IDC
IIT, Bombay

Accommodation system seat / berth layout for Force Ventilated air cooled coaches of Indian Railways

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Finally, I thank IDC staff for the invaluable support with the facilities.

Declaration

I declare that this written submission represents my idea in my own words and where other ideas or words have been included. I have adequately selected and referred the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any ideas / data / facts / sources in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the source that have not been properly cited, or from whom proper permission has not been sought.

Signature 

Name Amol Pakhale

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Date 28/07/14

Approval

Industrial Design Project III

"Accommodation system seat / berth layout for Force Ventilated air cooled coaches of Indian Railways"

By : **Amol Pakhale**

M.Des Industrial Design 2012-2014

Is approved as a partial fulfillment of requirements of post graduate degree in Industrial Design at IDC, IIT Bombay.

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Abstract

The objective of this design project is to explore ways of increasing people's comfort and connectedness in a public and private space using a good accommodation system concept as a medium within the constraints of the project description as per the Indian Railway scenario.

The interior design, sleeper comfort and manufacture efficient design for reduced energy consumption are the three essential factors for a successful operation in the competitive world. Scientific design of sleepers for increased comfort of the passengers is seldom seen.

The overall aim of this project was to design a 'Force ventilated air cooled sleeper coach' with enhanced interior, reduced mismanagement in accommodation and increased comfort for the passengers.

Design of passenger coaches must combine the state-of-the-art technology and the best of aesthetics with an Indian touch. Through this process report, the author will explain the design process for the project, analyzing for example existing design of self-expression in public spaces. The journey will then take you through the process of how the concept came into being through rigorous academic research, user study, thought and analyses. The report explains all the relevant aspects of these processes.

Details of and insights on the research methodology results will be found in the final design of the project.

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Introduction

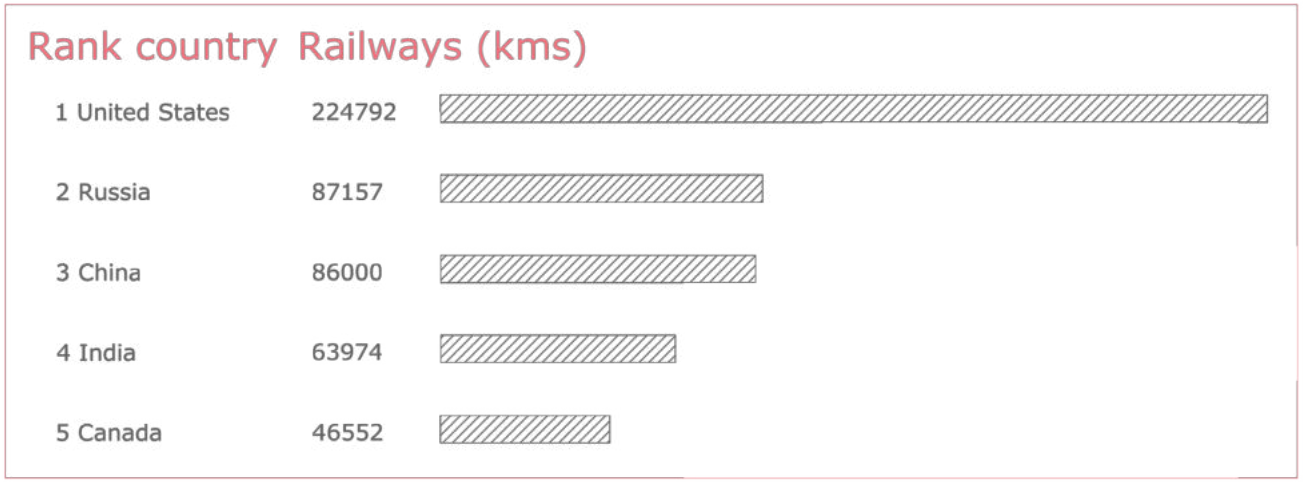

Fig 1 http://www.indexmundi.com/g/r.aspx?t=50&v=113

Country	Billion Passenger-km	Year
1 India	1046.0	2011
2 China	981.2	2012
3 European Union	397.8	2011
4 Japan	395.1	2011
5 Russia	139.8	2011

Fig 2 http://en.wikipedia.org/wiki/Rail_usage_statistics_by_country

Indian Railways (IR) is the third largest railway network in the world with 7,083 railway stations, 1, 31,205 railway bridges, 9000 locomotives, 51,030 passenger coaches, 2,19,931 freight cars and 63,974 route kilometers. Today IR operates 19,000 trains each day, comprising 12,000 passenger trains and 7,000 freight trains. It transports 2.65 million tons of freight traffic and 23 million passengers every day and 7.2 billion passengers per year. It currently has 1.36 million employees and an annual revenue base of Rs.1, 06,000 crores as projected on March 31, 2012. Indian Railways is also home to great talent and excellent organization focused on operation, efficiency and safety. As of 31 March 2013, 23,541 km (14,628 mi) (36%) of the total 65,000 km (40,000 mi) route length was electrified. Since 1960, almost all electrified sections on IR uses 25,000 Volt AC traction through overhead centenary delivery.

Figure 2 Shows the data about passenger-km of rail transport per year

Background

The expected development of high speed railways and coaches at the global level in the coming years is extremely spectacular: in the next 15 years the number of kilometer of new dedicated high speed lines will multiply by four the existing ones. Also the industrial development and the financial requirements calls for a particular attention to high speed railways and fully equipped coaches.

Need of improved coach system ...more Sustainable Transportation

- Improve the economic development of the regions served, increase their competitiveness and reduce their peripherally;
- Through the release of rail capacity, permitting improvement in both the capacity and transit times of freight services.
- There is need for capacity as well as comfort. New infrastructure should be capable of delivering Greater Capacity, Improved Journey Times & Support High Speed Services.
- High speed lines based on advanced rail technology have the advantage of being compatible with the conventional rail network.

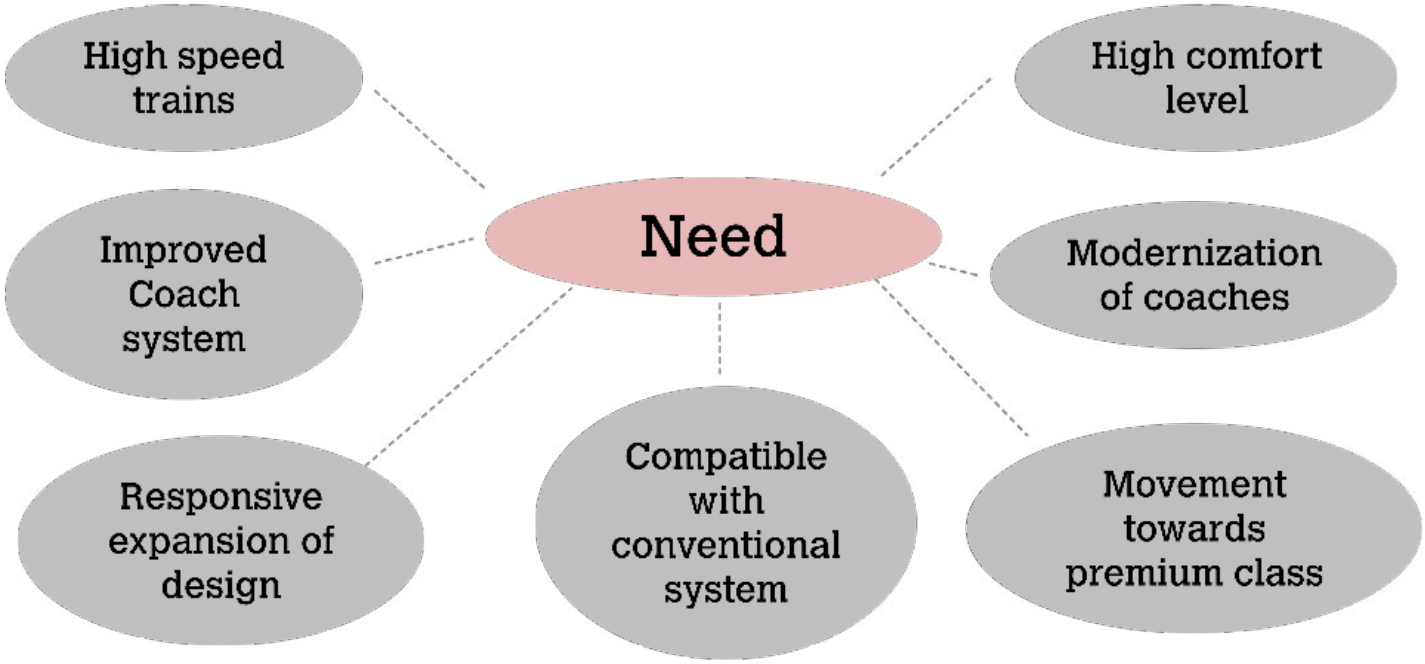

Fig 3 Need of Project

- Whilst energy consumption increases as speed rises, this can be offset through effective system and rolling stock design.
- The lead time for development and construction of HSR is very high such as 20 years, and this is why it is right to plan now for coaches that will be required in near future.

There would be a steady upward movement towards the premium classes. A number of initiatives have already been taken to cater to this trend but there still is a large number of areas which would require close attention. These include: development of modern passenger coaches, re-design of trains with pleasing, soothing colours and exteriors, plush interiors and green toilets, responsive expansion of supply to match demand, raising of speed, use of information technology to make the entire interface of passengers with the Railways a pleasant. Re-design of second class coaches to make them more comfortable for passengers.

(Indian Railways vision 2020 2009)

Types of railway coaches in India

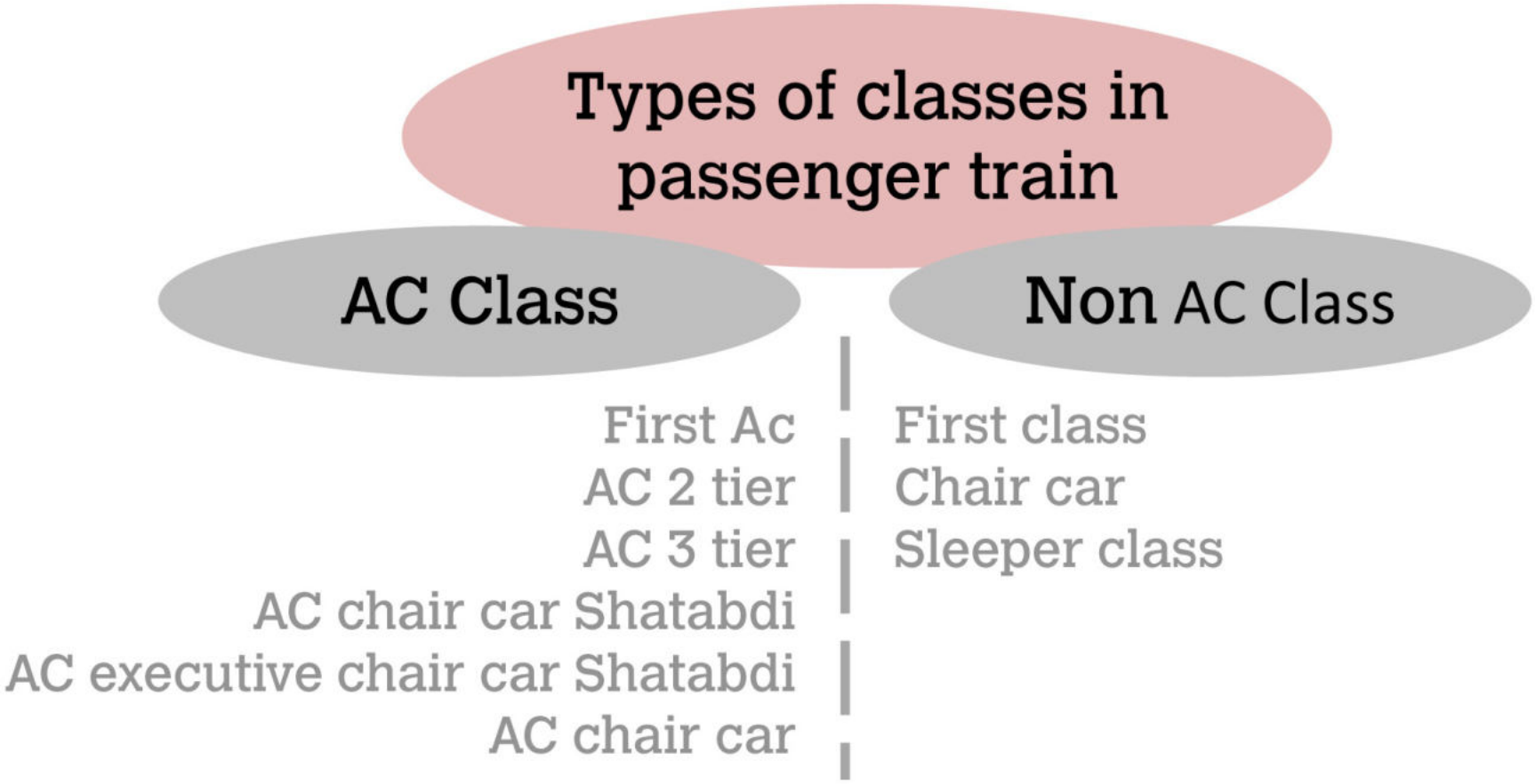

Fig 4 *Types of railway coaches*

First AC

Fig 6 http://www.indiarail.co.uk/acc1.jpg

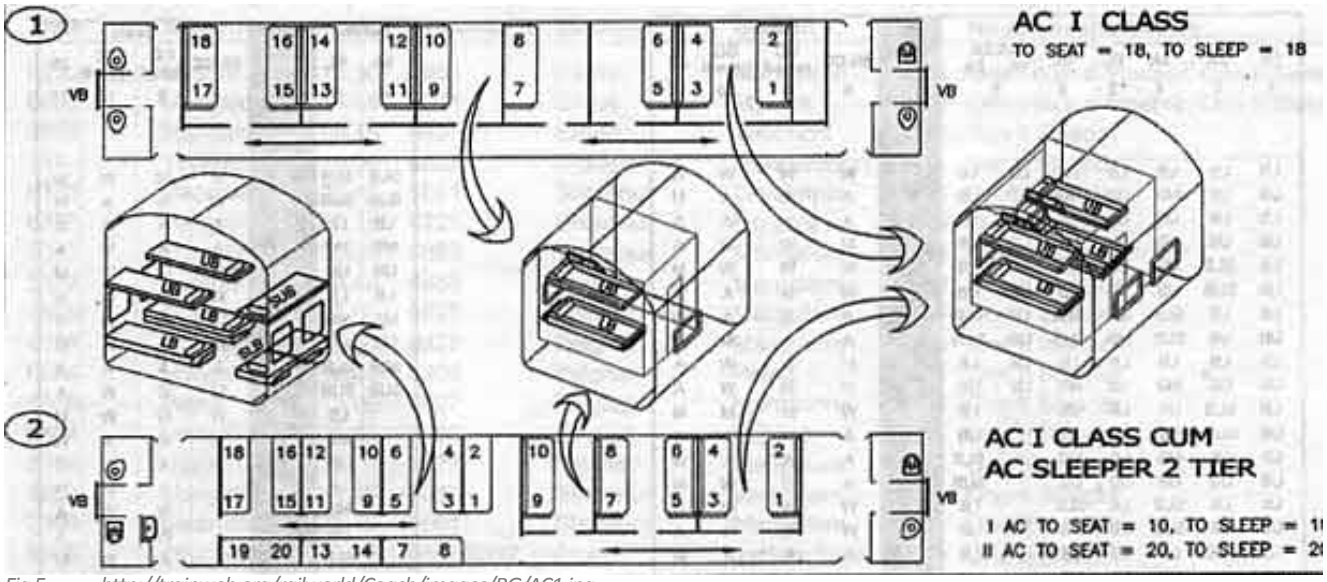

Fig 5 http://trainweb.org/railworld/Coach/images/BG/AC1.jpg

Fig 7 http://img507.imageshack.us/img507/4585/india071109lr8.jpg

Ac 2 tier

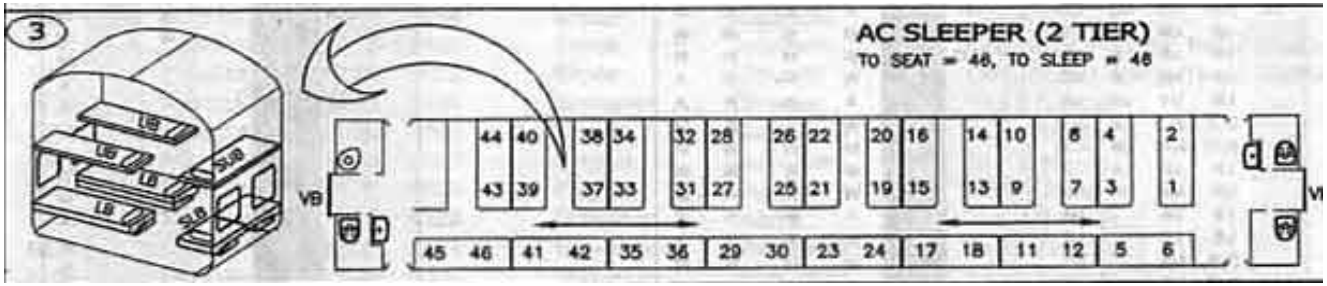

Fig 8 http://trainweb.org/railworld/Coach/images/BG/AC2.jpg

Fig 9 http://blog.theotherhome.com/wp-content/uploads/2012/06/AC-2-tier-coach.jpg

