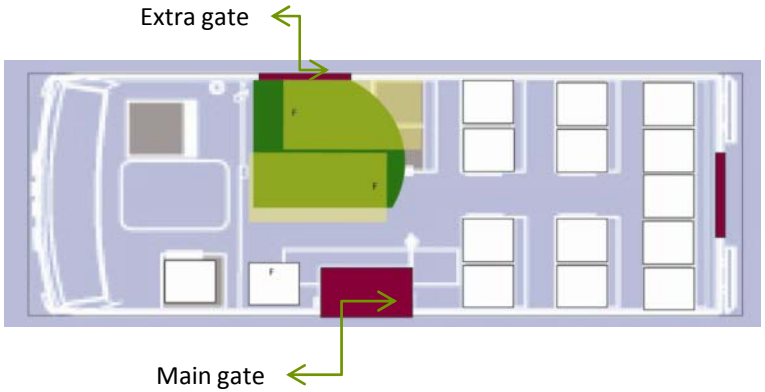

Fig: 42 (Layout 5)

EXTRA GATE POSITION

Entrance for wheel chair using lifting mechanism

Layout 4 : as show in Fig 41 when provided a Separate door for wheelchair and walking staircase then **15** elderly person and **2** persons on wheelchair can seat inside the bus. In this case there will be a direction problem for one person and door area remain block because of the wheelchair, and one cannot move outside or inside the bus without moving the wheelchair. According to Indian standard door position is always in the left hand side.

Layout 5 : As show in Fig 42 when provided a separate door for wheelchair and walking staircase then **15** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 2 persons , one person seating on the side and the one on the wheelchair. And according to Indian standard door position is always in the left hand side.

.

EXTRA GATE POSITION

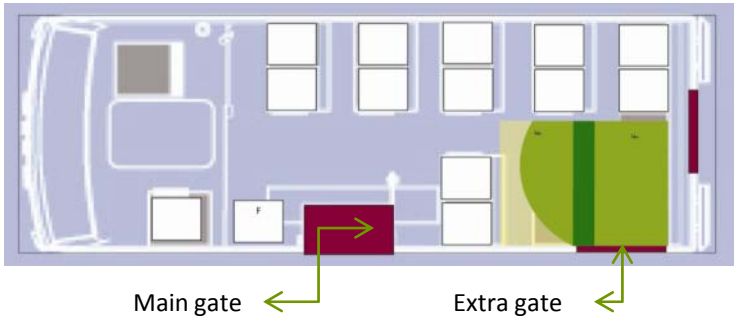

Fig: 43 (Layout 6)

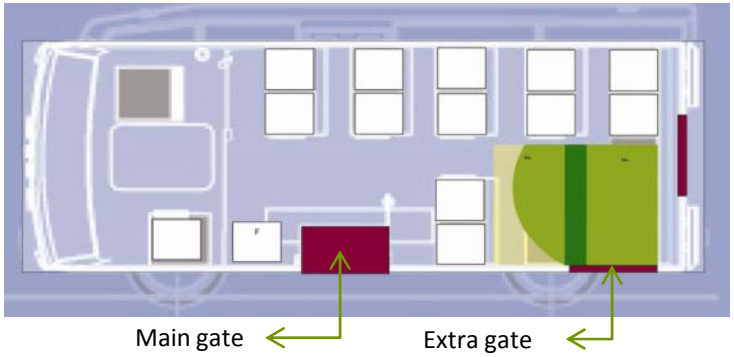

Fig: 44 (Layout 6(A))

Layout 6 : as show in Fig 43, when provided a Separate door for wheelchair and walking staircase then **14** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 3 persons, one person seating on the side and the two on the wheelchair. Door area remain block and there will be a problem for 4 persons to move inside and outside the bus without moving the wheelchair. Includes wheelchair presences on regular seats and two on.

Layout 6(A) : as show in Fig 44, Another issue with this layout is that the Lifting mechanism touches the tyres.

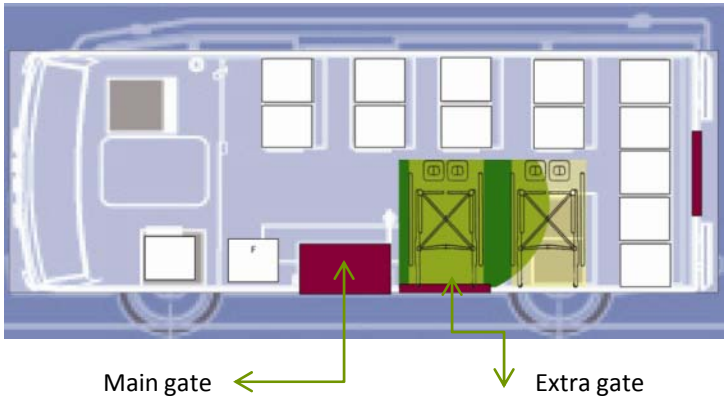

Fig :45 (Layout 7)

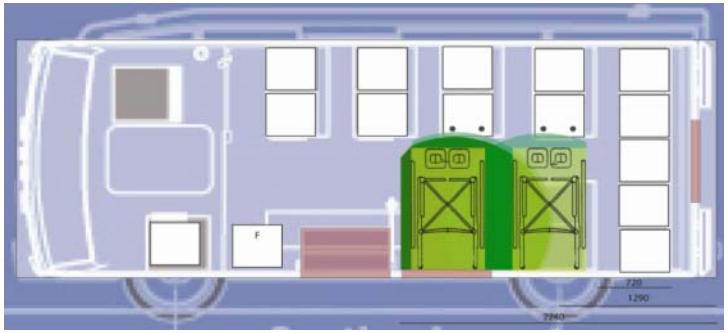

Fig: 46 (Layout 7(A))

EXTRA GATE POSITION

Layout 7 : As show in Fig 45, when provided a Separate door for wheelchair and walking staircase then **15** elderly person and **2** persons on wheelchair can seat inside the bus. In this case there will be a direction problem for 3 persons, one person seating on the side and the two on the wheelchair. Door area will remain block and there will be a problem for 9 persons to move inside and outside the bus without moving the wheelchair.

Layout 7(A) : as show in Fig 46,:With this layout Lifting mechanism does not touch the tyres.

EXTRA GATE or MAIN GATE NEW POSITION

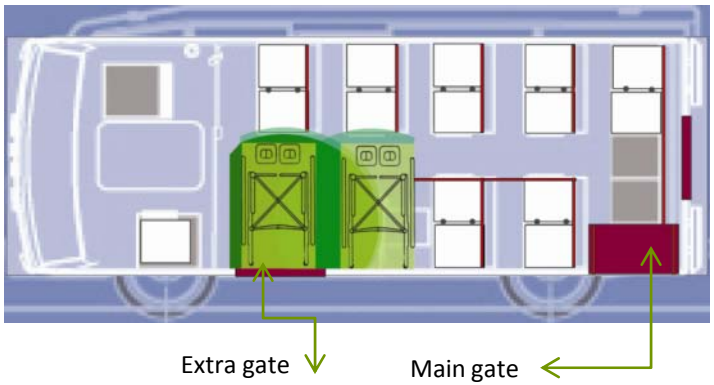

Fig: 47 (Layout 8)

Layout 8 : As show in Fig 47, when provided a Separate door for wheelchair and walking staircase. Now the position of the staircase is also changed, then **15** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 2 persons, two on the wheelchair. Door area will remain block and there will be a problem for 5 persons to move inside and outside the bus without moving the wheelchair.
Staircase mechanism touches tyres.

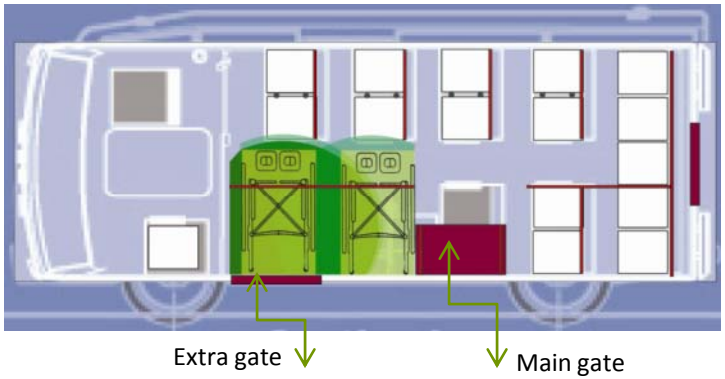

Fig: 48 (Layout 9)

Layout 9 : As show in Fig 48, when Provided a Separate door for wheelchair and walking staircase. Position of the staircase is changed. In this **16** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 2 persons, two on the wheelchair. Door area remain block and there will be a problem for 5 persons to move inside and outside the bus without moving the wheelchair.

EXTRA GATE or MAIN GATE NEW POSITION

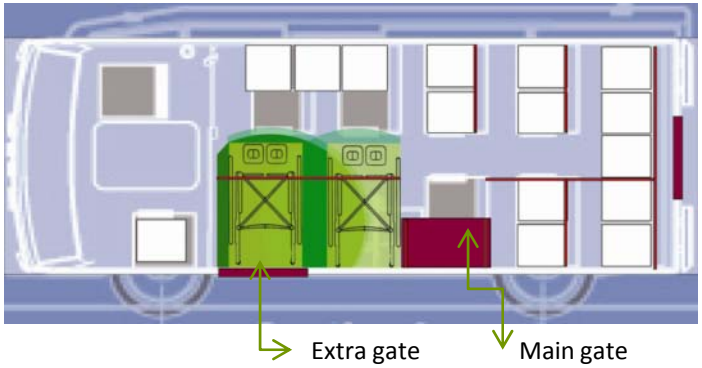

Fig: 49 (Layout 9)

Layout 9 :As shown in Fig 49, When provided with a Separate door for wheelchair and walking staircase. Now the position of the staircase is also changed, then **15** elderly person and **2** persons on wheelchair can seat inside the bus. In this case there will be a direction problem for 5 persons, 3 person seating on front of wheelchair and the two on the wheelchair. **Door** area will **not blocked** in this case.

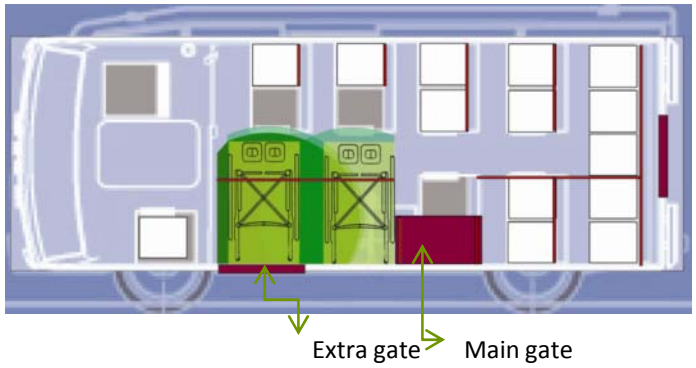

Fig: 50 (Layout 10)

Layout 10 : As shown in Fig 50, When provided a Separate door for wheelchair and walking staircase. Now the position of the staircase is also changed, then **14** elderly person and **2** persons on wheelchair can seat inside the bus. In this case there will be a direction problem for 2 persons, the two on the wheelchair. **Door** area will **not blocked** in this case.

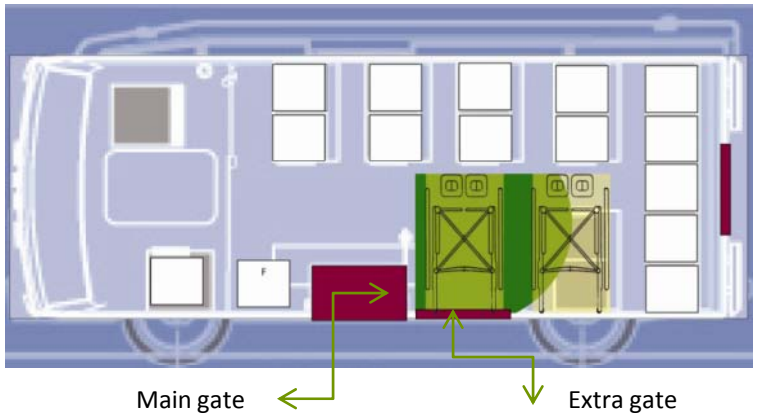

Fig: 51 Concept Layout 1

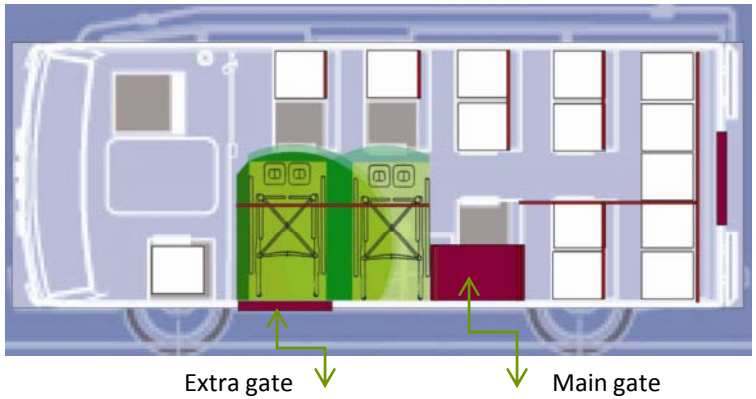

Fig: 52 Concept Layout 2

FINAL LAYOUT PERPOSE

Concept Layout 1 : As shown in Fig 51, When provided a Separate door for wheelchair and walking staircase then **15** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 3 persons, one person seating on the side and the two on the wheelchair. Door area will remain block for 9 person (Moving problem). inside or outside movement without moving the wheel chair.