Ac 3 tier

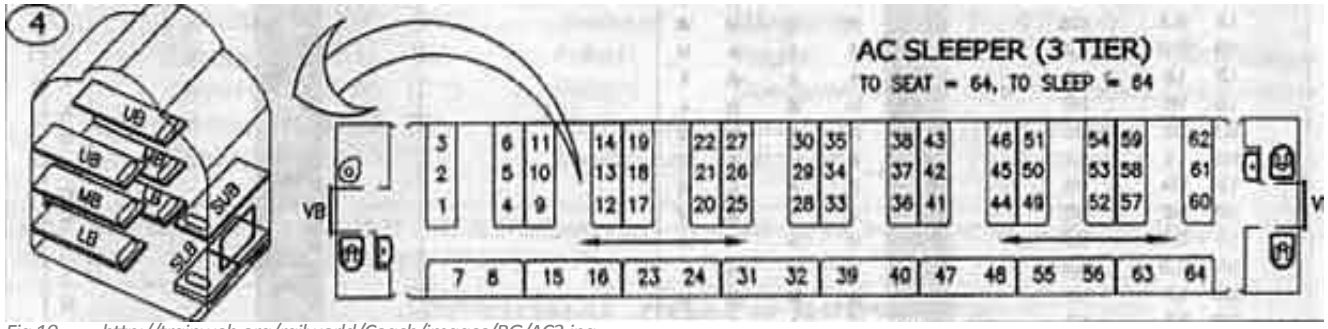

Fig 10 http://trainweb.org/railworld/Coach/images/BG/AC3.jpg

Fig 11 http://www.indiamike.com/files/images/60/32/11/executive-class-in-shatabdi.jpg

Ac executive chair car Shatabdi

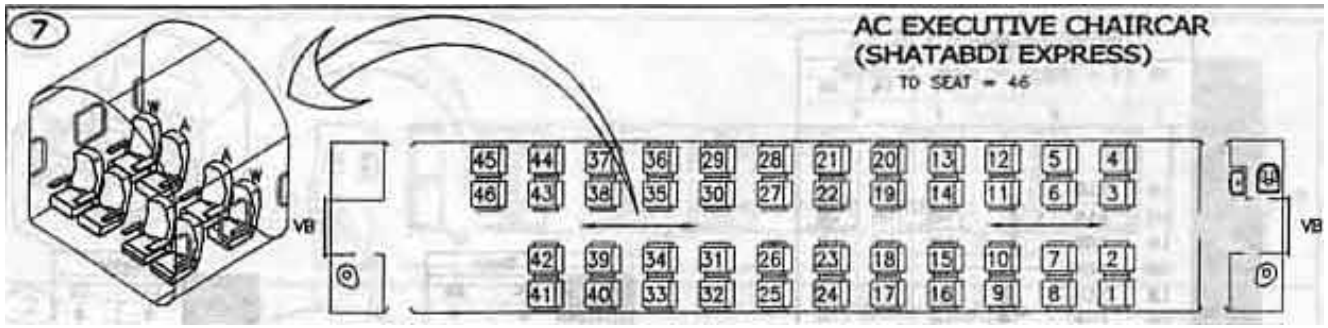

Fig 12 http://trainweb.org/railworld/Coach/images/BG/ECC.jpg

Fig 13 http://goo.gl/BBe5gA

Ac chair car Shatabdi

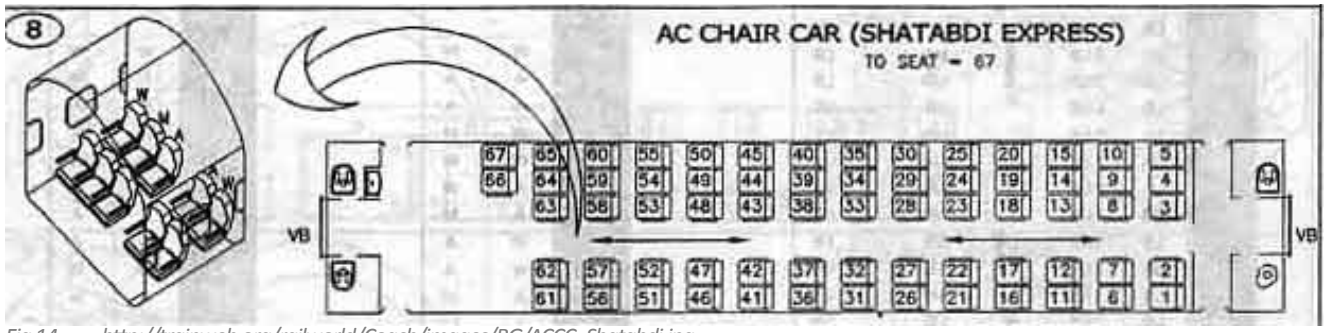

Fig 14 http://trainweb.org/railworld/Coach/images/BG/ACCC_Shatabdi.jpg

Fig 15 http://img693.imageshack.us/img693/3592/gr1.jpg

Ac chair car

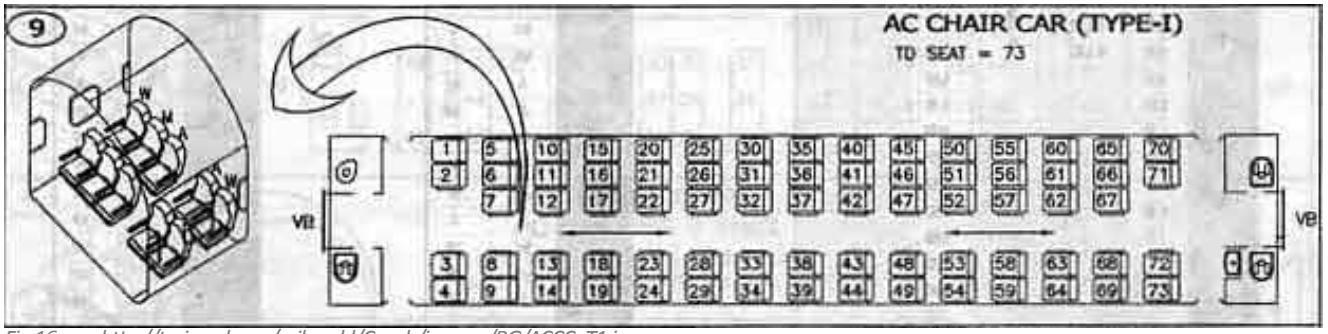

Fig 16 http://trainweb.org/railworld/Coach/images/BG/ACCC_T1.jpg

Fig 17 http://www.indiarail.co.uk/fc.jpg

First class

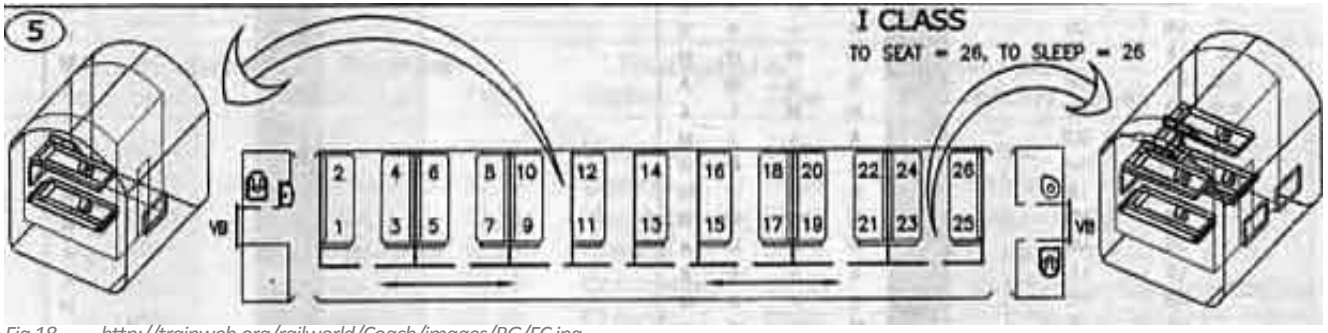

Fig 18 http://trainweb.org/railworld/Coach/images/BG/FC.jpg

Fig 19 http://www.indiamike.com/fckeditor/UserFiles/Image/trainimages/sleeper_class.jpg

Sleeper class

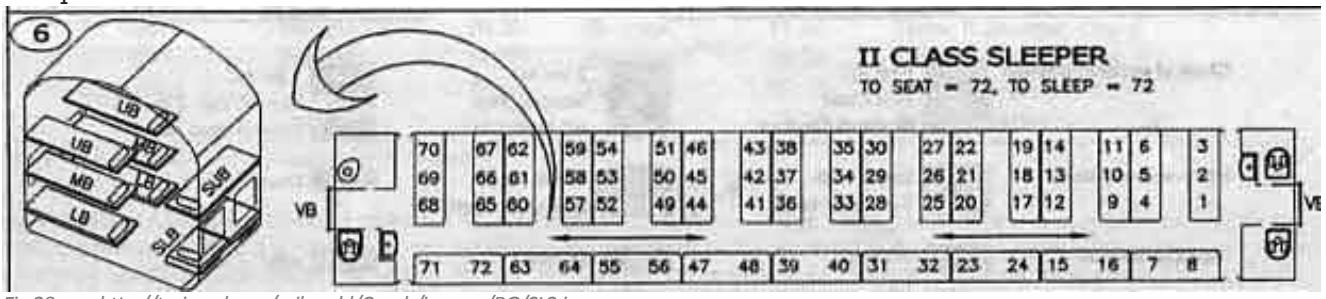

Fig 20 http://trainweb.org/railworld/Coach/images/BG/SL2.jpg

Indian railway scenario

The density of passenger in Indian Rail is not same every time. We can divide this scenario according to some time period.

Types of scenario

Peak hours

Office time.
People working nearby towns.
Some specific business time

Fig 21 http://goo.gl/vX9qHx

Season time

Marriage time
Some Festivals
Vacations

Fig 22 http://ejhobbs.files.wordpress.com/2012/01/india-train.jpg

Off season time

Mid time
No festivals
Exam time

Fig 23 http://i.ytimg.com/vi/bbBUAJWVgho/0.jpg

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High-Speed Passenger Coaches.

Indian Railways is adopting a multipronged strategy to provide safer, faster, cleaner, and more comfortable passenger trains. Seven corridors have been identified for conducting pre-feasibility studies for running high-speed trains (popularly referred to as bullet trains) at speeds above 350 kmph. These corridors will be set up through PPP route. Initially, the Mumbai-Ahmedabad corridor has been taken up for which the pre-feasibility study has been completed. Work is in progress in respect of the remaining corridors. A study is also being done on the Delhi-Mumbai route for raising the speed of passenger trains from 160 kmph to 200 kmph, i.e. for running semi-high speed trains.

The Vision aims at a major augmentation of capacity through doubling and quadrupling of lines in passenger accommodation, complete segregation of passenger and freight lines on High Density Network (HDN) routes. The central theme of the Vision is to prepare the Indian Railways for this Big Leap Forward.

The Railway coaches must set the highest standards of hygiene, sanitation, safety, security and hospitality and yet offer these services at affordable prices. Special attention must be paid to the needs of women, students, elderly and the physically disadvantaged.

(Ankit rastogi 2008)

Change in sleeper coach proposal.

This year he is likely to announce major changes in the interior design of 3-tier sleeper coaches. The figure below –courtesy ABP, Feb 1 – is a schematic of the new design.

According to the proposal the coach will be divided longitudinally into 2 equal halves. Instead of one corridor there will be 2 that will clearly lessen the crowding of passengers.

Windows will be made larger as in Rajdhani Express to give a feel of more space. However these will be alongside berths only. The coaches will have the same dimensions outside, and the number of berths too will remain unchanged.

A couple of disadvantages that come to mind are:

There will be no privacy since there will be no concept of cubicles. Chance of theft of luggage will increase.

If your seat comes on the wrong side of the coach when it stops in a station, it'll be difficult to buy things from the platform while remaining inside. Also, the Indian tradition of 'seeing off' will become difficult in that case.

(BHATTACHARYA 2008)

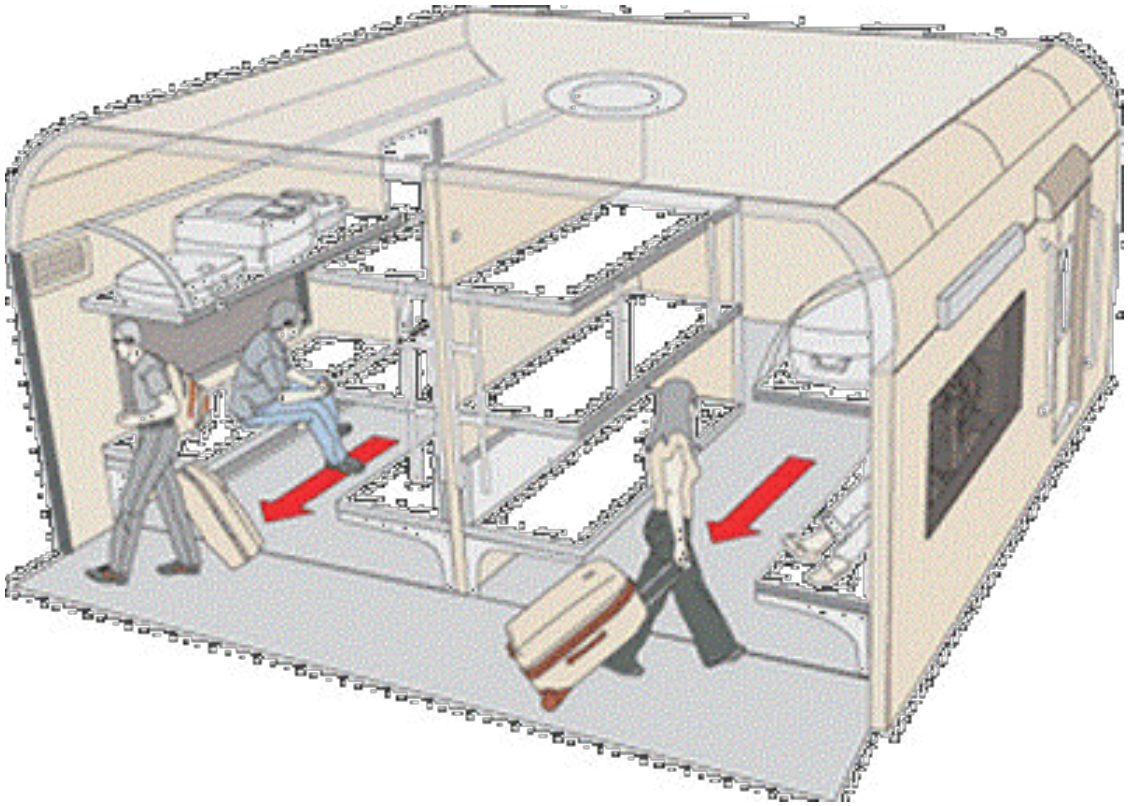


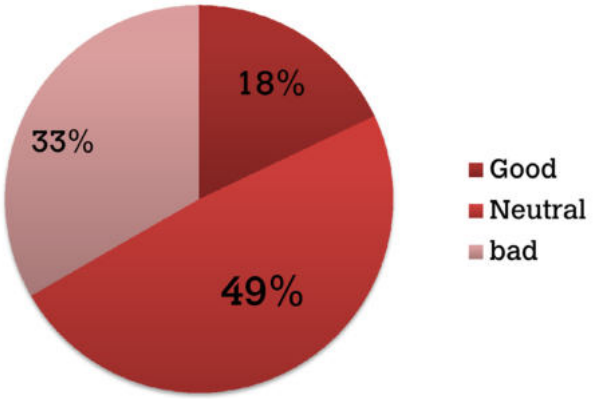
Fig 24 Change in sleeper coach

User study

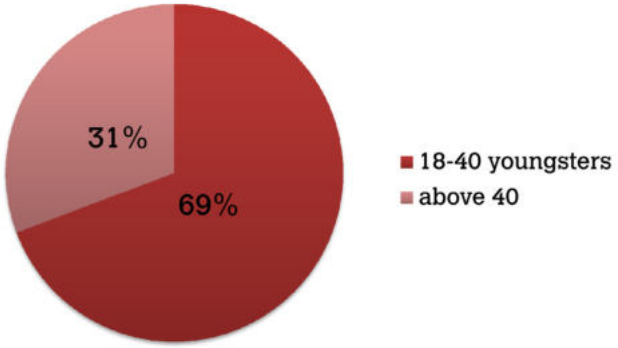
An analytical survey was conducted to observe people what they think about existing sleeper coach and what expectations they have from the new design.

Total 58 users interviewed to get the requirement and understand the problems faced by them. The evaluation and the sorting were also carried out according to their insights from the different background, professions and age groups.

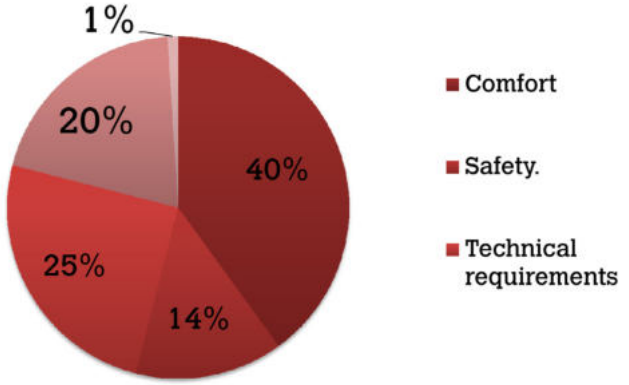
People's judgment on current condition of railway coaches:

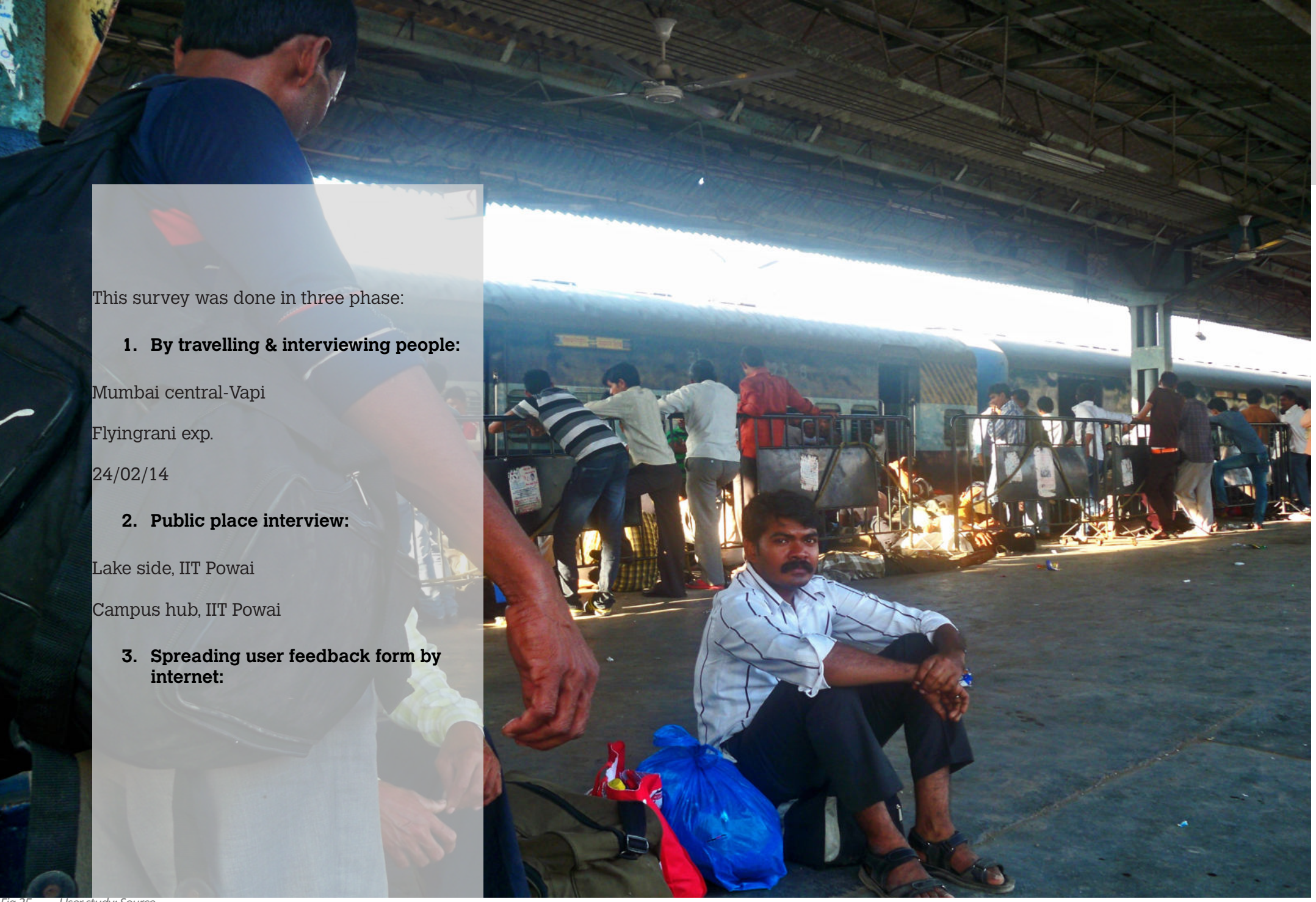


Percentage of people participated in survey according to their age:



Segregation of user aspirations:





This survey was done in three phase:

1. **By travelling & interviewing people:**

Mumbai central-Vapi

Flyingrani exp.

24/02/14

2. **Public place interview:**

Lake side, IIT Powai

Campus hub, IIT Powai

3. **Spreading user feedback form by internet:**

Fig 25 User study: Source

User aspirations & needs

User type 1

Category: Youngsters, students and professionals

Age: 18-30

Purpose of travelling: Home work

Home institute

Vacations

Frequency of travelling: 3-8 times per year

Journey duration: 6-28 hrs.

- Need technology like hi- speed internet.
- Adjustable fans or separate fan for every berth.
- Automatic operated windows.
- Mobile holder charger.
- Cushioned seating.
- Space for mobile holder, charger, spectacles.

Fig 26 Source

- Place for keeping sleepers.
- Color of compartment is very dull and boring.
- No personal reading lights.
- Window closing is very hard.

Fig 27 http://goo.gl/7byJOH

Fig 28 http://www.dealstan.com/wp-content/uploads/2013/05/Mobihold-300x300.jpg

User type 2 (Safety concern type users)

Category: Newly married, family & professionals

Age: 25-45

Purpose of travelling: Holiday trip, ceremony trip, visiting relatives place

Frequency of travelling: 1-4 times per year

Journey duration: 6-20 hrs.

- Luggage safety.
- Safety from windows.
- Outside venders or businessmen should not allow in train.
- Bar codes check system on entry and exit of train.
- Security and alarms.

User type 3 (Comfort)

Category:	Old couples, per son with some medical issues
Age:	40-70
Purpose of travelling:	Heath or medical treatment trip, ceremony trip, visiting relatives place
Frequency of travelling:	1-3 times per year
Journey duration:	6-18 hrs.

- Middle berth owner cannot sleep at daytime.
- The air from fan barely comes through to the lower berth.
- Hard to adjust with Rac berth, length is too short hard to adjust with long people.
- Light from window is very less.
- Ergonomics of the seats can be improved.

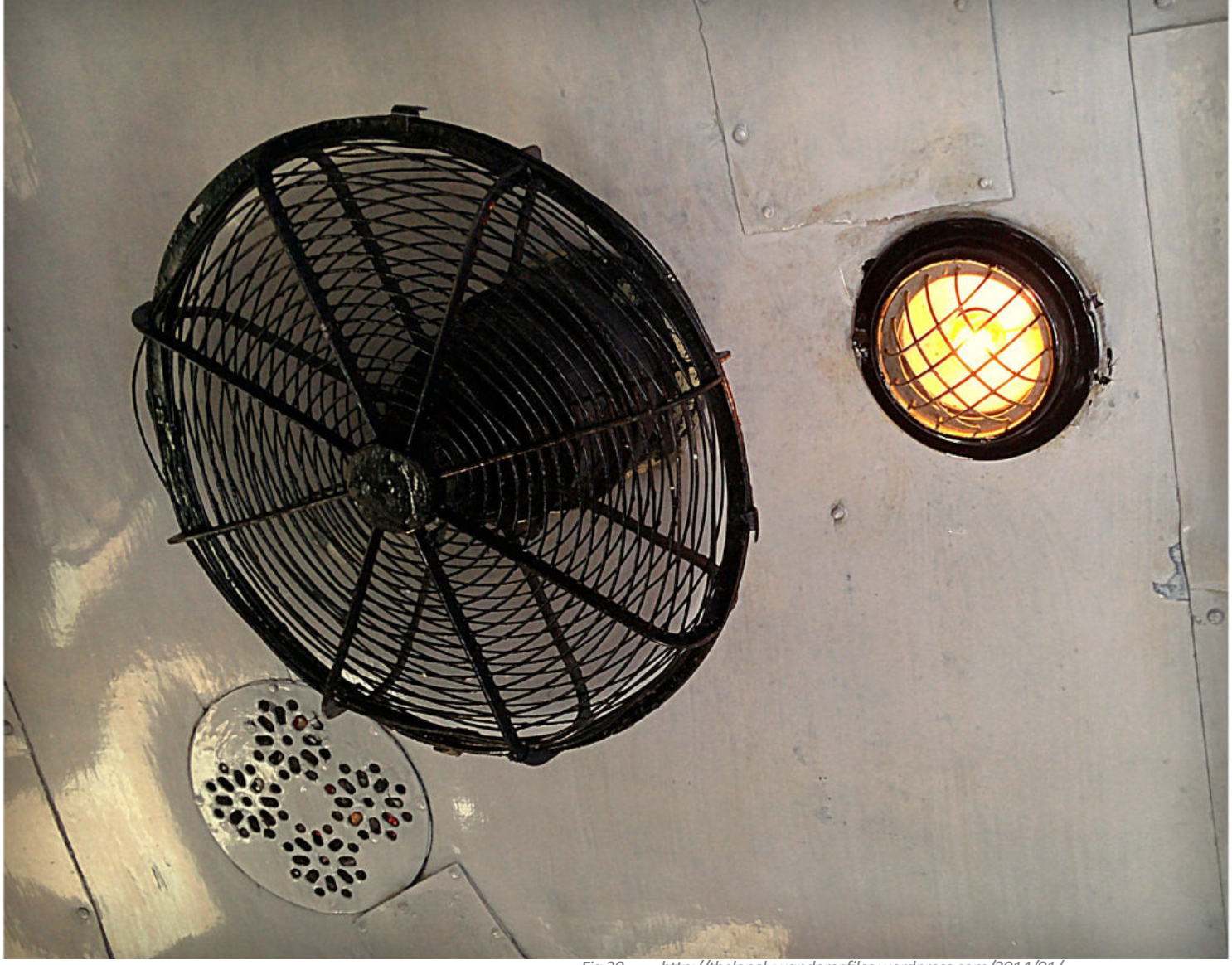


Fig 29 http://thelonelywanderer.files.wordpress.com/2014/01/img_20131207_154220.jpg

- 90 degree backrest is not ergonomic.
- Movement of luggage is troublesome.
- Windows are too small.
- Difficult to climb upper berth.

User type 4 (hygiene and medical)

Category:	People suffering from disease, people generally travels in 1Ac or 2Ac.
Age:	25-70
Purpose of travelling:	Ceremony trip, visiting relatives place & Heath or medical treatment trip
Frequency of travelling:	1-2 times per year
Journey duration:	6-20 hrs.

- Smell from toilet.
- Soiled and oiled seats.
- Plastic and other wastes are thrown outside, so need of waste disposal.
- Should look at international standards.
- Platforms are unsanitary.
- Disturbance from other activities trespassing, food serving people.

Fig 30 *Sourcse*

- Separate washbasin is needed.
- Cockroaches and rats.
- Noise from running train is too high.
- Fabric of seats/berths is bad.

User type (special case)

- One lady was disagreeing to sleep on middle berth, because she was afraid of falling down, because the berth was hanging on two chains only.
- People suffering from late night urinating.
- Some people can't sleep in trains at night.

Novice user

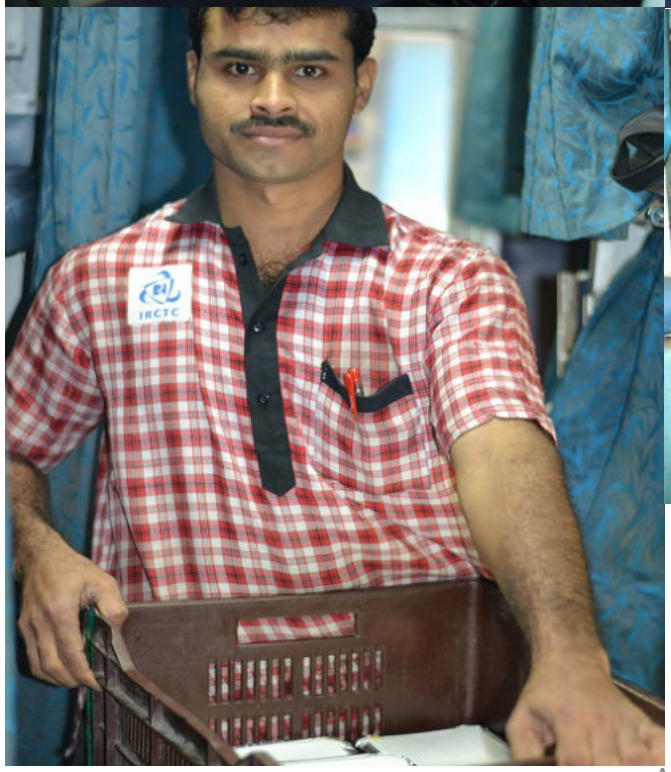
- Do I have to carry pillow and blanket?
- How to deal with theft of baggage?
  How is sleeper toilet? Is it nasty same like general compartment?
  How can I ensure safety of my mom and sister?
- Confusion about berth UB/LB/MB.
- How I can climb the upper berth?
- Confusion about Rac system.
- How to close window.