Concept Layout 2: As shown in Fig 52, When provided a Separate door for wheelchair and walking staircase. Now the position of the staircase is also changed, then **14** elderly person and **2** persons on wheelchair can sit inside the bus. In this case there will be a direction problem for 2 persons, the two on the wheelchair. **Door** area will **not blocked** in this case.

Concept 2 is the most suitable and fulfilling all requirements

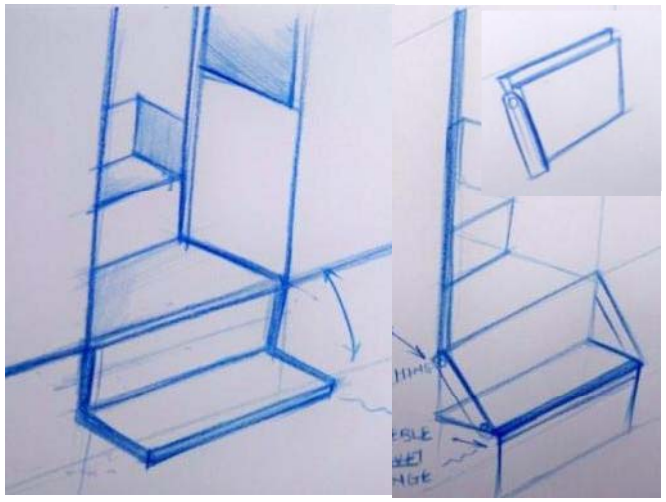

Fig: 53

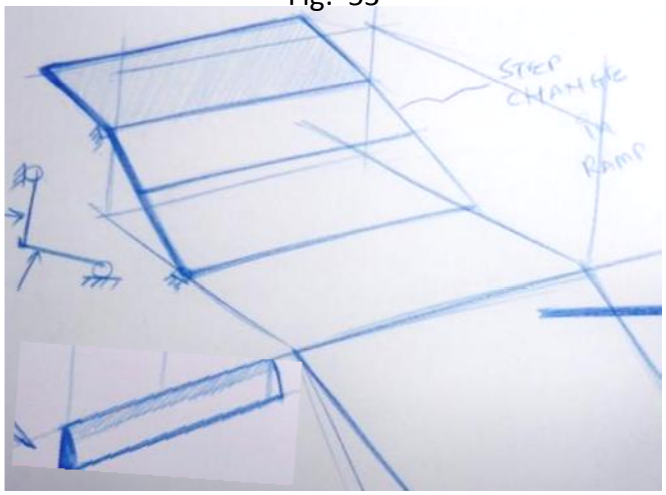

Fig: 54

IDEATION FOR INGRESS PROBLEM

The height of the first step while entering the bus is 13” is really high for elderly. According to ergonomic standard step height should be 7” for elderly.

Fig 53 in foldable steps
Fig 54 in step convert into slope

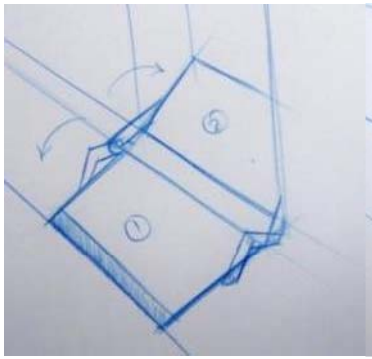

Fig: 55

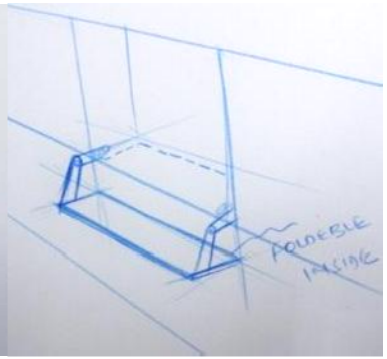

Fig: 56

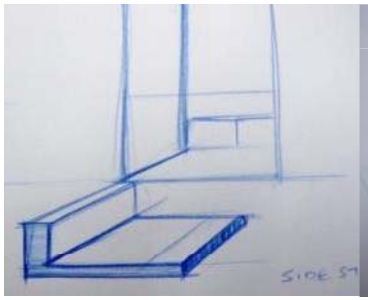

Fig: 57

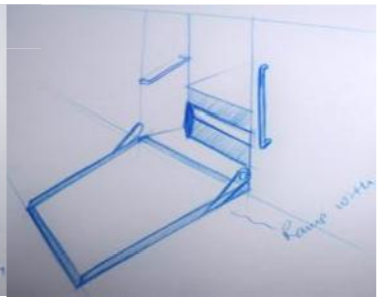

Fig: 58

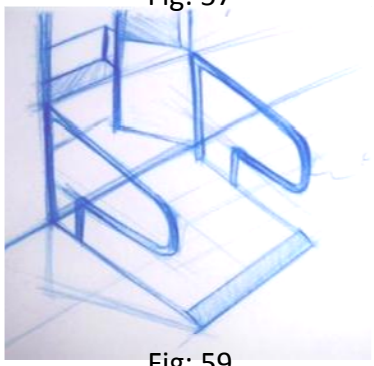

Fig: 59

Fig: 60

IDEATION FOR INGRESS PROBLEM

Fig 55 :foldable slope
Fig 56 : foldable step
Fig 57 : side step
Fig 58 : folding slope
Fig 59 : sliding slope with folding handle mechanism
Fig 60 : sliding slope with sliding handle in door mechanism.

The first step of the bus is 13” , which is too high for elderly, And the step height according to the ergonomic data is 7”, as an extra step cannot be added, so the best solution is to Provide an adequate slope.

SLOPE MECHANISM
(OPEN & CLOSED CONDITITION)

The height of the step was 8” and the aim was to bring it down to 7”, and by bringing step height down, the first step height increased from 13” to 15”.

Fig 61: sliding mechanism in closed condition
Fig 62: sliding mechanism in open condition

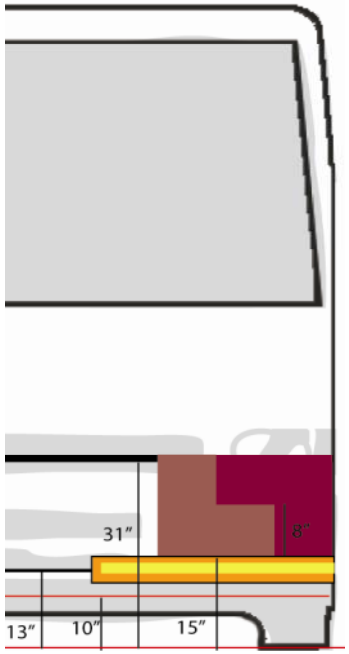

Fig: 61 mechanism closed

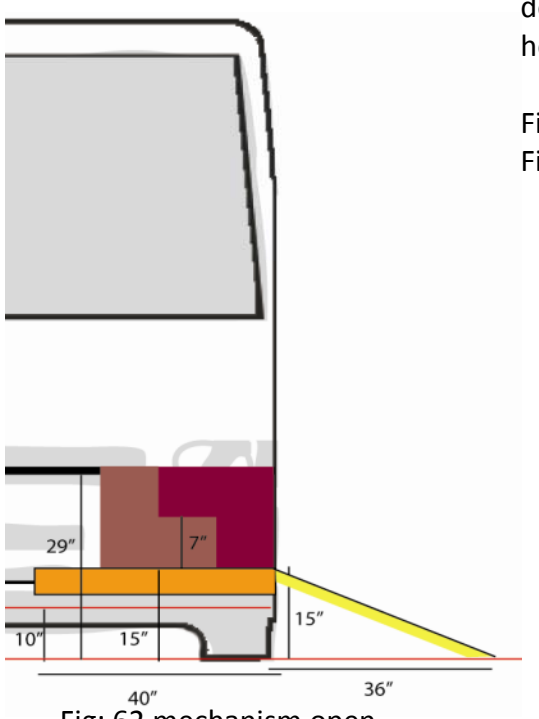

Fig: 62 mechanism open

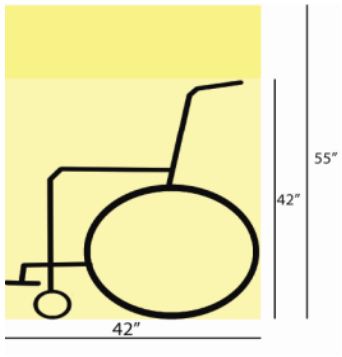

Fig: 63 wheelchair dimension

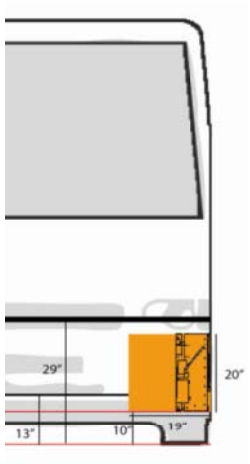

Fig: 64 Lifting mechanism

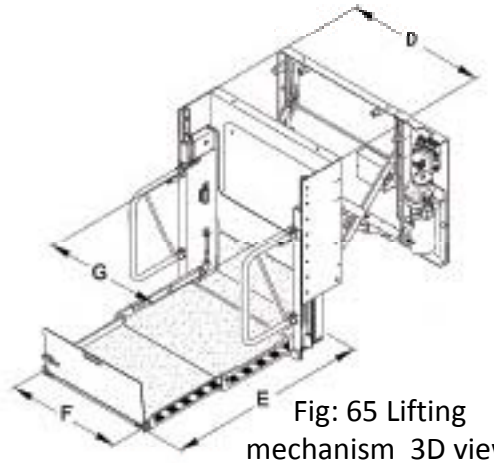

Fig: 65 Lifting mechanism 3D view

LIFTING MECHANISM DETAILS

By applying the lifting mechanism to the bus, the ground clearance of the door specially for wheelchair is 10".

Fig 63 – Dimensions the wheelchair is 24 X 42" and height is considered as 55", considering the clearance of the height of the person sitting on the wheelchair, thus the final considered dimension is 24 x 42 x 55.

Fig 64 - closing condition of lifting mechanism
Fig 65- mechanism open view

Mechanism details

Load carrying capacity	- 275kg
Lifting weight	- 268kg
Power	- Electro- Hydraulic
Hydraulic Cylinder .	-(2)diameter 1.75" Single-Acting / gravity down
Power rating @24V DC	-65amp / Cycle 1800 psi
Manual Backup(up)	- Hand pump
Manual Backup(down)	- Pressure Release Valve
Overall dimension	- 19 X 20 X 35"

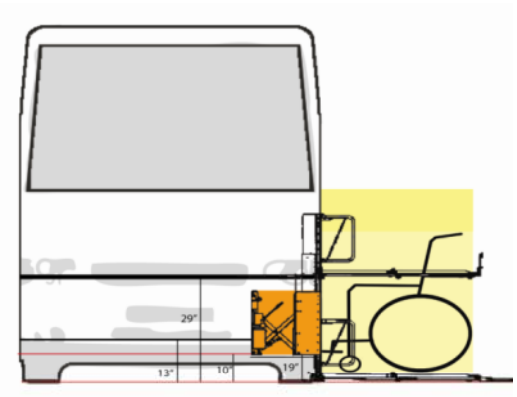

Fig: 66 wheelchair on lifting floor

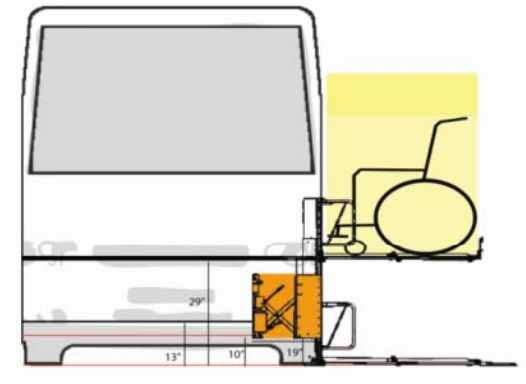

Fig: 67 wheel chair upward direction

LIFTING MECHANISM DETAILS

The lifting mechanism opens, a floor for wheelchair will come out and then the hydraulic system will start working after keeping the wheelchair on it, and will push the wheelchair floor in the upward direction.

Fig 66 – wheelchair floor opens and wheelchair is kept on it
Fig 67 – hydraulic cylinder pushes the wheelchair floor in the upward direction.

Fig: 68 mechanism dimension

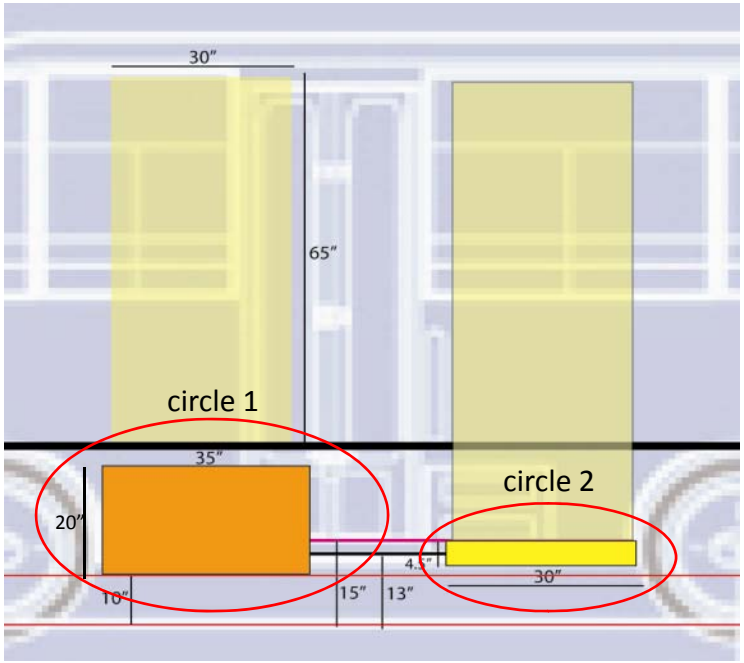

Fig: 69 enlarge view of Fig 68

SLOPE & LIFTING MECHANISM DIMENSION

Dimension of the slope mechanism is 30 X 4.5”, floor height 15”and ground clearance is 12”, as shown in Fig 69 in circle1.

Dimension of the lifting mechanism is 35 X 20”, and ground clearance is 10”, as shown in Fig 69in circle 2.

SIMULATION OF WHEELCHAIR MOVEMENT TO UNDERSTAND THE SPACE

A simulation experiment was carried out for the movement of wheelchair inside the bus which is shown in Fig 70,71,72&73. It was observed that more of motion inside bus more space it will consumes and it also hit the seats around and specially the four legs of the seats.

Gangway side Seating chair legs shift inside.5 to 6” to give a space to easily wheelchair rotated .

Fig: 70 gang way in wheelchair

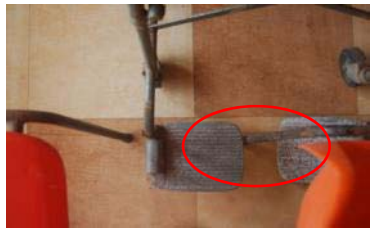

Fig: 71 wheelchair foot rest hits chair legs

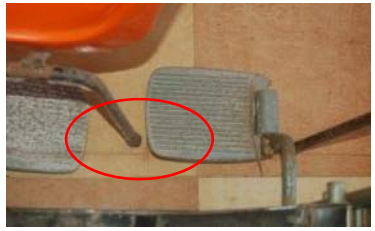

Fig: 72 wheelchair foot rest hits chair legs

Fig: 73 wheelchair foot rest hits chair legs(side view)

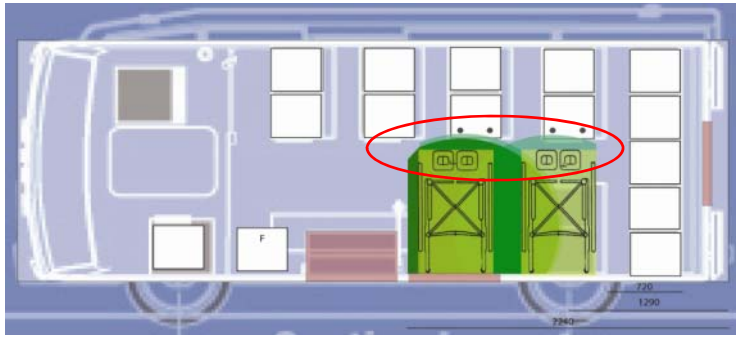

Fig: 74 simulation in concept layout

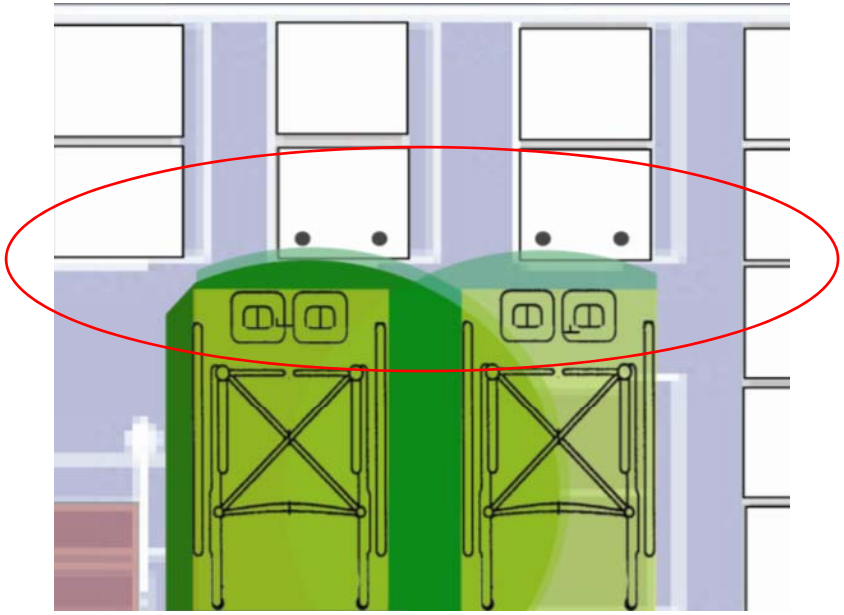

Fig: 75 enlarge view of Fig 74

SIMULATION OF WHEELCHAIR MOVEMENT TO UNDERSTAND THE SPACE

A theoretical simulation experiment was carried out for the movement of wheelchair inside the bus was carried out as show in Fig 74, Wheelchair consumed more space. As shown in Fig 75, in explain enlarge view of Fig 74

Concept 1- Legs of the seat can be shifted inside, for solving the problem of moving the wheelchair

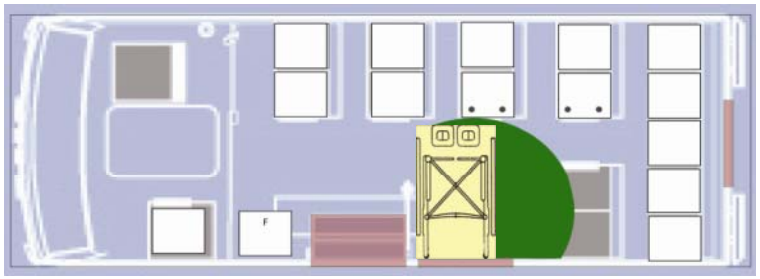

Fig: 76 wheelchair 1st place

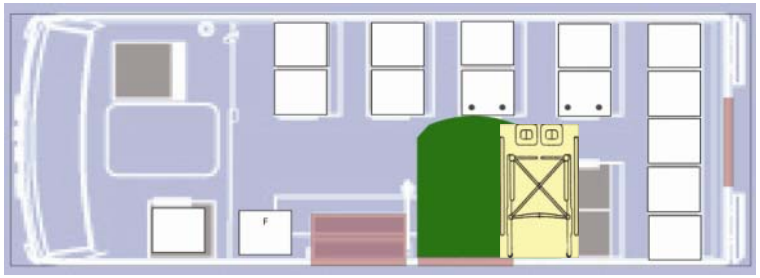

Fig: 77 wheelchair move to other place

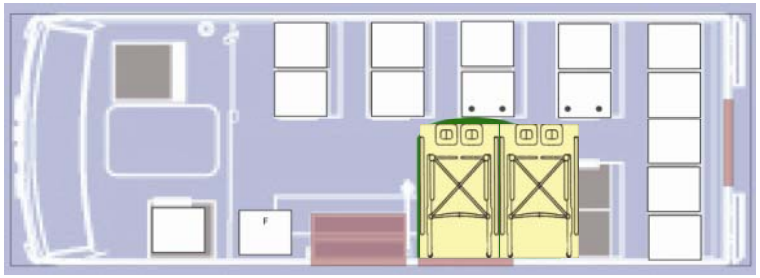

Fig: 78 second wheelchair come

SIMULATION OF WHEELCHAIR MOVEMENT TO UNDERSTAND THE SPACE

Concept 2 Moving wheelchair by sliding mechanism from one place to another place. In this case no need to shift the legs of seats

Fig 76 - one wheelchair is placed
Fig 77 - wheelchair placed with sliding mechanism
Fig 78 - second wheelchair is placed

Problem Identified- wheelchair locking problem and height level of wheel chair

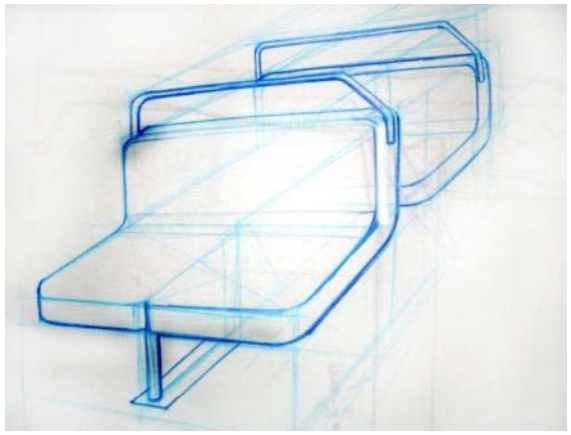

Fig: 79 Centre support seat

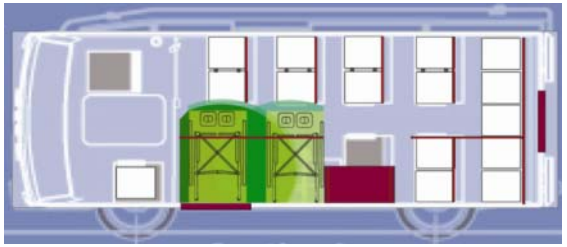

Fig: 80 layout propose

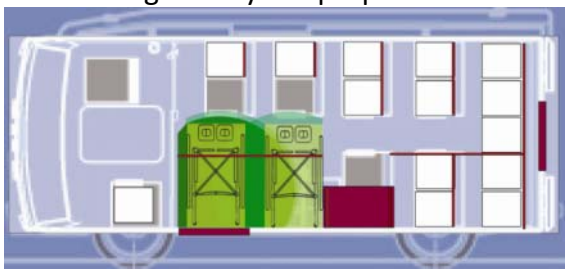

Fig: 81 Final layout concept

FINAL CONCEPT

Final Concept 1 – four leg support base converted into centre support of chair both side cantilever structure type.

Fig 79 - centre support seat
The problem with the centre support is that, the seat can vibrate with small amplitude vibration which is not good for elderly.

Fig 80 - 16 person and 2 wheelchair person seating layout is also possible
Fig 81 - final layout- no requirement of centre support chair

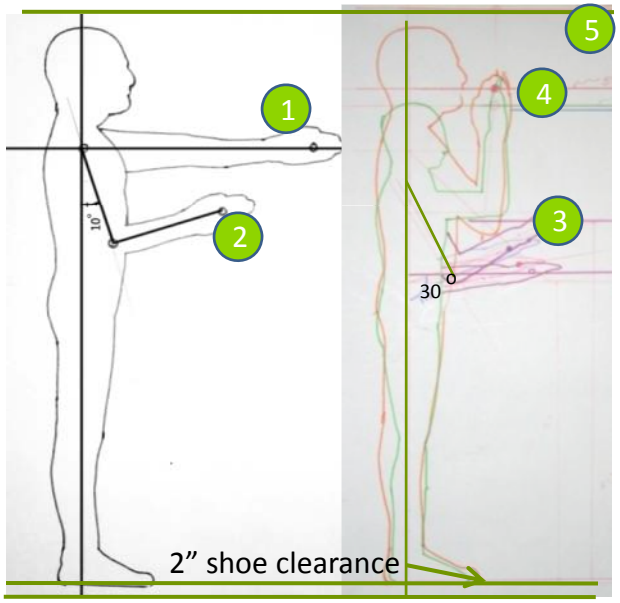

Fig: 81 Anthropometric posture

ANTHROPOMETRIC DETAILS

As a ergonomic standard the posture in Fig 81 is more comfortable and one has to apply less effort

Hand position 1- Straight hand at 90 degree with vertical line. It is position for climbing the staircase and considerable can be developed for pulling muscle force activity.

Hand position 2- Folding hand in upper arm angle 10 degree with vertical line elbow angle between 90-95 degree. In this position maximum pulling force is generated by biceps which help in climbing the staircase.

Hand position 3- Folding hand in upper arm angle 30 degree with vertical line. It is position better for horizontal surface condition with below shoulder height handle grip.

Hand position 4- Folding hand in upper arm angle 45 degree with vertical line. It is position better for horizontal surface condition with upper shoulder height handle grip.

Hand position 5- Folding hand in upper arm angle approx. 90 degree with vertical line. It this position persons doesn’t hit each other. Handle height is higher as compared to user height, considering 2” for shoe clearance of the user.

CONSIDERED HANDLES

Best suitable place for handles in a bus is suggested in the report.