Fig 31 http://goo.gl/i3VbeP

Fig 32 http://www.gapagap.com/blog/wp-content/uploads/2013/06/train1.jpg

Other issues

- Rush in boarding and alighting trains.
- People standing behind the door create obstacles.
- People carrying lots of luggage cannot enter at one time and the width of the passage is insufficient.
- Movement of the passenger interrupts due to movement of another passenger in opposite direction.
- User prefers keeping the luggage close to them.
- Female passenger does not like to place their hand bag on the hook.
- In absence of space the user keeps his/ her bags on the floor near to his seat.
- The pouch does not easily accommodate newspapers with magazines and water bottles.



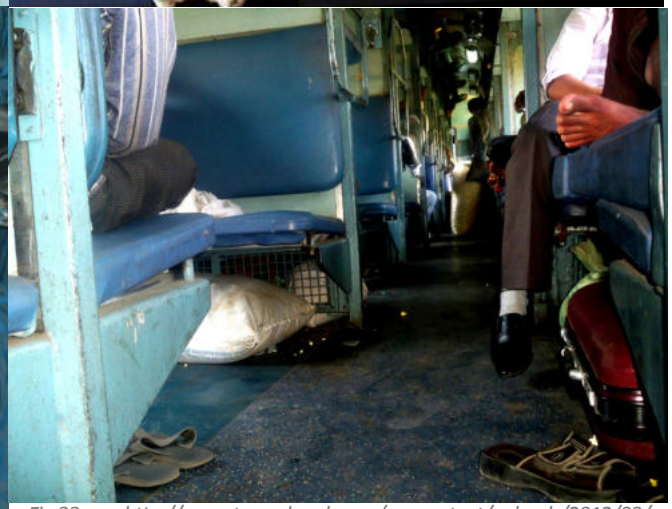


Fig 33 http://www.tomarhawk.com/wp-content/uploads/2012/03/Me-in-Sleeper-Class-Not-the-most-comfortable-bed.jpg
Fig 34 http://www.gotransit.com/public/en/travelling/safety.aspx
Fig 35 http://www.minordiversion.com/wp-content/uploads/2012/01/Train-Biryani-Seller.jpg

Design brief

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The goal

The goal of this project is to design accommodation system which includes seats/berths luggage carrying and accessibility system layout for air cooled coaches of Indian Railways.

Methodology

Data collection

- Scenario categorization
- Study of existing design
- User interview
  - User categorization
  - Inferences
  - Observation
  - Pros & Cons
- Problem findings

Design Brief

- Mood board
- Benchmark product
- Study of parellel product
- Product space

Considerations

- Fire safety norms
- Ergonomic & Anthropometric
- Circulation & flow of passenger
- Materials
- Luggage standards

Analysis

- Task analysis
- Activity analysis
- Error study

Ideations

- Small mechanisms
- Layouting
- Featured ideas

Concept

- Concept categorisation
- Comparison
- Unions
- Alternative approach
  - Mock-ups
  - Scale model
- Concept evaluation

Crafting

- Detailed 3d model
- Dimentional drawing
- Evaluation & testing
- Scale model

Forced air ventilation systems generally take fresh air from the roofspace and mechanically force the air into the home via a diffuser in the ceiling. The moist air within the house is diluted with the increased ventilation and migrates outside through openings in the building envelope. The same concept we are trying to use in railway coaches.

(A R Pollard 2010)

Force ventilated air cooled sleeper coaches.

Forced air or supply only ventilation systems have increased in popularity considerably over the last 10 years and are commonly encountered in new and renovated houses. These systems take fresh air from the roofspace and introduce it into the house. This transfers moisture and heat from the roofspace.

Considerations in Interiors:

- Windows will be fixed with the tinted glass are not openable.
- Temperature will be maintained inside the coach.

Limitations

- This project is limited to sleeper class passenger coaches, and this project is not going to deal with suburban or any other class of Indian Railways.
- This project is done by academic fulfillment and due to limited period of time, mechanical detailing, estimation and cost part cannot be done.
- Design of toilet and other facilities like pantry car, generator coach is not covered in this project.
- Since this is a design project so the chassis and structural shell are not going to consider in this project. The whole design is based on existing shell and chassis.
- Detailing of safety issues like fire safety, emergency door and window, emergency stopping chain etc could not be fetched in this project.

Study of parallel products

Canadian Trains

This is the luxury option. Formerly known as Silver & Blue class (and then briefly Sleeper Touring Class, in Sleeper Plus class you have your own private 2-berth bedroom or 1-berth roomette or 'section' with comfortable beds, the fare includes all meals in the elegant Sleeper Plus class restaurant car, There are several different types of sleeper, all with hot showers at the end of the corridor: but open-plan seats arranged in pairs facing each other each side of the aisle. Curtains are fitted to each bunk for privacy. If you are travelling alone, you will travel in a roomette. This is a very compact single room, just big enough for a large seat with plenty of legroom and a leg-rest with a toilet bowl hidden underneath. There is a washbasin in the corner. At night, a bed folds down from behind the seat, taking up almost all of the roomette. Bedrooms are larger rooms for two people, with separate en suite washroom and toilet. An upper and lower berth converts to seats for daytime use. Bedrooms are the same price per person as a roomette.

A roomette, perhaps the consist room for one person on the rails! Just big enough for one armchair by day with toilet shown here with padded lid closed, washbasin and fold out table. The bed is stored behind the seat, on its end (in the middle picture you can see the handle to lower the bed). At night, the bed folds down and take up most of the compartment - you need to raise it to use the toilet!

(Train travel in Canada... n.d.)

Fig 36 http://www.seat61.com/Canada.htm#.Uxi0Ys6hYZ4

European trains

Who or what is Thello?

Pronounced Tell-O, Thello is a partnership between Trenitalia (Italian Railways) and Veolia, a private transport company, formed to run overnight trains between Paris and Italy.

All passengers on the Thello sleeper train get a sleeping berth in either a proper sleeping-car or more economical couchette car. There are no ordinary seats. The berths convert to seating for evening and morning use. The trains are entirely non-smoking.

A sleeper offers fully-made-up beds in small but cozy private compartments. Each compartment has an upper, middle and lower bed and can be used for single, double or triple occupancy. Each bed comes with a soft pillow and duvet, an individual reading light and its own 220v 2-pin socket for laptops & mobiles. There's a washbasin in the corner and each passenger gets a towel, a small bottle of mineral water and a complimentary toiletries pack containing soap, toothbrush & toothpaste, mouthwash, disposable slippers and (if you really feel you need them) ear-plugs. There are toilets at the end of the corridor which will be unlocked shortly after departure. For the evening & morning part of the journey, the beds fold away to form a private sitting room with sofa. The seat back of the middle part of the sofa lowers to form a table if you need one. There's room for luggage on the rack above the window and in the big recess above the door projecting over the corridor ceiling. The compartment doors have a security deadlock that cannot be opened from outside. Sleepers are ideal for couples or business travelers, but beds are sold individually so passengers travelling alone may book one bed in a 2 or 3-bed compartment and share with other civilized sleeper passengers of the same sex.

(Paris to Italy by Thello train . . . n.d.)

Fig 37 http://www.seat61.com/thello-train-from-paris-to-italy.htm#.Uxiyys6hYZ4

Fig 38 http://www.seat61.com/thello-train-from-paris-to-italy.htm#.Uxiyys6hYZ4

Thailand trains

In 1st class sleepers berths are not in compartments, but are arranged 'open plan' either side of a central aisle. During the evening and morning part of the journey, pairs of seats face each other on each side of the aisle. At night, each pair of seats pulls together to form the bottom bunk and an upper bunk folds out from the wall. Curtains which are provided for each bunk to give you privacy (see how he does this in the video below!).

Fig 39 http://www.seat61.com/Thailand.htm#.UxirQs6hYZ5

Fig 40 http://www.seat61.com/Thailand.htm#.UxirQs6hYZ5

2nd class sleepers come in both air-conditioned and non-air-conditioned varieties, with the air-con ones usually being cleaner and more modern, but the non-a/c ones offering windows that open, better for photography. The fare for an upper berth is a fraction cheaper, but the upper bunks tend to be narrower. There's plenty of luggage room, take a bike lock if you want to chain up your luggage for peace of mind. Security is not a problem, it's a great way to travel which saves time even compared to flying, and saves a hotel bill too. Upper berths are fine for anyone up to 6' 2" tall; if you're taller than that you should choose a lower berth as these are significantly wider, allowing tall people to sleep comfortably on the diagonal.

(Train travel in Thailand n.d.)

Anubhuti coach

Anubhuti coach is a luxury LHB coach belonging to Indian Railways. These coaches will progressively be introduced on the Shatabdi and Rajdhani Express trains.

The new Anubhuti coaches may be rolled out from the rail coach factory in Rae Bareli, the constituency of the UPA Chairperson Sonia Gandhi. This is a proposal under the consideration of the Railway Ministry. Another option is to have such coaches manufactured at each of the coach factories, including Rail Coach Factory, Kapurthala and Integrated Coach Factory, Chennai.

Interiors

The new proposed coaches of the Indian Railways with better interiors — termed as Anubhuti or experience — may be priced about 40 per cent higher than the AC chair car. These coaches will have about 50 seats in one coach as against 56 in the executive class coaches. The interiors have been specifically designed to provide a pleasing ambience.

Improved facilities

"They would have much better interiors, more space for a person, improved lighting, upgraded toilets, automatic opening and closing of internal doors, roller blinds as curtains, LCD video screen, amongst others. Anubhuti, the first of its kind modern LHB coach with ergonomically designed cushioned seats.

Shatabdi trains

The plan is to place one Anubhuti coach in each of the Shatabdi trains that ply on a range of about 400 km, with a travel time of four-six hours. The Executive Chair Car coaches cost about Rs. 2.5 crore. These coaches will cost another Rs. 30-40 lakh extra.

Mock-ups

Coach interiors of Anubhuti would be on the lines of mocks designed by West Central Railway Coach Rehab Workshop, Bhopal, for other coaches. The mock-ups of improved chair car, AC 2 tier, and AC 3-tier coaches were at the coach care centre near New Delhi Railway Station. Two Vadodara-based vendors — Kemrock Industries and Exports and Hindustan Fibre Glass Works — have supplied raw

Fig 41 http://www.thehindubusinessline.com/industry-and-economy/logistics/anubhuti-rail-coaches-may-roll-out-from-rae-bareli/article4472211.ece

material for the new coaches. Mock models of Anubhuti coaches have not been designed yet, said Railway officials. Design specifications of the AC luxury class 'Anubhuti' coaches, first of which is likely to be included in the Chandigarh Shatabdi train, are being finalized at Integrated Coach Factory (ICF) in Chennai. The prototype of the special coach proposed in this year's Rail Budget to provide high-level comfort to travelers, will be ready in the current financial year, a senior railway ministry official said. Adding more luxury reuters It has been proposed to keep the fare 60 percent higher than the prevailing executive chair car in Shatabdi trains. Anubhuti, the first of its kind modern LHB coach with ergonomically designed cushioned seats, LCD screens, modular toilets and world class interiors is estimated to cost about Rs 3.25 crore, Rs 60 lakh more than the regular LHB coach. There will be a total 56 seats in the Anubhuti coach, similar to the capacity of existing executive chair car, according to the finalized design.

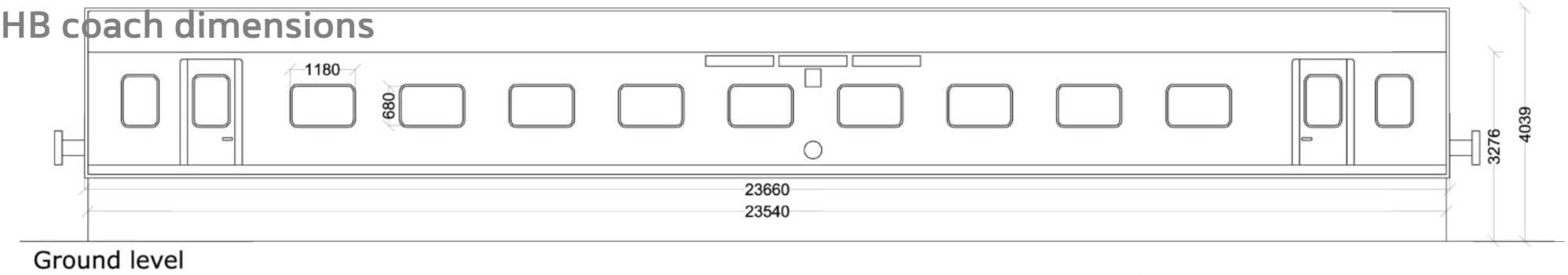
(Anubhuti rail coaches may roll out from Rae Bareli 2012)

(Railways ready luxury Anubhuti coach design for Shatabdis 2013)

Fig 42 http://www.thehindubusinessline.com/industry-and-economy/logistics/anubhuti-rail-coaches-may-roll-out-from-rae-bareli/article4472211.ece

Product benchmarking

LHB coach dimensions



Features of LHB coaches

- Designed for an operating speed up to 160 km/h and tested up to 180 km/h.
- Anti-telescopic.
- Crashworthy design.
- Improved suspension system ensuring more riding comfort for the passengers.
- Microprocessor controlled high capacity air conditioning system.
- The automatic center buffer coupler (AAR tight lock type CBC).
- CBC coupler has a support frame which is providing an anti-climbing protection in case of accidents. The coupler can be opened from the side by a lever.

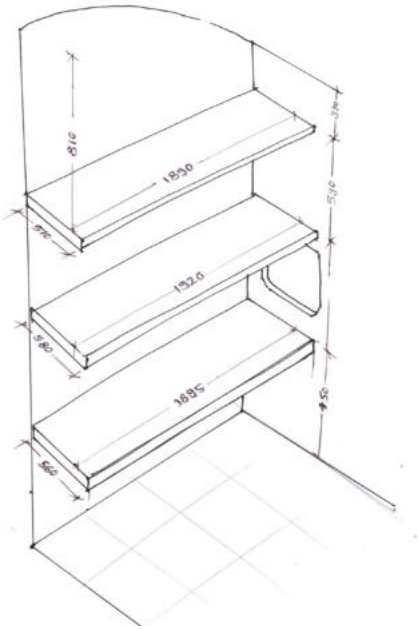
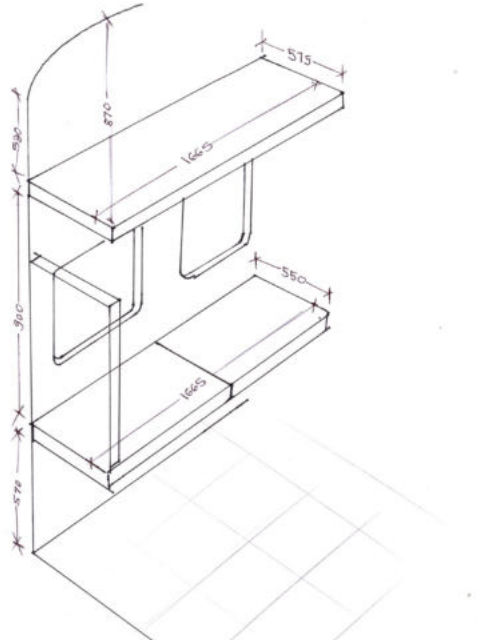


Fig 43 Source

- The design allows also the use of screw coupler instead of center buffer coupler.



- Stronger bogie -body connection and intra-bogie connection.

(wikipedia n.d.)

Basic parameters

SN	Description	Parameters
1	No of passenger to sit/Sleep	72
2	Door aside	02
3	No of lavatories	04
4	No of passenger per door	18 Nos.
5	No of passenger per lavatories	18 Nos.
6	Length over body	23540 mm
7	Length over CBC	24000 mm
8	Height of the coach from rail level	4039 mm
9	Maximum widths over body	3240 mm
10	Width of central passage	600 mm
11	Width of side passage	540 mm
12	Total circulation area	30316462 sq mm

Sn.	Description	Size (mm x mm)	Area	Nos.	Total area (sq mm)
1	Side lower	1810X575	1040750	9	9366750
2	Side upper	1810X575	1040750	9	9366750
3	Lower	635X1865	1184275	18	21316950
4	Middle	635X1865	1184275	18	21316950
5	Upper	635X1865	1184275	18	21316950
	Total area in seating				82684350

Fig 44 http://farm9.static.flickr.com/8192/8099646563_e46ecbc338_m.jpg

Fig 45 http://farm9.staticflickr.com/8468/8130951867_b4e82b7efa_z.jpg

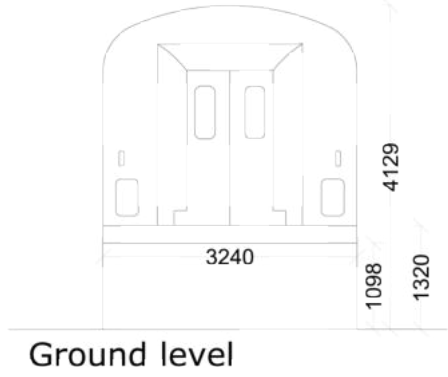


Fig 46 source

Accommodation system seat/berth layout for force ventilated air cooled coaches Indian Railways

Product space

Existing product space

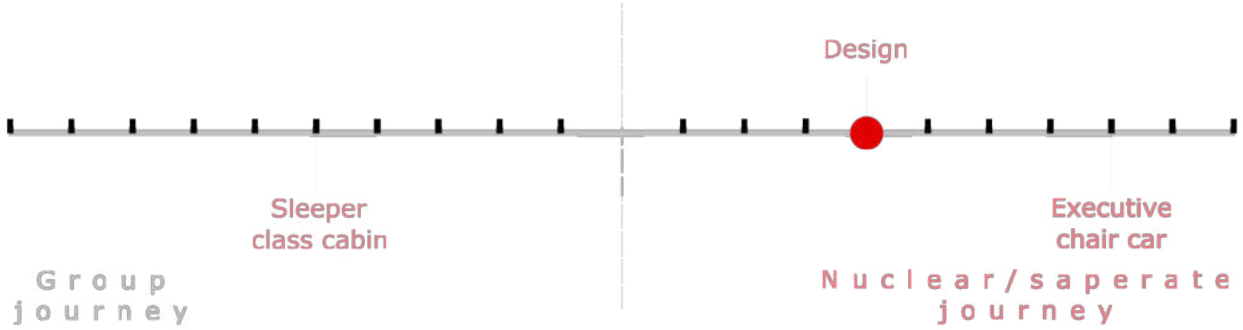


Fig 47 Existing product space

Group journey **Cabin system**	**Nuclear/ Separate journey** **Chair car system**
• Security level is high. • Best for family & picnic trip. • Interaction level is high. • Privacy level is low. • Activity of other passenger disturbs another. • Dependency on other passenger's activity.	• Less security. • Hard to adjust for families and groups. • Interaction level is low. • Privacy level is high. • Activity of other passenger doesn't effect. • Less dependency on other passenger's activity.

Graph Shows the product placement in various aspects and also the position of the existing product in same aspect.

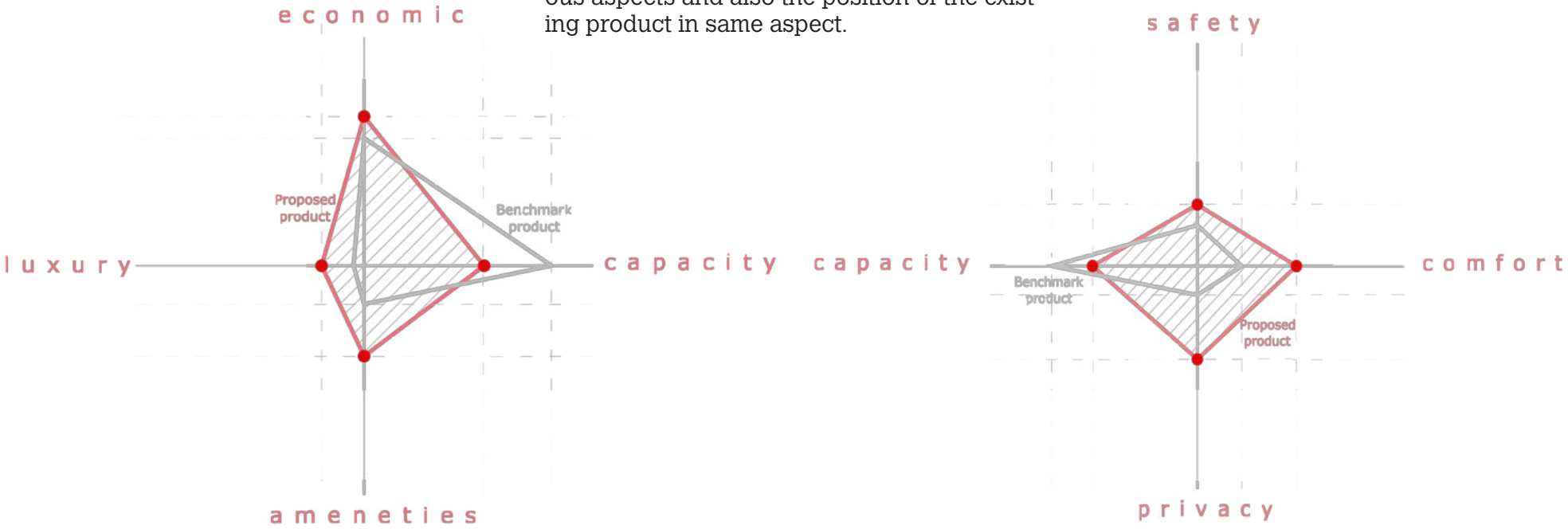


Fig 48 Product space

The graph shows the relation between comfort and the capacity, in Indian Railway coach scenario

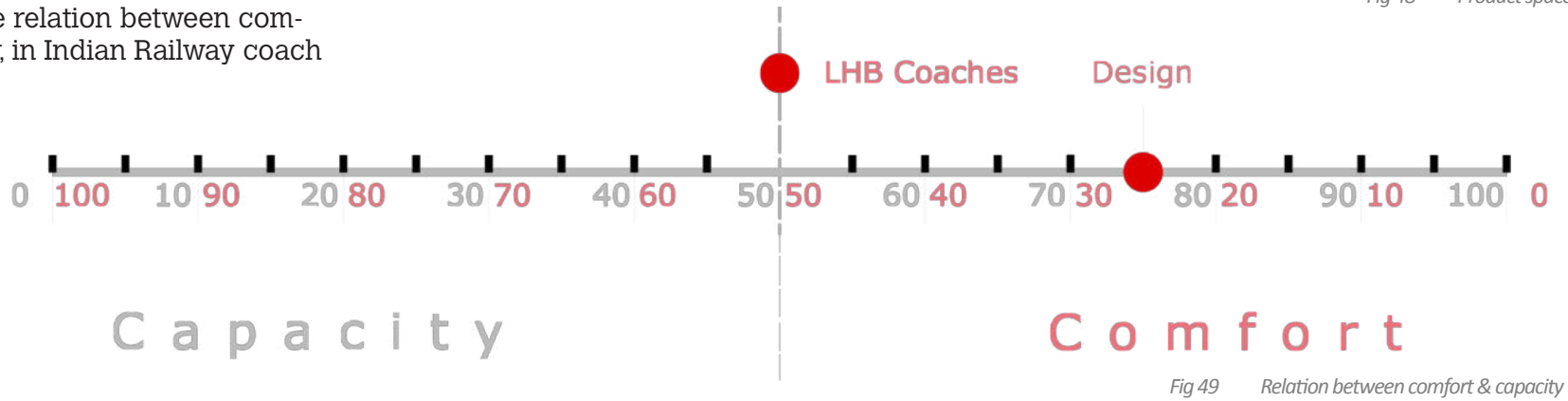


Fig 49 Relation between comfort & capacity

Target issues

Comfort

Railway vehicles provide a range of more comfortable facilities compared to the other means of passenger transportation in respect to the ability of performing sedentary activities like reading, writing, etc. Facilities that are commonly seen in railway passenger cabins are tables, spacious seats, pantry cars, toilets, etc. As a consequence, many passengers particularly choose the railway to be able to work while travelling. Several factors influence discomfort in relation to passenger activities, e.g. seat design, seated posture, use of backrest, etc, Passengers usually adopt their posture to attenuate the intensity of vibrations and jerks in order to perform their activities satisfactorily. There are, however, limitations in the seating place since the space and accommodation to the human body is higher if a passenger uses armrest, backrest or places both feet on the floor.

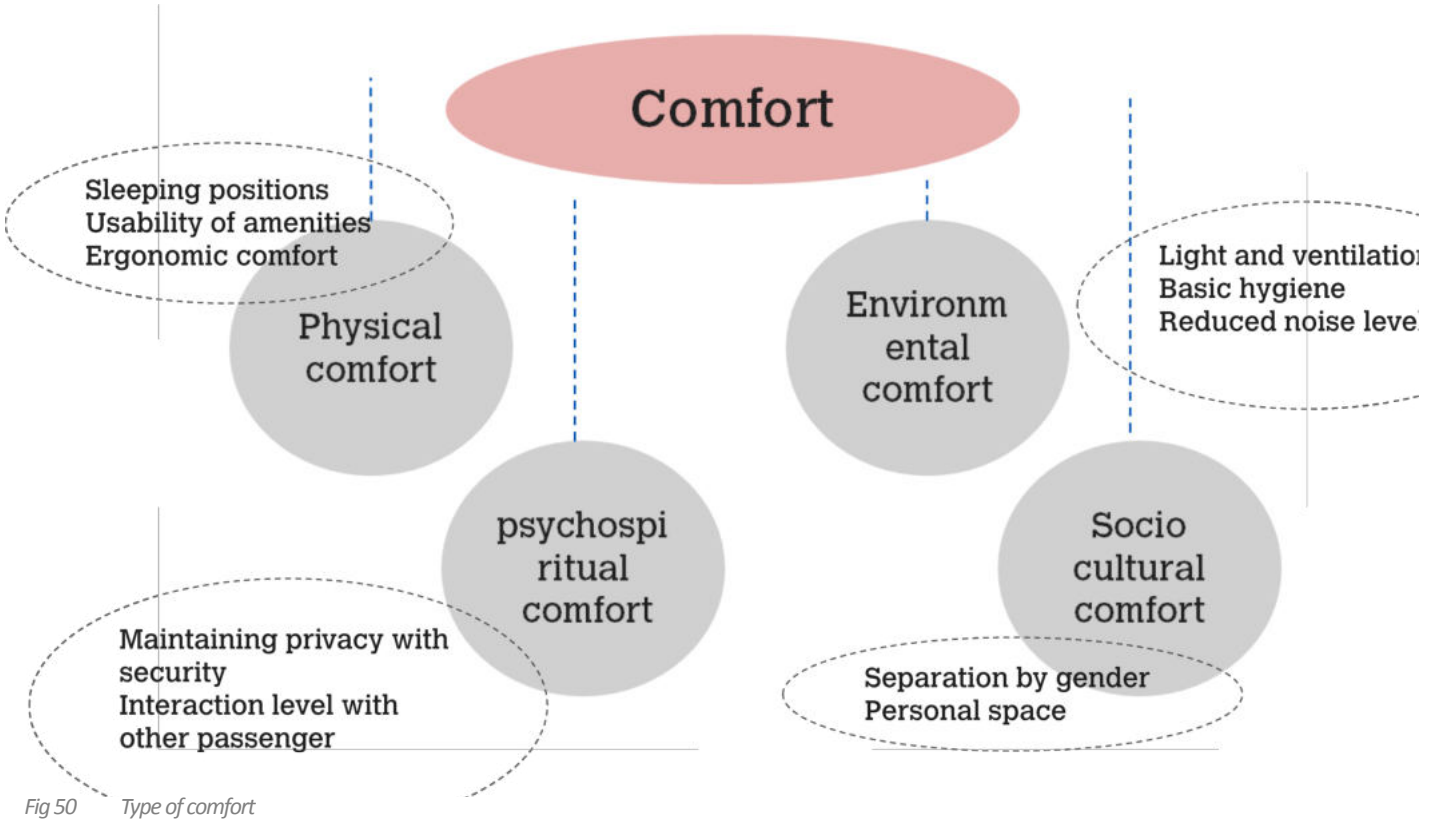


Fig 50 *Type of comfort*

The **comfort zone** is a behavioral state within which a person operates in an anxiety-neutral condition, using a limited set of behaviors to deliver a steady level of performance, usually without a sense of risk. A person's personality can be described by his or her comfort zones. A comfort zone is a type of mental conditioning that causes a person to create and operate mental boundaries. Such boundaries create an unfounded sense of security.

(Comfort zone n.d.)

Privacy

Privacy is severely lacking due to the open plan nature of the compartments. If beds are stacked vertically in two tiers on either side the compartments, It would add benefit of privacy and this class of accommodation is quite devoid of any interaction. The beds located along the aisle outside the main compartments (referred to as 'side berths') also offer a bit more personal space, and are less claustrophobic. However, they are enclosed at both ends. Anyone who values their privacy has not to share a compartment with anyone.

Passage width

The layout of passage and seats provides a significant impact on vehicle capacity and comfort. Seat layout need to be designed for optimum dwell time requirements while sufficient seating is essential to provide reasonable comfort for a majority of longer distance passengers. Passage should be designed to reduce the impact of the obstruction to access caused by passengers standing against the draught screen. It also reduces the evacuation time during disaster. In coaches width of the passage is too short so people cannot cross each other with luggage, it creates trouble during boarding and alighting trains.

Problems with the side berths

The berths placed vertically along the coach are side berths (side upper & side lower), not have enough length to accommodate people having more height than 5'9".

Problems with the middle berth

Owner of middle berth have to share its space with other people. Middle berth owner has reserved seat and if he/she want to sleep in the afternoon, but no, that is inconvenient because people want to sit, so you have to wait for others' approval. If mutually acceptable then owner can sleep anytime. It is also inaccessible for old, fat and long people.

Dependency of passenger activities

Sometimes passenger has to depend on other passenger's activity. (e.g. If a passenger having food so others have to wait till he/ she finishes). An activity of a passenger disturbs the privacy of others. (e.g. people travelling with toddler, people with some medical issues, fat people etc.)