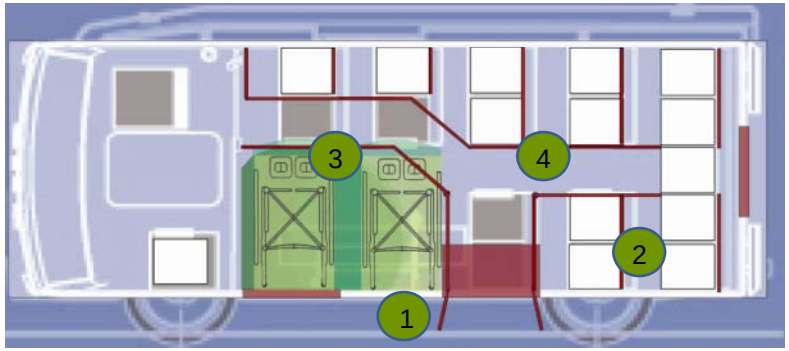

Fig: 82 Final handle layout concept 1

Final handle layout concept 1- as shown in Fig 82, Handle 1 is door handle ,handle 2 is chair handle, handle 3 is roof handle on the left side and handle 4 is roof handle on the right side

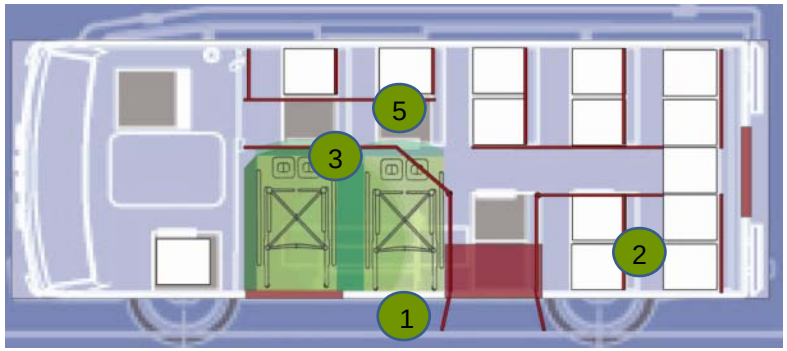

Fig: 83 Final handle layout concept 2

Final handle layout concept 2- as shown in Fig 83, Handle1 is door handle, handle 2 is chair handle, handle 3 is left side or roof handle and Handle 5 is roof handle of right side. It is in two parts.

CONCEPT HANDLES

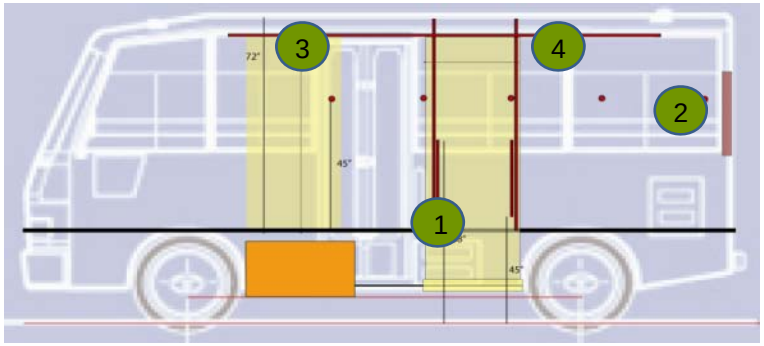

Fig: 84 Handle height in concept 1

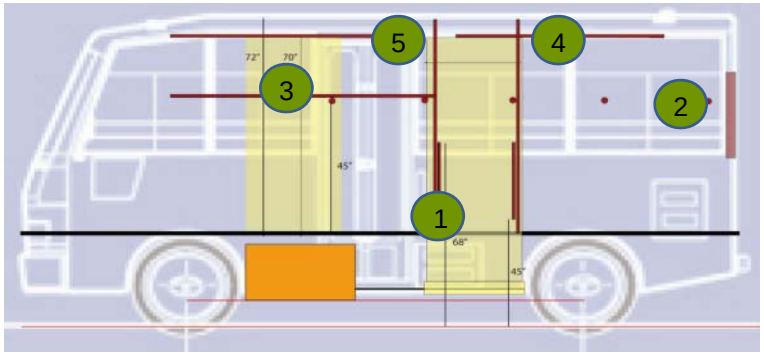

Fig: 85 Handle height in concept 2

Handle height in concept 1- Handle 1 is door handle ,handle 2 is chair handle, handle 3 is roof handle on the left side and handle 4 is roof handle on the right side, as shown in Fig 84

Handle height in concept 2- Handle1 is door handle, handle 2 is chair handle, handle 3 is left side or roof handle and Handle 5 is roof handle of right side. It is in two parts, as shown in Fig 85

Fig: 86 Dimension of handle

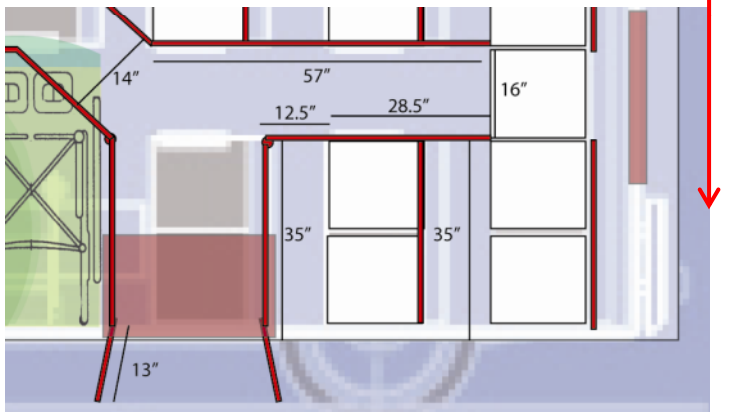

Fig: 87 enlarge view of Fig 86

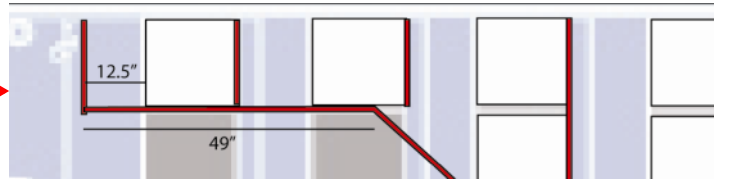

Fig: 88 enlarge view of Fig 86

HANDLE DIMENSIONS

Circle 1- Dimension of Door handle (handle 1) , seat handle (handle 2), roof handle on the right side (handle 4), gang way , seat pitch distance , sitting dimension and seat periphery handle distance, as shown in Fig 87

Circle 2- Front seat clearance and roof handle dimension, as show in Fig 88

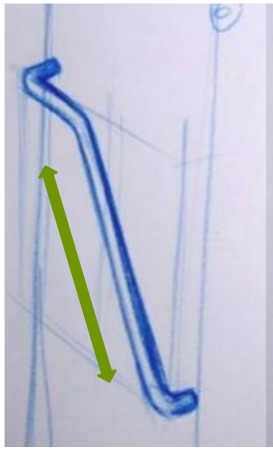

Fig: 89

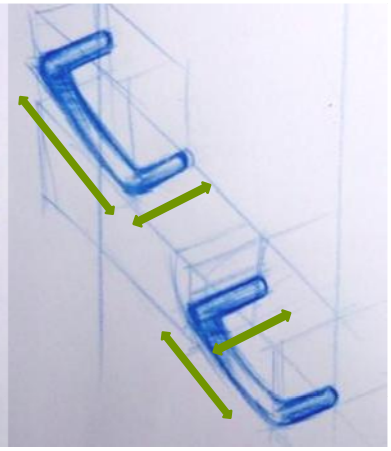

Fig: 90

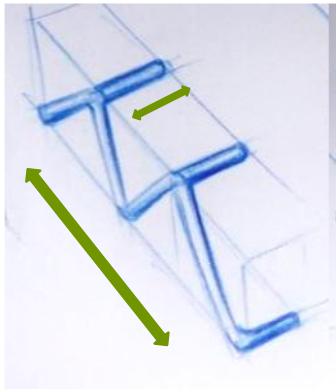

Fig: 91

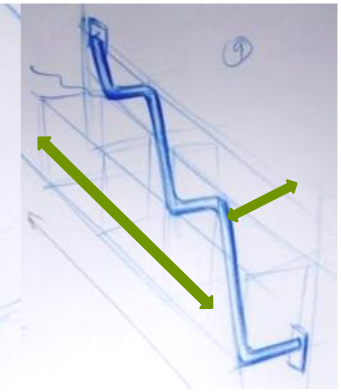

Fig: 92

IDEATIONS FOR DOOR HANDLE (HANDLE-1)

The ideation for door handle was based on the ergonomic study . They are as follows:

•Grip should be linear in form
•Handle should be in step form
•Grip should be comfortable

Fig 89- single step, linear
Fig 90- Multi step
Fig 91- multi dimension grip
Fig 92- Linear, multi step grip

IDEATIONS FOR DOOR HANDLE (HANDLE-1)

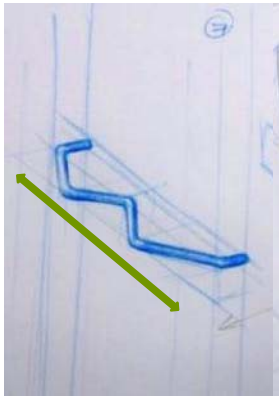

Fig: 93

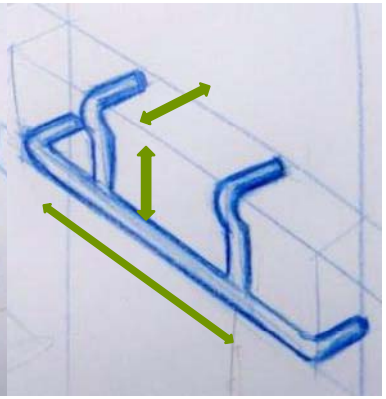

Fig: 94

Fig 93- Linear, multi step
Fig 94- Multi step grip
Fig 95- Multi dimension grip
Fig 96- Linear, single step grip

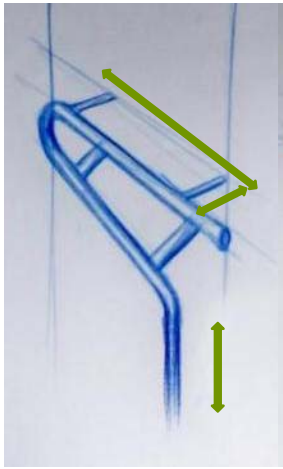

Fig: 95

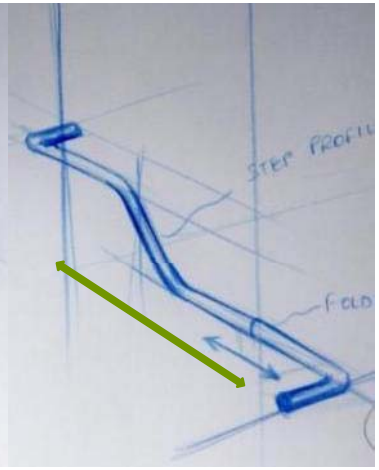

Fig: 96

IDEATIONS FOR DOOR HANDLE (HANDLE-1)

Fig 97- Linear, multi step
Fig 98- more support grip
Fig 99- moving handle
Fig 100- moving handle different shape

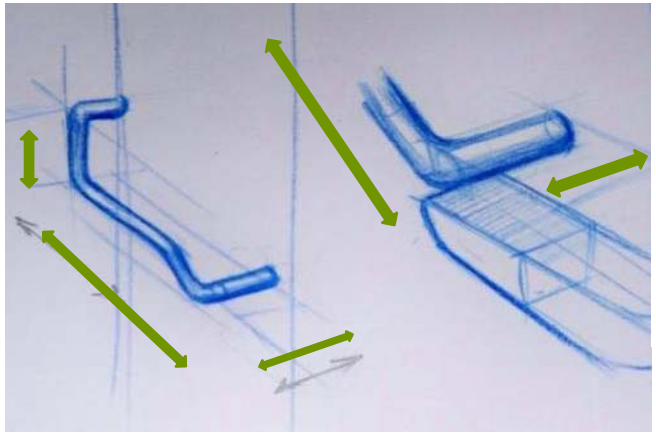

Fig: 97

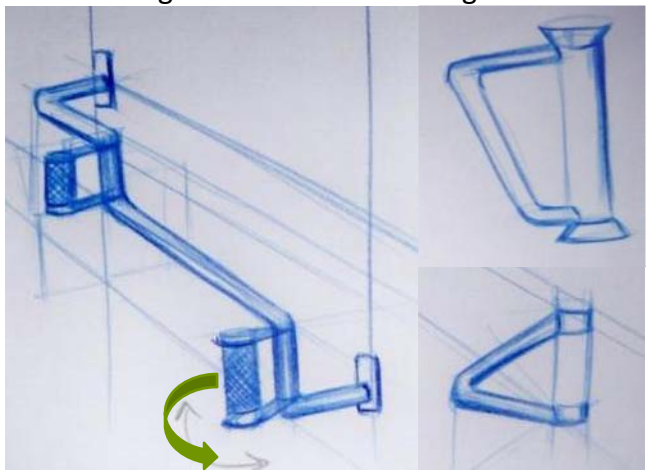

Fig: 99

Fig: 100

ANTHROPOMETRIC DRAWING (HANDLE-1)

When the hand position is straight wrist angle is approximately 45 degree vertical for comfortable posture, as shown in Fig 101.

Fig:102 shown the best fit anthropometric position in which one can apply maximum pulling force is generated by biceps which helps in climbing the staircase .

Fig:103 Manqué (5 percentile of female, 95percentile of male)
Used for finding upper and Lower limit of the hand position according to movement. All the points are mapped.

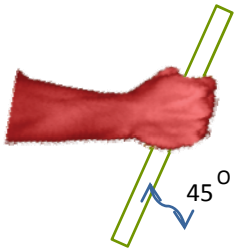

Fig:101 wrist angle in normal condition

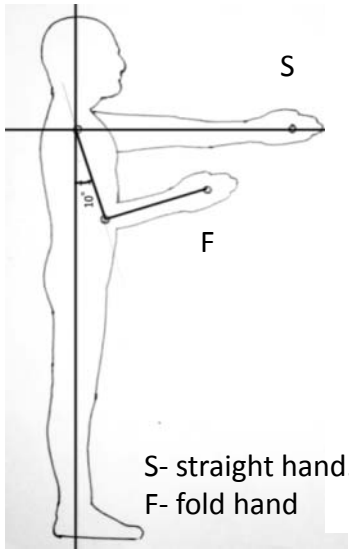

Fig: 102 Anthropometric position

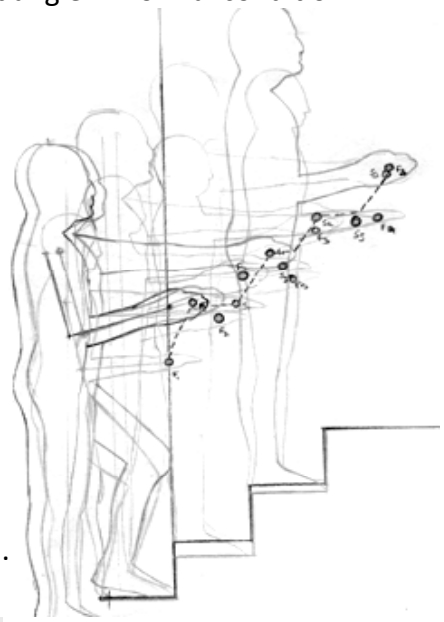

Fig: 103 Manqué works profile

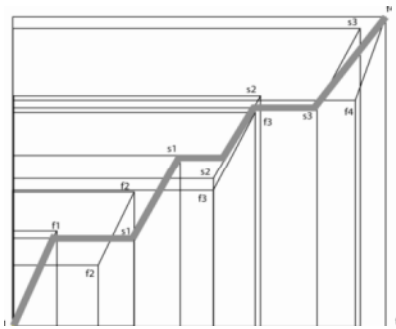

Fig:104 Concept1

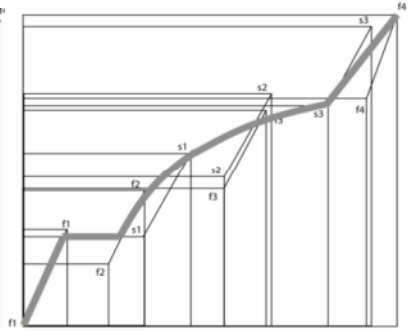

Fig: 105 Concept2

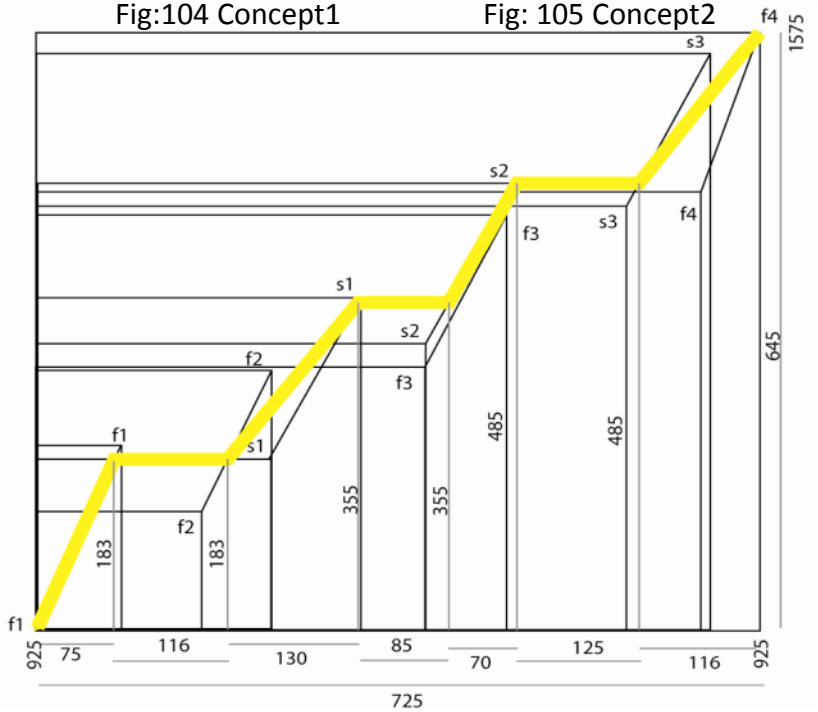

Fig: 106 Concept3 (Final concept)

CONCEPT FOR DOOR HANDLE PROFILE(HANDLE-1)

Manqué (5%ile of female, 95%ile of male) is used and find out lower and upper limit point position. The points are plotted on graph to make different handle profile.

Here S-straight hand, F-fold hand

Concept 1- linear with steps, as shown in fig 104
Concept 2 – linear with curvy profile, as shown in Fig 105
Concept 3 – maximum points considered, as shown in Fig 106

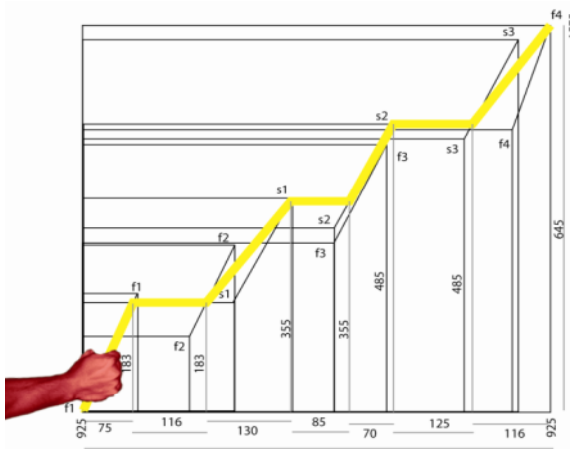

Fig: 107 normal position 1st hand come

-FOLD HAND

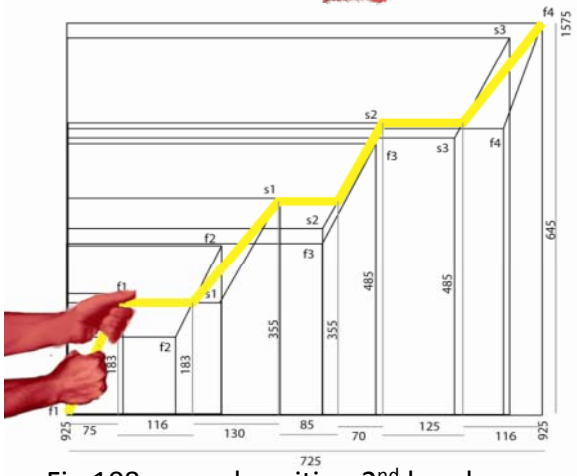

Fig:108 normal position 2nd hand come

-FOLD HAND

FINAL CONCEPT (DOOR HANDLE PROFILE: HANDLE-1)

normal position of a person standing in outside a door while climbing, 1st hand come(right-hand)up (As shown in Fig 107)Fold right hand posture for entering the bus, then in same position 2nd hand (left-hand) as shown in Fig 108 Fold left hand posture for entering the bus

FINAL CONCEPT (DOOR HANDLE PROFILE: HANDLE-1)

Person takes the next step, person hold the grip with right hand again do activity. Right hand move hold a grip bar as show in Fig 109 Straight right hand posture. Then same step in 2nd hand(left hand) come as shown in Fig 110 is Fold left hand posture

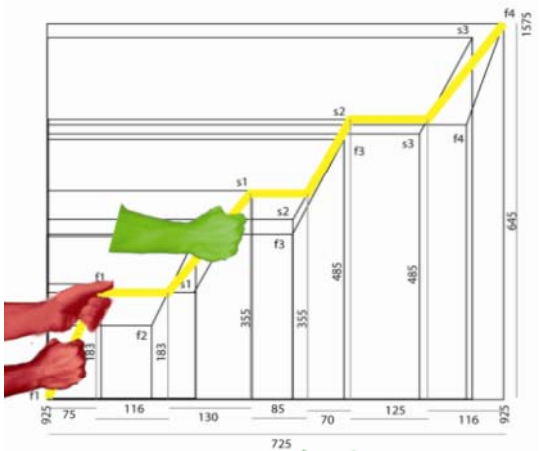

Fig: 109 next step in 1st hand come

-STRAIGHT HAND

-FOLD HAND

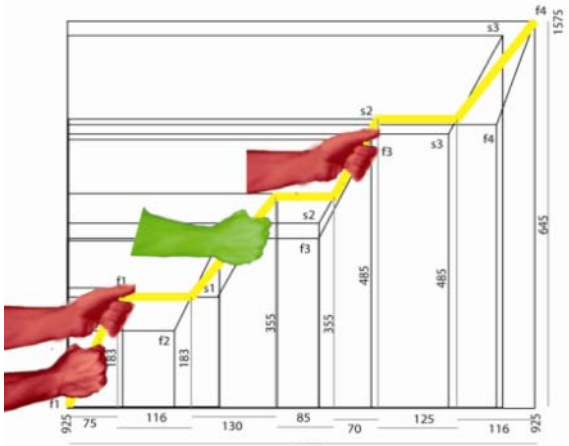

Fig: 110 same step in 2nd hand come

-STRAIGHT HAND

-FOLD HAND

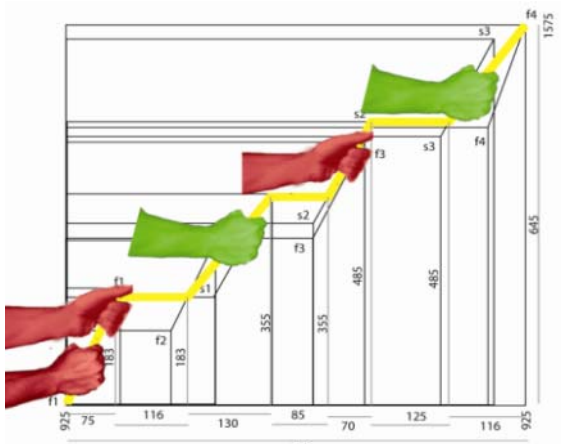

Fig: 111 next step in 1st hand come

-STRAIGHT HAND

-FOLD HAND

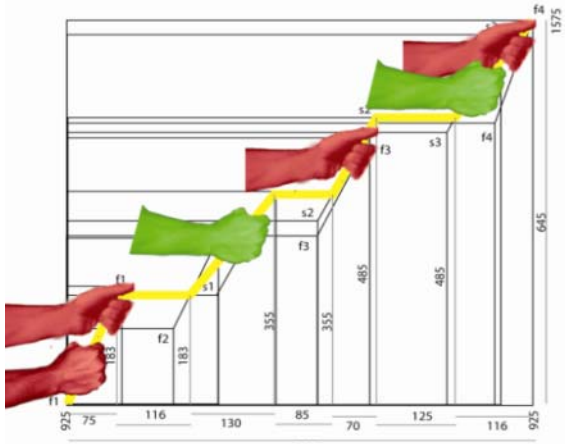

Fig: 112 same step in 2nd hand come

-STRAIGHT HAND

-FOLD HAND

FINAL CONCEPT (DOOR HANDLE PROFILE: HANDLE-1)

When the person takes another step the positions are: once again 1st hand come(right-hand) as shown in Fig 111 Straight right hand posture, then same position 2nd hand activity (Left-hand) move as shown in Fig: 112 Fold left hand posture

The process of climbing will continue following the same trend of hand movement which is shown in the Figures

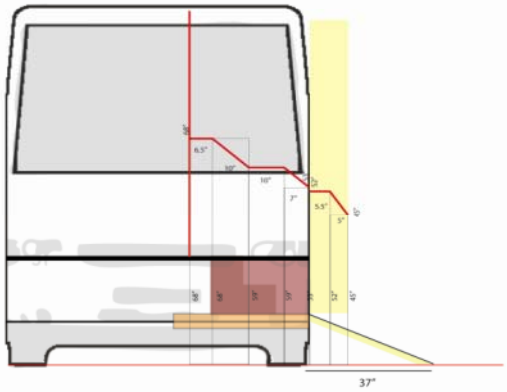

Fig: 113 handle fit inside bus

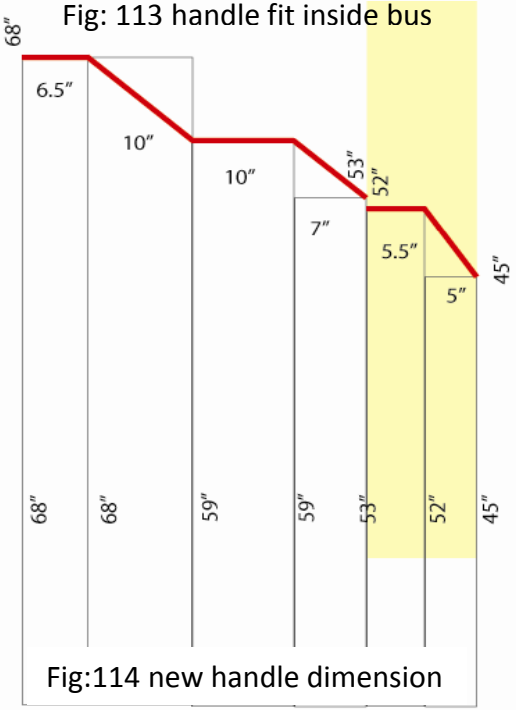

Fig:114 new handle dimension

FINAL DOOR HANDLE CONCEPT (HANDLE-1)

The door handle is divide into two parts. The door opens outside so that the handle comes outside providing more grip for comfortable climbing. Normally all door open inside that condition handle is show far with person.