Fig 51 Source
Fig 52 Source

Anthropometric consideration

Sn.	Description	Dimension(mm)					
		5th %tile	50%tile	95%tile	Extra (+,-)	Total	Existing
1	Length of berth (a)						
	Male	1537	1648	1781	60	1841	1865
	Female	1429	1517	1632			
	Combined	1439	1619	1771			
2	Width of berth (b)						
	Male	415	503	619	1	620	610
	Female	391	469	599			
	Combined	405	494	619			
3	Height of berth from foot rest ©						
	Male	380	425	471	25	450	450
	Female	365	399	441			
	Combined	374	419	466			
4	Height of back rest (d)						
	Male	566	616	670	30	700	
	Female	512	555	601			
	Combined	531	605	667			
5	Breath of seat (e)						
	Male	399	455	512	95	550	combined

	Female	384	439	494			
	Combined	394	451	509			
6	Head room (f)						
	Male	759	837	905	100	1005	900
	Female	713	774	834			
	Combined	738	824	901			

(Chakrabarti n.d.)

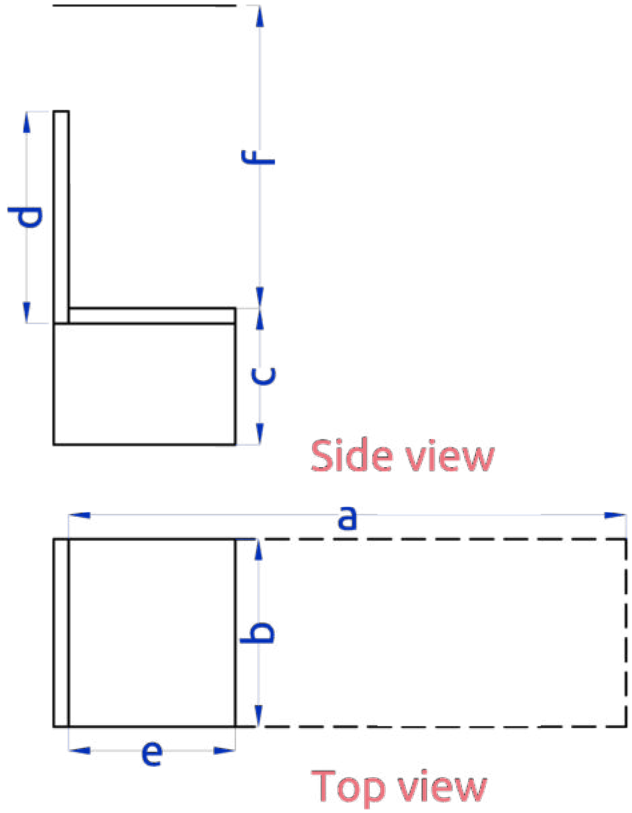


Fig 53 Layout of seat.

Ergonomic consideration

Sleeping Posture

Since the average person spends about a third of his/her journey in sleeping, bed posture is as important as standing or sitting posture. Passenger's sleeping position, bed, and use of pillows, all determine the bed posture.

Sleeping Position:

- Pressure on the back varies with sleeping position. Sleeping on the back produces the least amount of pressure, followed by sleeping on your side. Stomach sleeping is the most stressful sleeping position. Sleep on your back or side rather than your stomach whenever possible.
- Use pillows under the neck and knees if passenger sleep on the back.
- Side sleepers should use pillows between their ear and the bed and between their knees to maintain spine alignment. The top leg should be even with, or slightly behind the bottom leg, with both knees bent.
- Use of small pillow to keep head in a neutral or aligned position when sleeping on stomach.

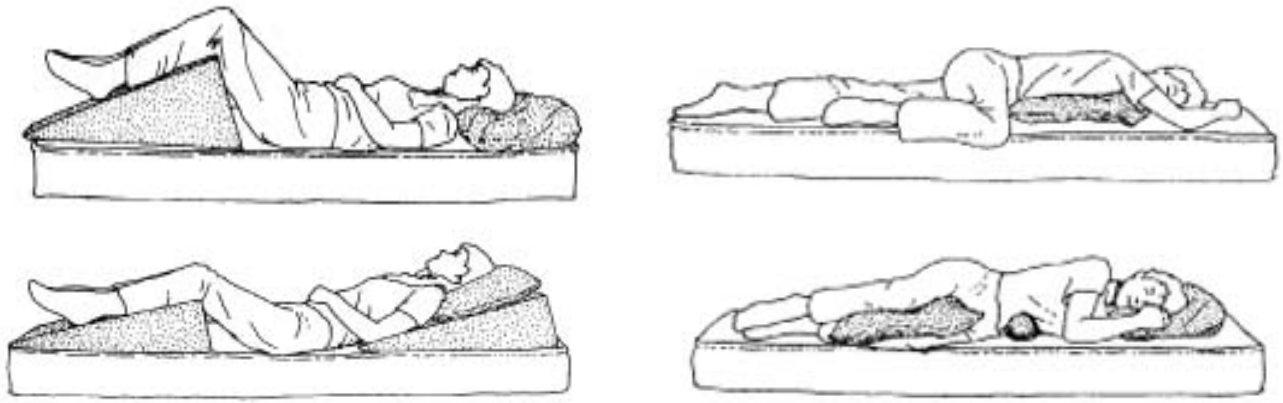


Fig 54 http://www.backdesigns.com/images/Learn/Sleep/sleep_positions.JPG

- Lying horizontally, rather than at an angle, makes for better sleep by relieving pressure on some body parts. It also lets people sleep on their sides or stomach in more natural positions.

Bed Design:

- The cushion of berth firm enough to provide good back support and alignment. Stomach sleepers require firmer mattresses than back or side sleepers.
- This design has an egg-carton appearance and feels soft but resilient to touch.

(144)

Pillow

An ergonomic pillow is designed to accommodate the user's sleeping position and to minimize any associated tension that may result from prolonged time spent in one position.Pillows are used for sleep, although some are used for lower back support while sitting. *(Burkhart n.d.)*

Luggage analysis

Total 32 users interviewed to get their requirement and understand problems faced by them. The evaluation of different criteria and data about luggage were carried out by different background and profession of people.

Different type of bags were divided into three groups (1, 2 and 3)and analyze what type of bag people generally carries during travelling, and average luggage quantity per person carried out in this survey.

Types of luggage bag	Usability (%)
Air bag/duffle bag	23
Trolley bag	19
Ruck sacks	13
Laptop bags	12
Brief case	7
Cartons	3
Plastic bags	23
	100

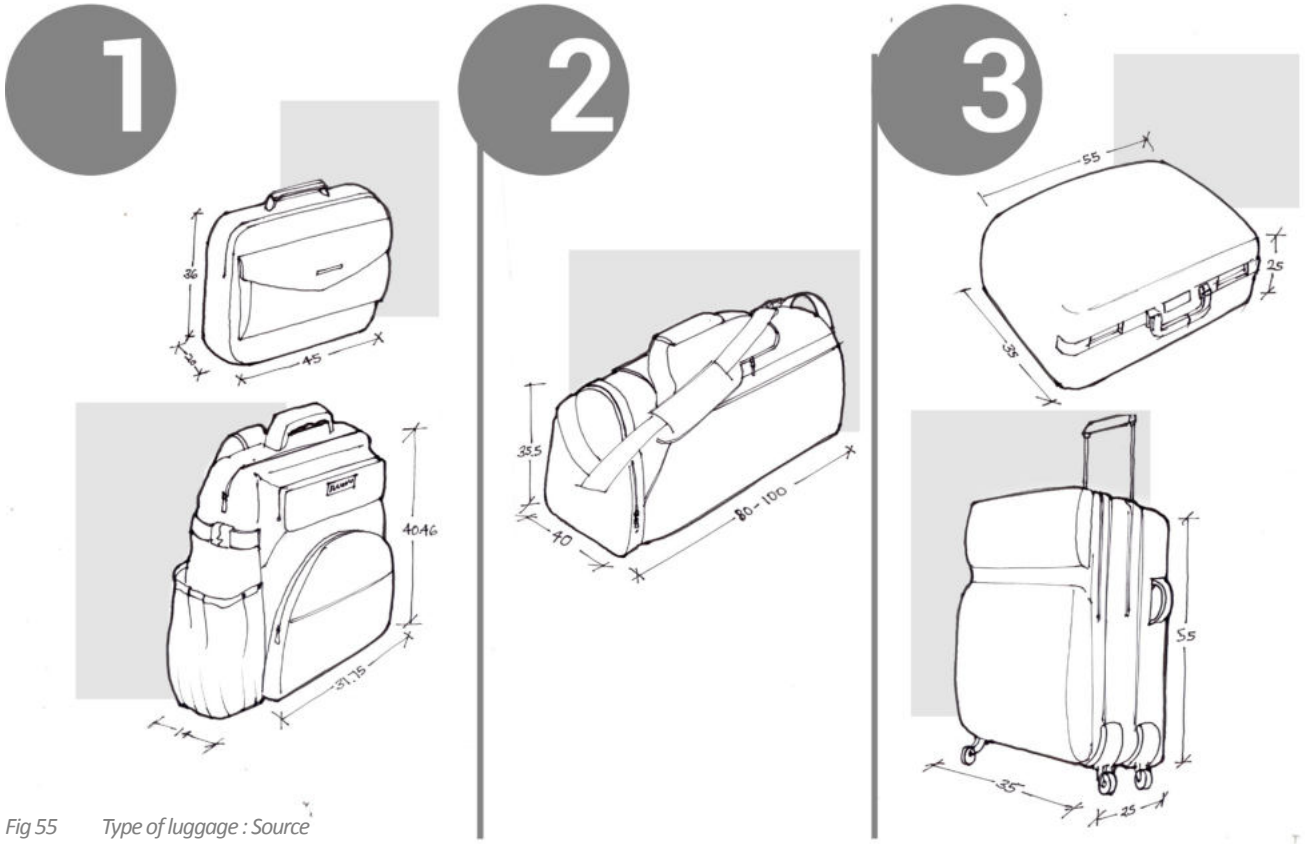


Fig 55 Type of luggage : Source

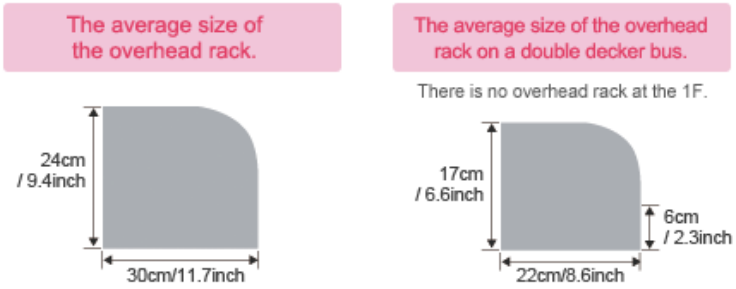


Fig 56 http://willerexpress.com/x/bus/dynamic/3/en/html/pc/departure/img/baggage/i_rack.gif

The rack in sleeper coach is 53cm wide; a 28" luggage can be placed on it

The closet in some sleeper compartment has smaller space than a rack.

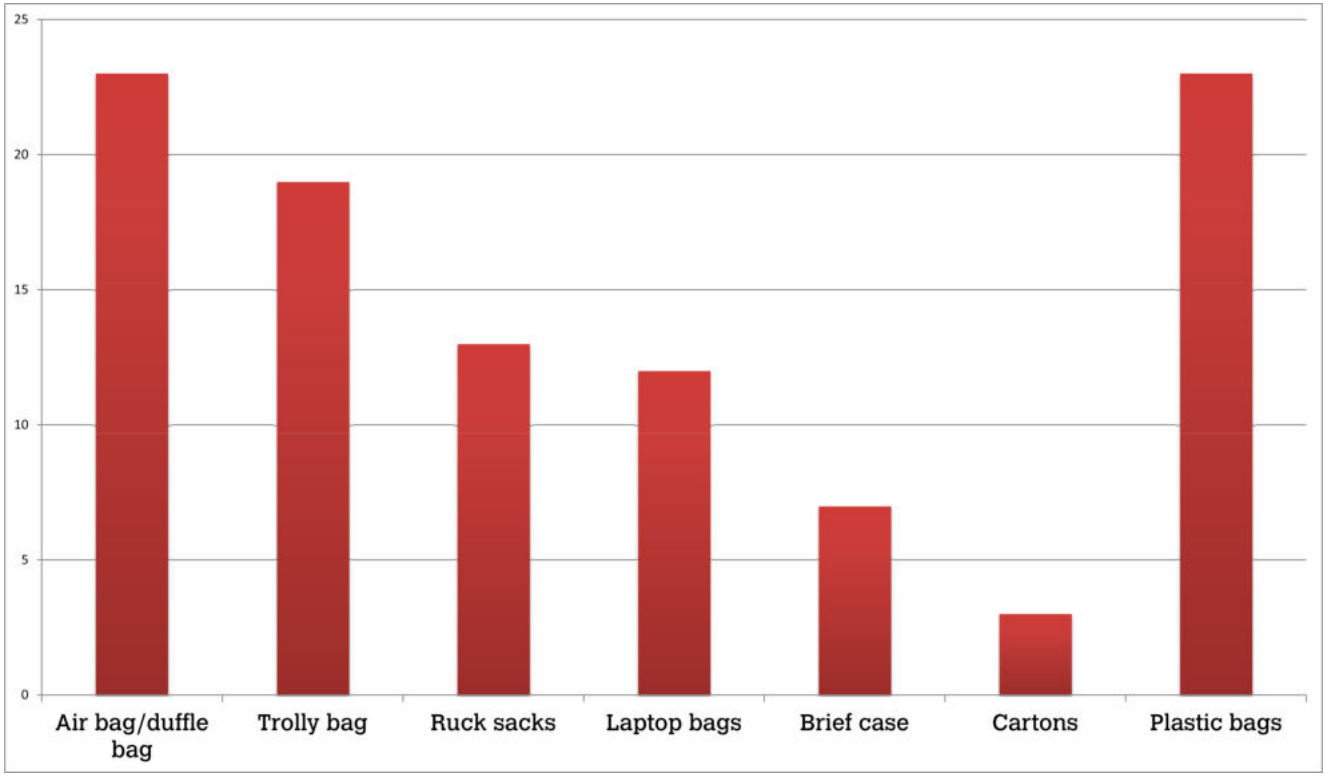


Fig 57 Usage graph of luggage

International standard luggage with the linear dimensions within158cm(length:67cm, width:63cm, height: 28 cm) almost take the whole aisle between two berths.