Door handle fit inside bus as show in Fig 113
Door handle dimension with reference of ground as show in Fig 114, person stay in ground height of handle is 45”

Fig: 117 5%ile Female in 1st step

Fig: 118 95%ile male in 1st step

Fig: 119 95%ile male in 2nd step

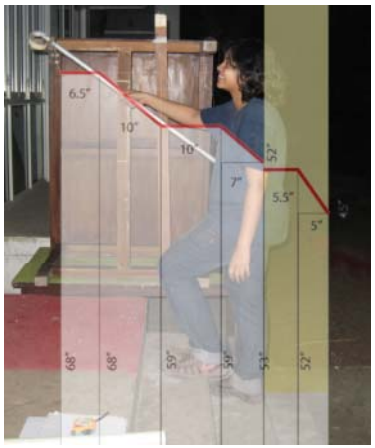

Fig: 120 5%ile Female in 4th step

SIMULATION OF DOOR HANDLE TO UNDERSTAND IS COMFORTABLE

For any person, normally it will take 5 step to get in to the bus. First two steps on the ramp and next three steps for the stairs.

5%il Female walk in ramp, first step with straight hand consider as shown in Fig 117.

Similarly 95%il Male walk in ramp, first step with foldable hand as shown in Fig 118.

95%il Male walk in ramp, 2nd step with straight hand consider as shown in Fig 119

Similarly 5%il Female walk in bus 4th step, with straight hand consider as shown in Fig 120.

FINAL DOOR HANDLE SKETCH (HANDLE-1)

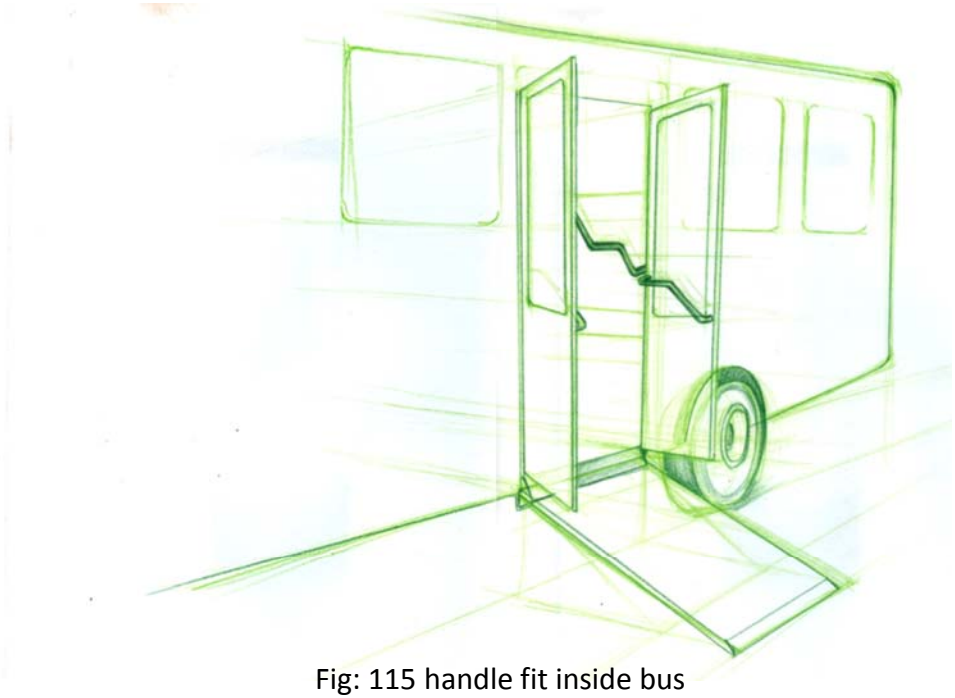

Fig: 115 handle fit inside bus

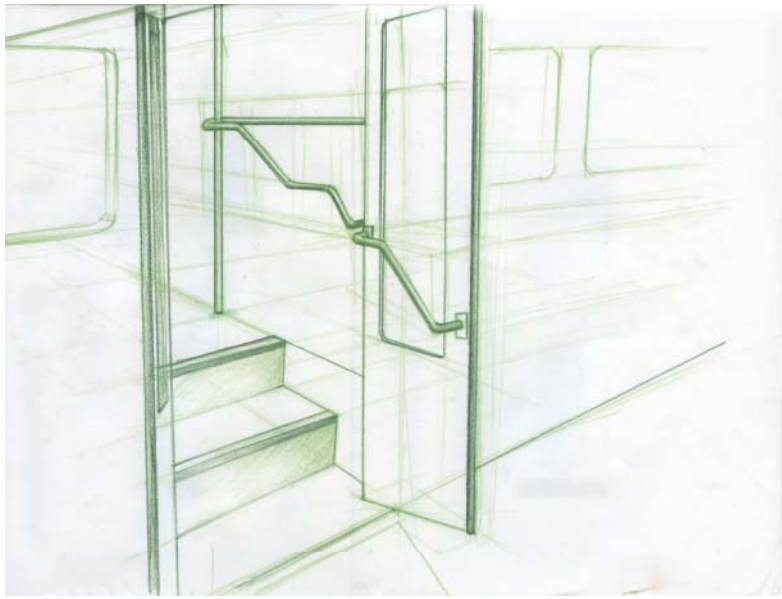

Fig: 116 handle fit inside bus

FINAL DOOR HANDLE PROTOTYPE (HANDLE-1)

Fig: 116(a) handle fit inside bus

IDEATIONS FOR SEAT HANDLE (HANDLE-2)

The ideation for Seat handle was based on the ergonomic study for the comfortable posture of elderly. They are as follows:

•Grip should be linear in form
•Handle should be help for get up get down
•Grip should be comfortable

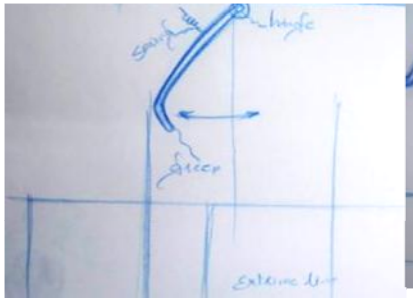

Fig: 121

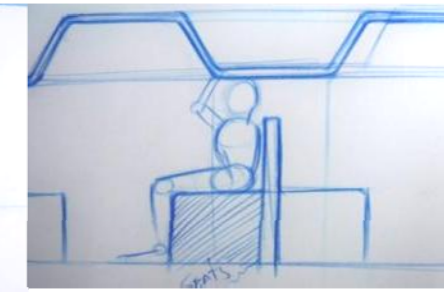

Fig: 122

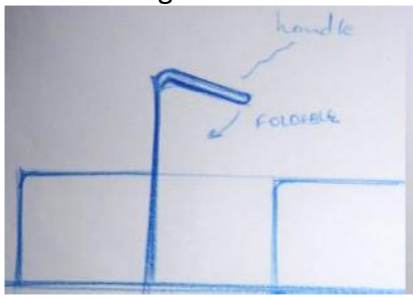

Fig: 123

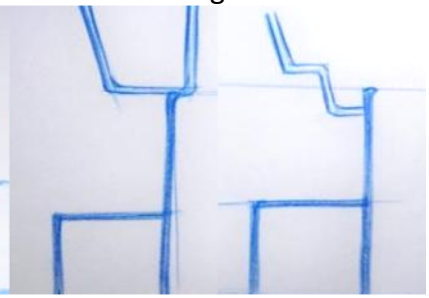

Fig: 124

Fig 121- Spring system
Fig 122- Multi step
Fig 123- Foldable handle
Fig 124- seating and stand person for handle

FINAL CONCEPT FOR SEAT HANDLE (HANDLE-2)

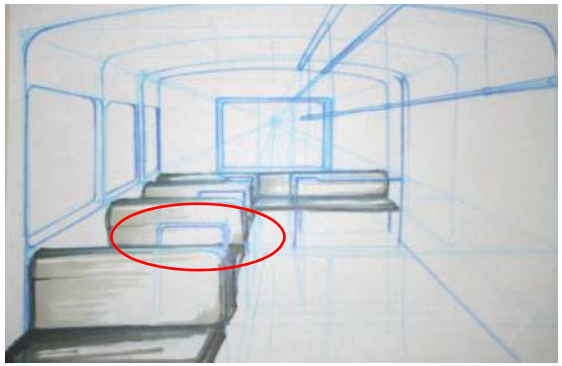

Fig: 125 Concept 1

After ideation, concluded that handle should be linear and helpful for getting up and down at the door, for movement inside bus a seat handle must be in ergonomic form, shown in Fig 125.

In concept 1 given handle only on gang way side, person can take help only when they were using gangway. Handle edge is chamfer in side(Circular shape).

In concept 2,the handle is linear and side was fillet at an angle of 45 degree ascending to wrist angle, Briefly explained in Fig 101. it is for helping in gang way walking as well as standing and sitting movement on seat.

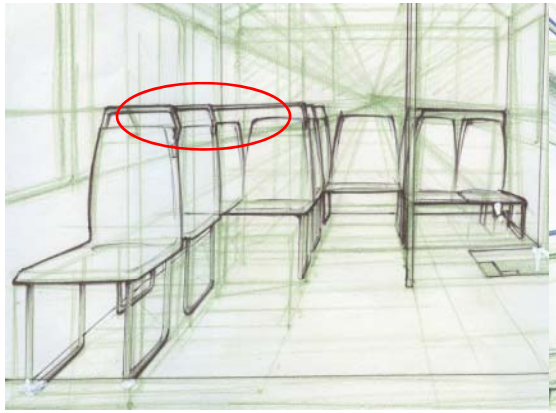

Fig: 126 Concept 2

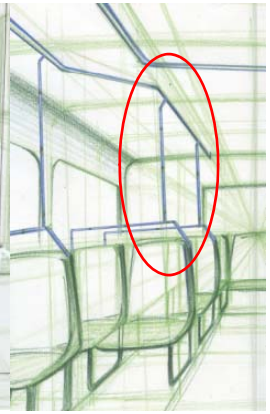

Fig: 127 Final concept (Handle-2)

In concept 2,handle is more comfortable ergonomically, also looks good and giving support to Gang way vertical handle this whole assembly makes the gangway motion easy. handle as shown in Fig 127, is final concept

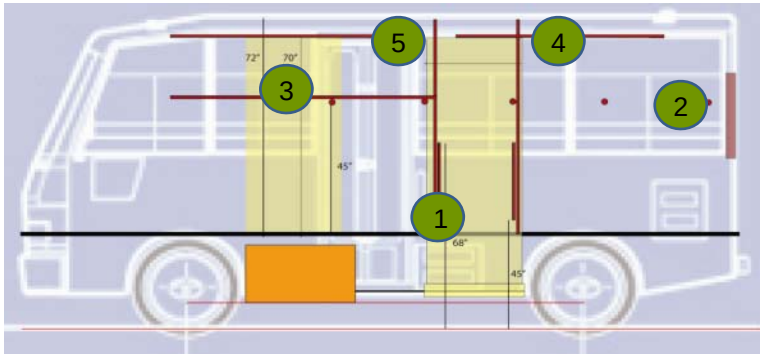

Fig: 128 Roof Handle Left side

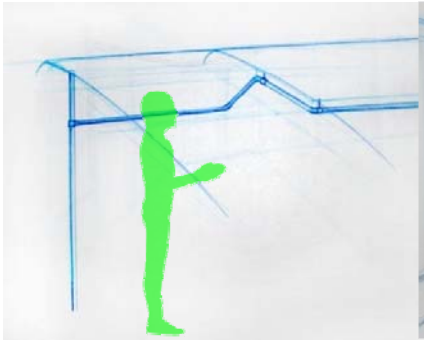

Fig: 129 Roof Handle Left side (Concept 1)

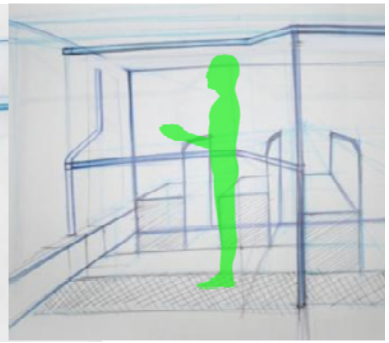

Fig: 130 Roof Handle Left side (Concept 2)

FINAL CONCEPT FOR ROOF HANDLE (HANDLE-3)

The ideation for Roof handle was based on the ergonomic study . They are as follows:

•Grip should be linear in form
•Handle should be in continues form
•Grip should be comfortable for grip

Roof handle(handle-3) above the wheelchair position can be lowered for the support because there lots of space unused. [Refer Fig 83 bus handle layout].

CONCEPT 1: In Fig 129, Linear roof handle for wheelchair on the left side, bended slight portion just above the shoulder to give space to shoulder for better grip upper side position this posture is more comfortable for elderly but fear of hitting head on handle.

CONCEPT 2: In this case the handle position is lowered down just below shoulder to give proper grip throughout the way for movement . These handle position will hit nobody but aesthetically doesn't look good.

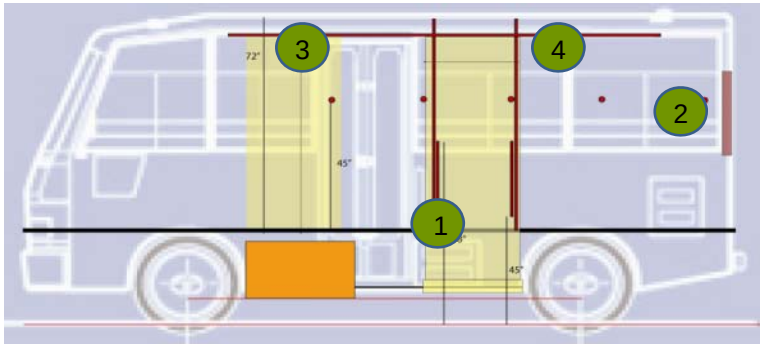

Fig: 131 Roof Handle Left & Right side

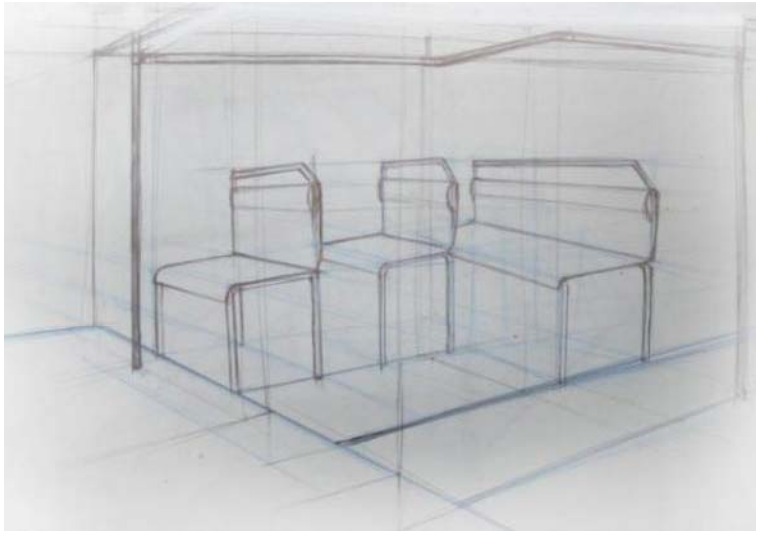

Fig: 132 Final Roof Handle Left & Right side (Concept 3)

FINAL CONCEPT FOR ROOF HANDLE
(HANDLE-3 OR 4)

The ideation for Roof handle was based on the ergonomic study . They are as follows:

•Grip should be linear in form
•Handle height should be 95%il above(no once hit)
•Grip should be comfortable

Roof handle(handle-3 or 4) roof handle left side and right side is same height and continued and linear

CONCEPT 3: considering roof handle height is above the 95%ile Male with adding of 2”clearance for shoe will not hit anyone. All handle in same height so that it will look like same family.

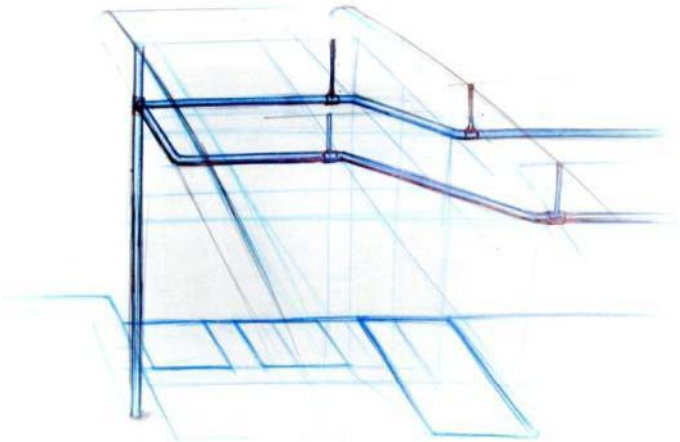

Fig: 133 Final Roof Handle Left & Right side (Concept 1)

Fig: 134 Final Roof Handle Left & Right side (Concept 2)

FINAL CONCEPT FOR ROOF HANDLE JOINT

(HANDLE-3 OR 4)

The ideation for Roof joint

Concept 1: Roof handle joint Left side or Right side roof handle join as shown in Fig 133

Concept 2: Roof handle Left side and Right side handle in part as shown in Fig 134. it is not continuous linear handle but break in two or three parts

We required linear and smooth handle. we go with concept 1 Fig 133

FINAL CONCEPT FOR ALL HANDLE

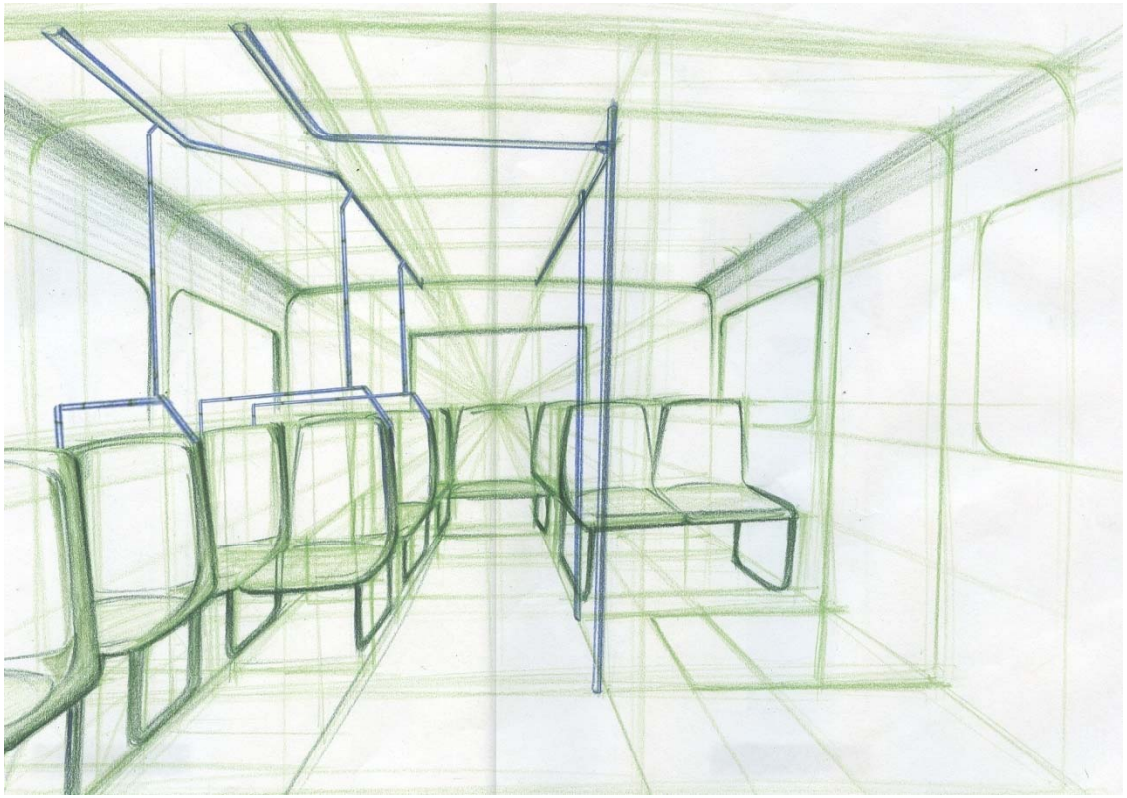

Fig: 135 Final concept handle-2,3 or 4

ALL HANDLE DIMENSION

In Fig 136, the dimension of all bus handles which we considered according to our requirements. Dimension of Roof handle is given in enlarge view, Roof height is 72” and handle height 70”, Seat handle height is 45” for bus floor. According to ergonomic posture Refer Fig 81 which specify all handle position. Door handle height is 45” from ground Refer Fig 114.