Activity analysis

Upper beth analysis

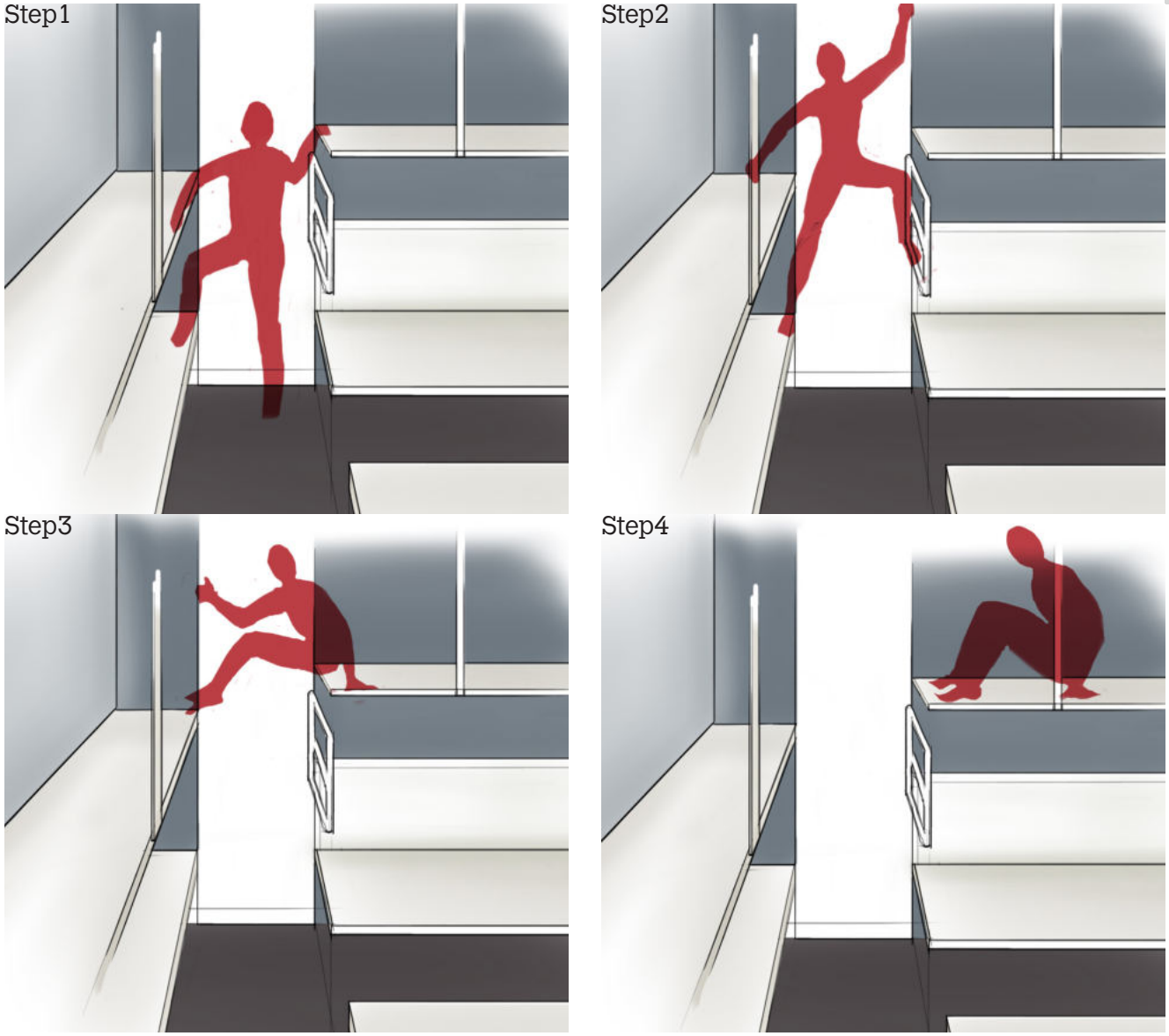


Fig 58 Action analysis of upper berth

Middle berth analysis

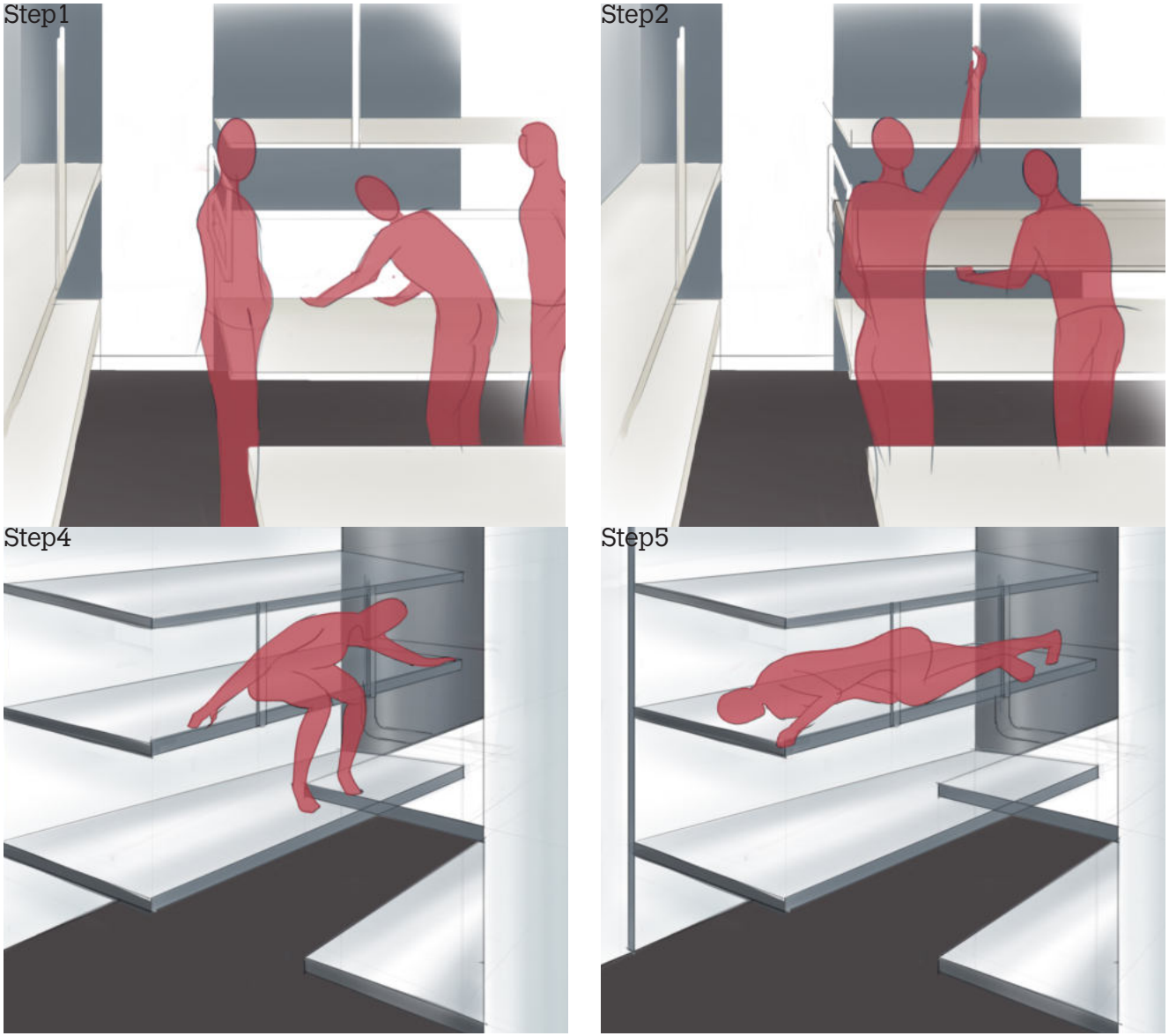


Fig 59 Action analysis of middle berth:Source

Activity	Tasks	Error
seating and chatting	Listening music	Other people makes disturbance.
	Playing cards	Block space from other people.
	watching movies/ working	Need table to put laptop. Need to take laptop on our thies.
sleeping	Placing luggage and locking.	Setting up other's luggage before setting our luggage.
	Taking off footwear	Footwear might get stolen/ lost.
	Spreading of bed sheet on berth	Cannot fix properly.
	Placing the pillow if it is there	
Eating	Cleaning of space	Sometimes food got stuck on seat.
	washing hands	Some people wash their hands on window.
	spreading newspaper	News paper runs away sometimes.
	taking out food and water bottle	
	Having food	Food fall down, neighbor passenger might get disturbs.
	Disposing waste food	
	Cleaning of space	
	washing hands	

Buying foods and stuffs		Not easy to find wallet.
Cleaning and maintenance	Dry cleaning of floor	cleaning small & narrow spaces is very hard
	Cleaning with finail	
pregnant ladies		Hard to find a private space.
		Special care from crowd.
		Prefer to seat from back support.
Patients	Seating.	Noise.
	Sleeping	Maximum sleeping time.
	Boarding & alighting train	less space in passage to support patient.
	Need a person for help.	
Toddler	seating beside window	They lick windows & hygiene issue.
	Crying	Runs all over the corridor.
	Roaming and playing on berths and floor	Danger from falling from upper berth.
	Playing with toys	Try to put their finger in fans.

Ideation

Design insights

Observation	Insight	Design Idea
Luggage		
Luggage on top rack is accessible	Height of most of the Indian users is not considered in existing design	Luggage rack could be lowered for access.
		Floor could be stepped up from aisle level.
Passenger prefers to keep luggage close to them.	Security of luggage is upmost importance.	Semi transparent material can be used for storage of luggage.
	Passenger prefers luggage visibility while seated during the journey hours for assurance.	Can be stored on floor.
Middle berth passenger.	Cannot sleep at daytime	Each passenger can have their own private space and need not to share berth or seating with any person.
Ergonomic seating	Present seating condition is not ergonomic.	Inclined seating with adequate cushioning.
Headrest		
Different comfort level for every person.	In India people belongs from various places and their comfort level also varies accordingly.	Individually operated cooling control.
		Ambient light can be defused
User amenities		

Waste disposal	Waste generally thrown from window or on the floor	Waste disposal system can be incorporate.
Place for storing mobile phone, laptops, spectacles, charger, wallet, headset, etc small thing.	Personal luggage space with security.	Some small storage space can be given nearby seat.
PA systems for information.	Passengers are anxious to know about the details before approaching the destination.	Next station, stoppage time, Left time to arrive.
Seat number identification is very poor.		
Emotional, Aesthetic & Psychological aspect		
Factors of cold touch in most of the elements.	Too much use of metal which creates problem in cold touch.	New materials and design in plastic.
Passengers are unaware of amenities provided or don't know how to use them.	Visual positioning of user amenities is lacking.	Design of amenities should be intuitive.
	Passenger may feel hesitant to use unknown or alien features in new surroundings.	Should be visually coded to identify position of use.
Unhygienic conditions	Little time in maintenance of coaches.	Lesser the number of surface to be clean and having large surface for easy cleaning.
	Minimal maintenance design is invited by both the railways and the end user.	

Noise level from trains to be reduced.	Silence/minimal noise is required during sleep hours on train and constantly disrupted by external/ambient noises.	Use of plastic parts and dampeners to reduce vibrations.
	Too much vibration from use of metal parts creates lots of noise inside compartment.	Acoustic materials on cladding of interior elements can cut down the noise level.