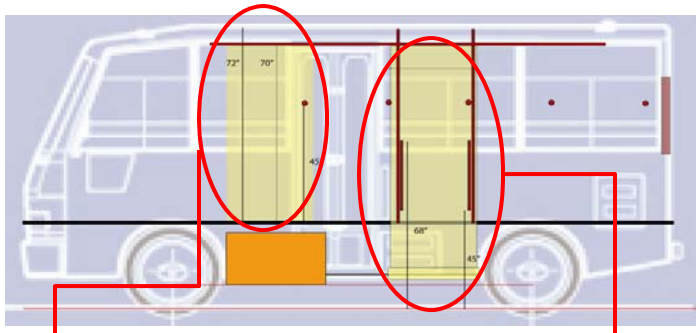

Fig: 136 Bus Handle Dimension

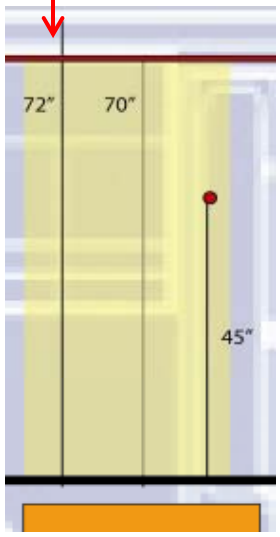

Fig: 137 Roof Handle Dimension

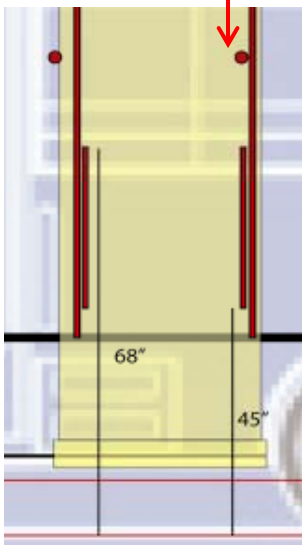

Fig: 138 Door Handle Dimension

FINAL HAND RENDER VIEW OF ALL HANDLE

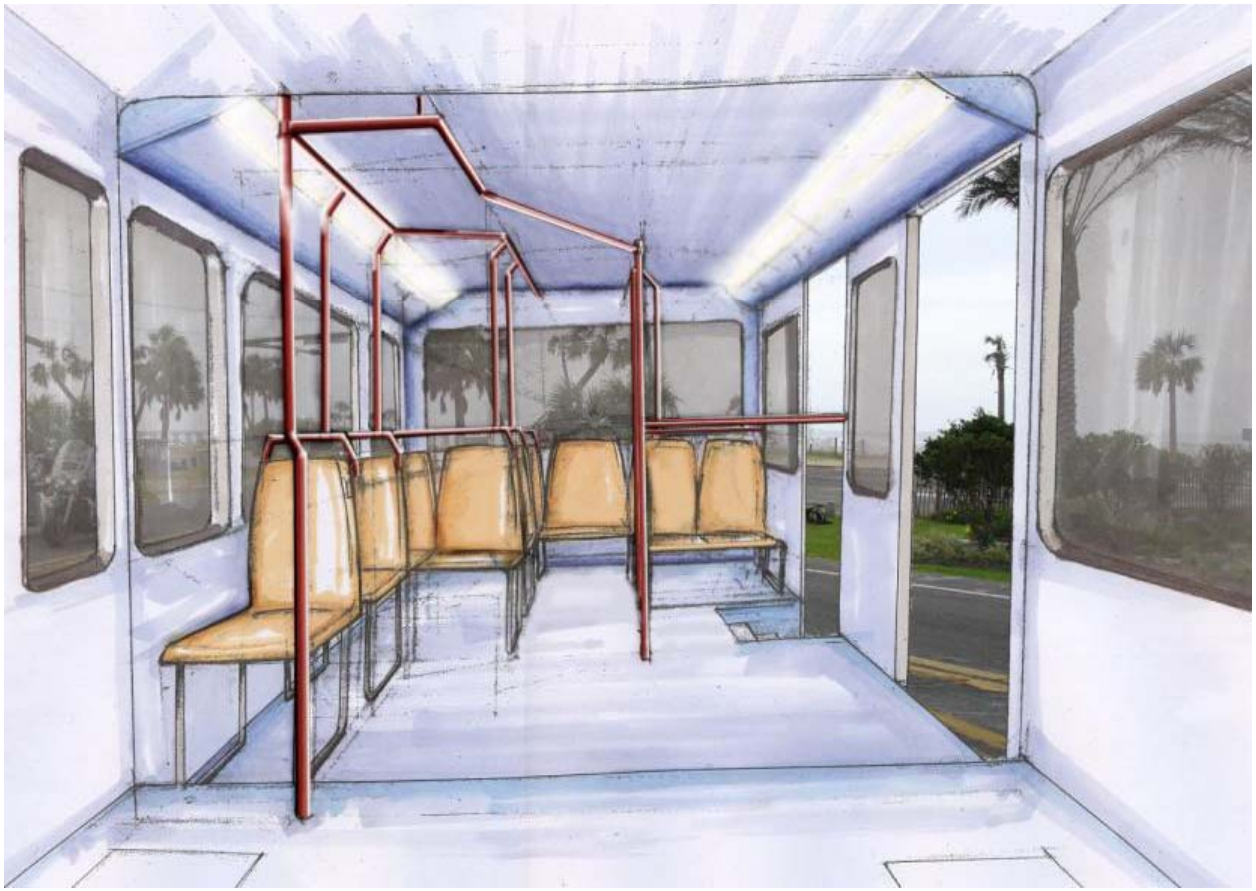

Fig: 139 Final Rendering inside view

FINAL PROTOTYPE TOPVIEW OF ALL HANDLE

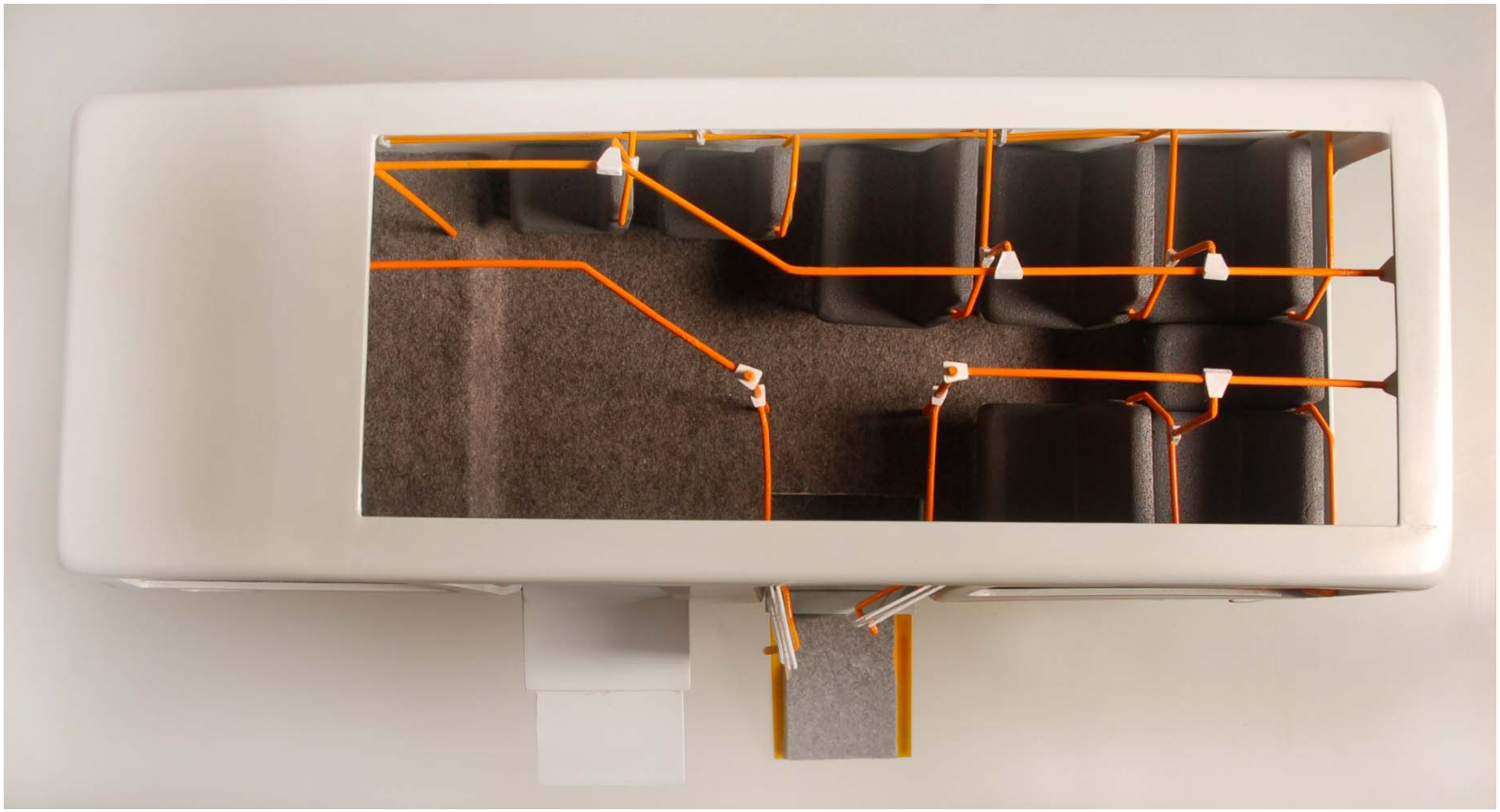

Fig: 139(a) Final Prototype inside view

FINAL PROTOTYPE OUTSIDE VIEW OF BUS

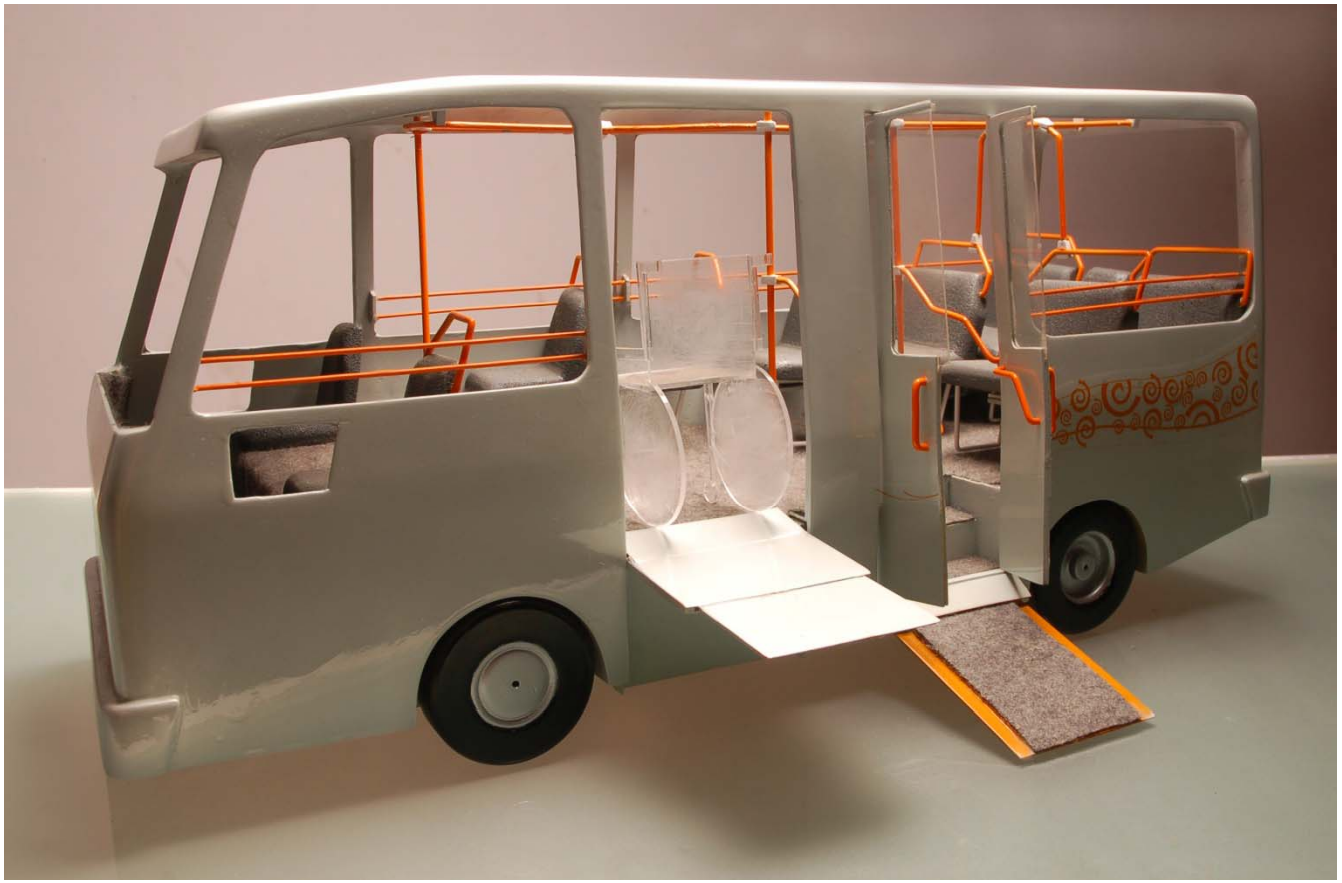

Fig: 139(b) Final Prototype outside view

SPACE LAYOUT

Space layout of sitting arrangement of bus as show in Fig 140. Door to pillar distance is 35”which is same as two seat dimension Single seat dimension is 16” X 16”, and pitch distance of seat is 28.5”, that comes leg room space is 12.5” and gangway width is 14”. all dimension shown in Fig 141.

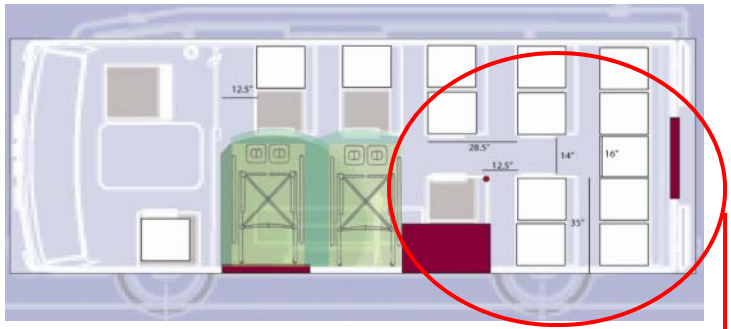

Fig: 140 space layout

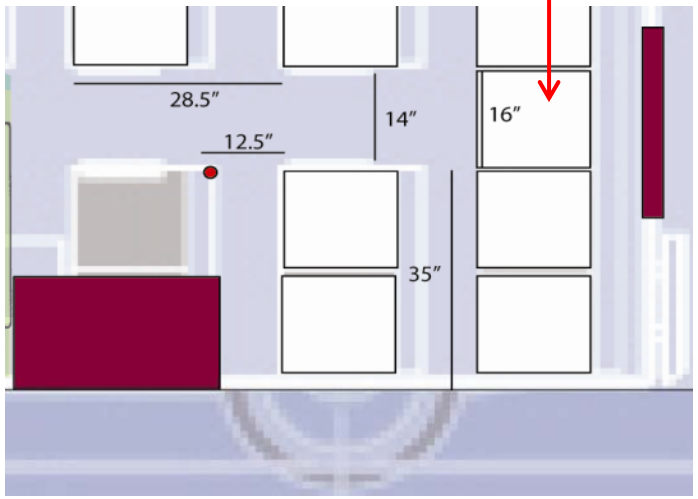

Fig: 141 space layout enlarge view of Fig 140

HAND GRIP DIMENSION

Handle grip dimension is given Fig 142. in table , considering 16 person hand grip dimension data study in 14 Male and 2 Female, average hand grip diameter is 3.9, handle lower limit is 3.7cm
My final handle grip diameter is 37mm,
Inside of pipe diameter is 30mm, and all over diameter is 37-38mm 1 mm clearance
When u r grip handle apply the force grip is shrinkage

No. of person	M/F	dimension
1	M	3.7
2	M	3.7
3	M	3.7
4	M	3.8
5	M	3.8
6	M	3.8
7	M	3.8
8	M	3.9
9	M	4
10	M	4
11	M	4
12	M	4.1
13	M	4.2
14	M	4.2
15	F	3.8
16	F	3.9
	Avg	3.9
	SD	0.167332005

Fig: 142 hand grip table

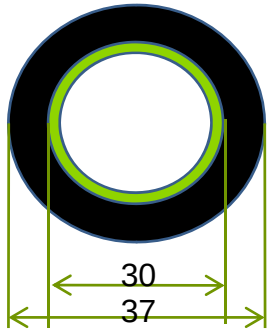

Fig: 143 section grip of handle

HAND GRIP MATERIAL

Fig: 144 Splined- foam

Fig: 145 durablend-foam

Fig: 146 NPVC -foam

Market in three types of grip available
Is all are foam types
According to bus handle select [Ref 10]

Spkined-foam as shown in Fig 144. An interesting variation on the standard foam tube, splined foam tubes (or sleeves) contain a number of exterior ribs designed to enhance the appearance of the part. They are a cost effective way to add value.[Ref:6 page 71]

Durablend-foam as shown in Fig 145. Durablend foam is GripWorks' proprietary material that combines two high-grade rubber compounds to form extremely durable grips with excellent outdoor weathering properties. but were also resistant to oil and gas.[Ref:5 page71]

NPVC-foam as shown in Fig 146 Our workhorse material due to its low cost, NPVC foam grips are available in three standard densities [Ref : 9 page 71]

Splined is make in tube form is good for linear bus handle

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12th nov'o8(11:15 PM)

Ref 2: Fitting the task to the Man (E. Grandjean) page no. 77

Ref 3: http://auto.indiamart.com/bus/

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13th nov'08(2:51)

Ref 5: http://www.gripworks.com/durablend-foam.htm
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Ref 6: http://www.gripworks.com/splined-foam-tubes.htm
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