Basic mechanisms

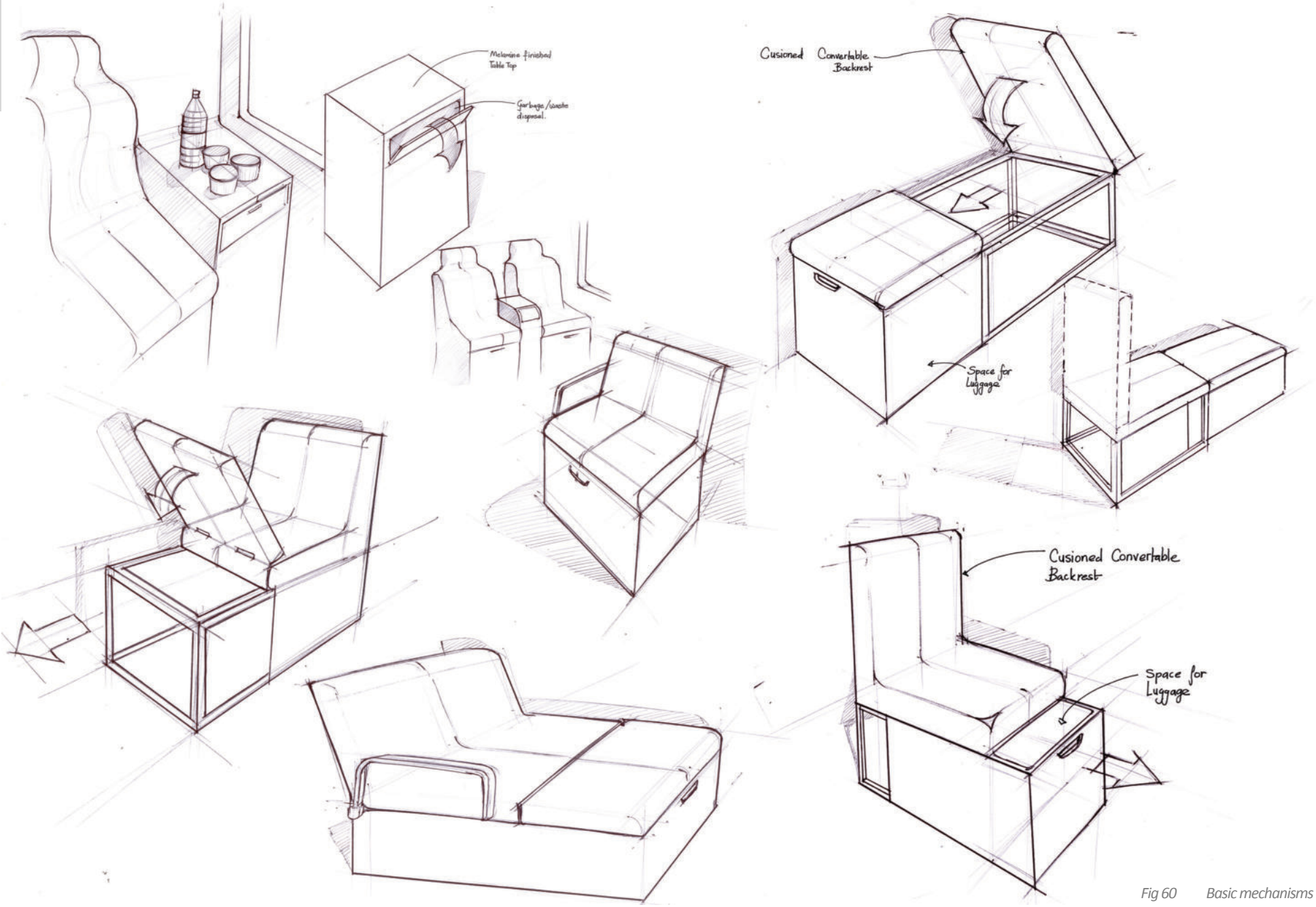


Fig 60 Basic mechanisms

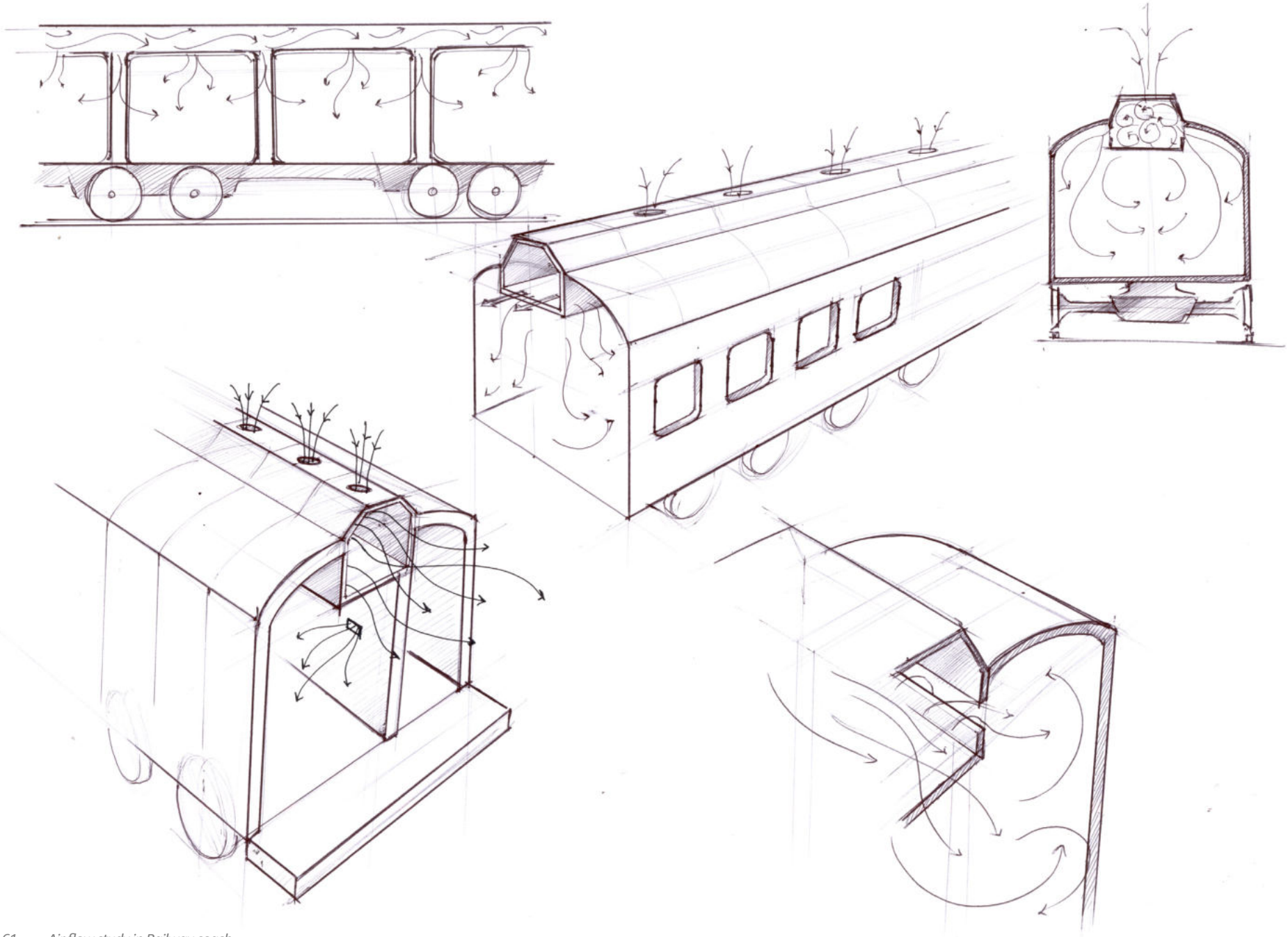
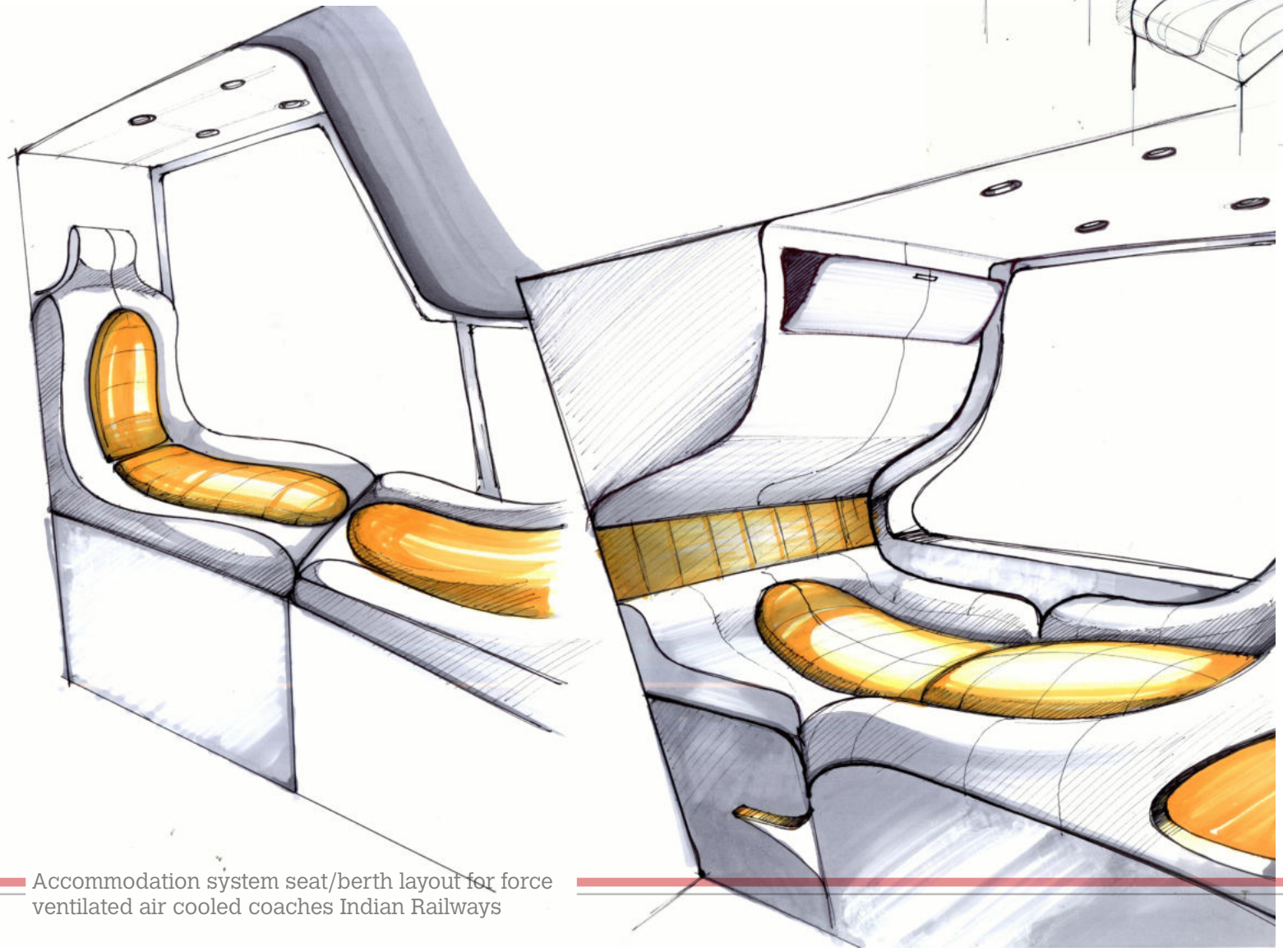


Fig 61 Air flow study in Railway coach

Product conceptualization



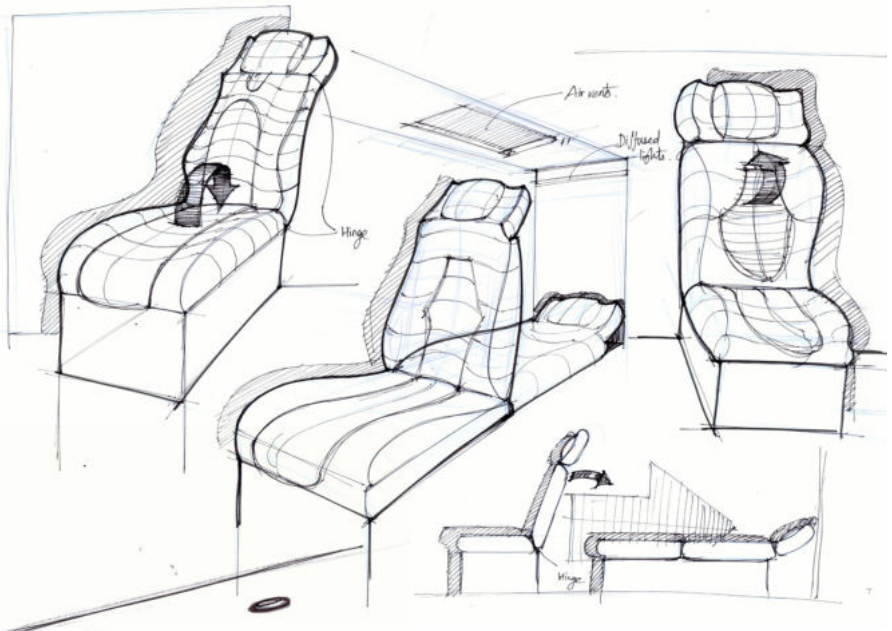


Fig 62 Berth and seat conversion

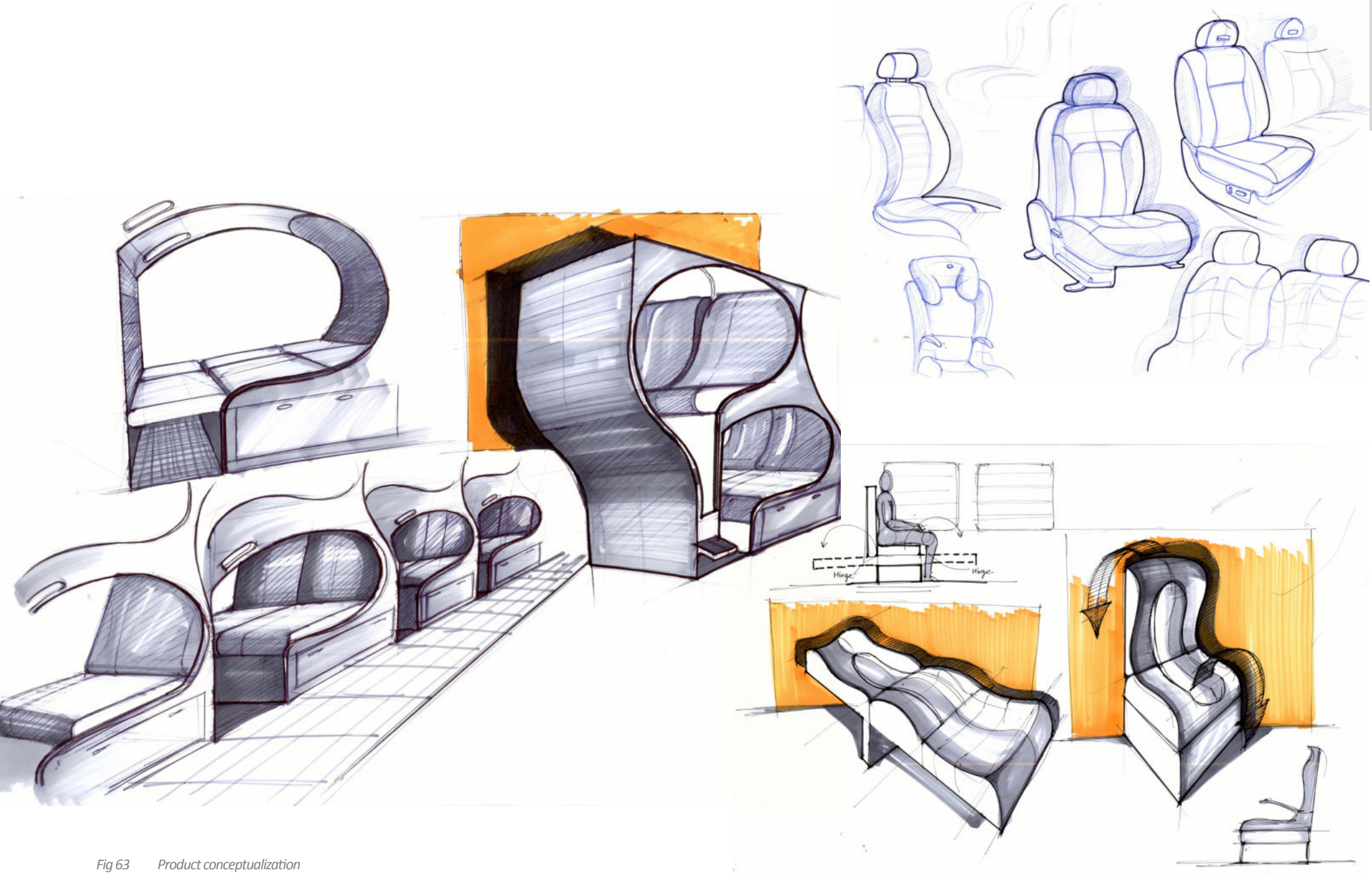


Fig 63 Product conceptualization

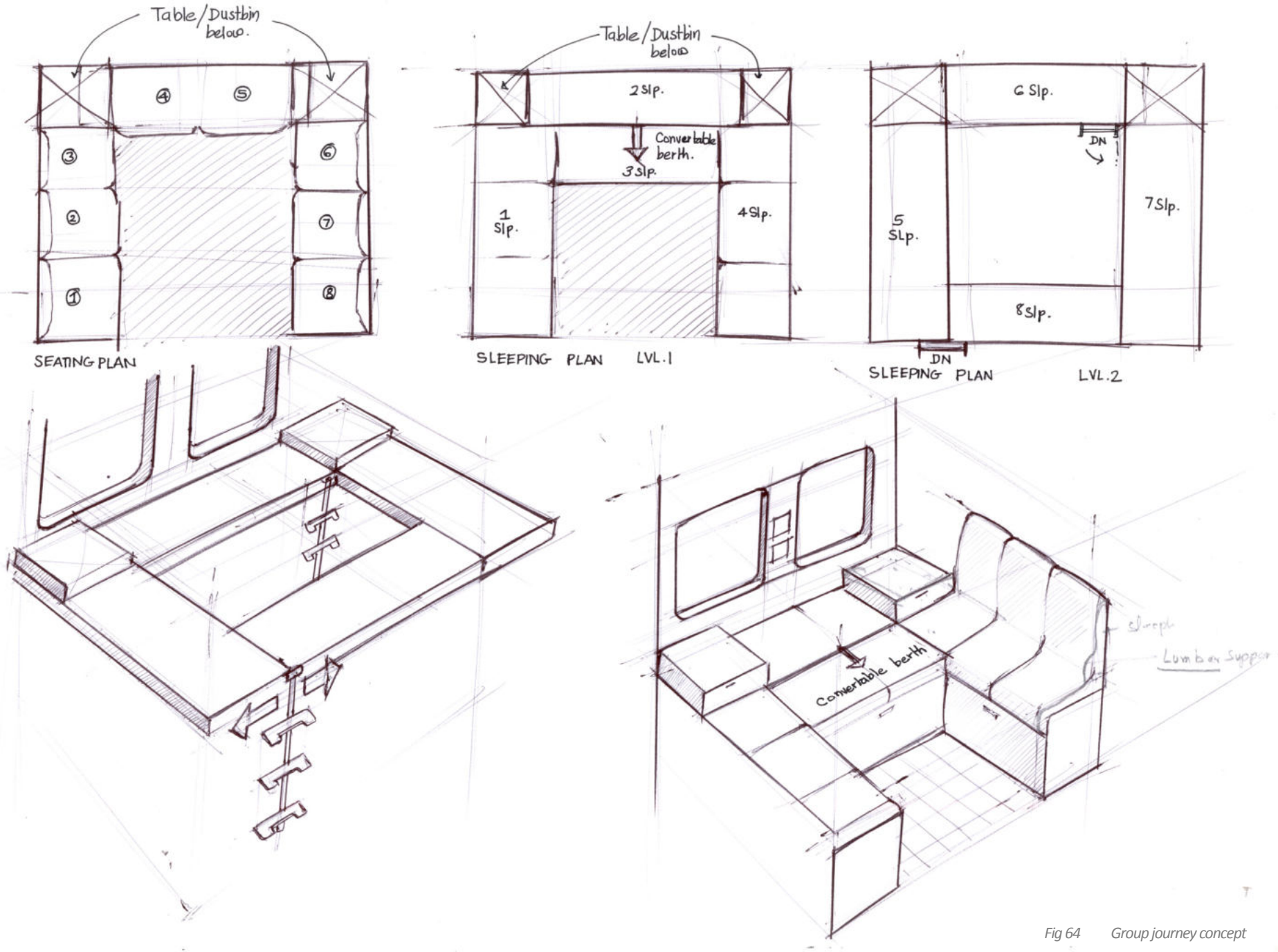


Fig 64 Group journey concept

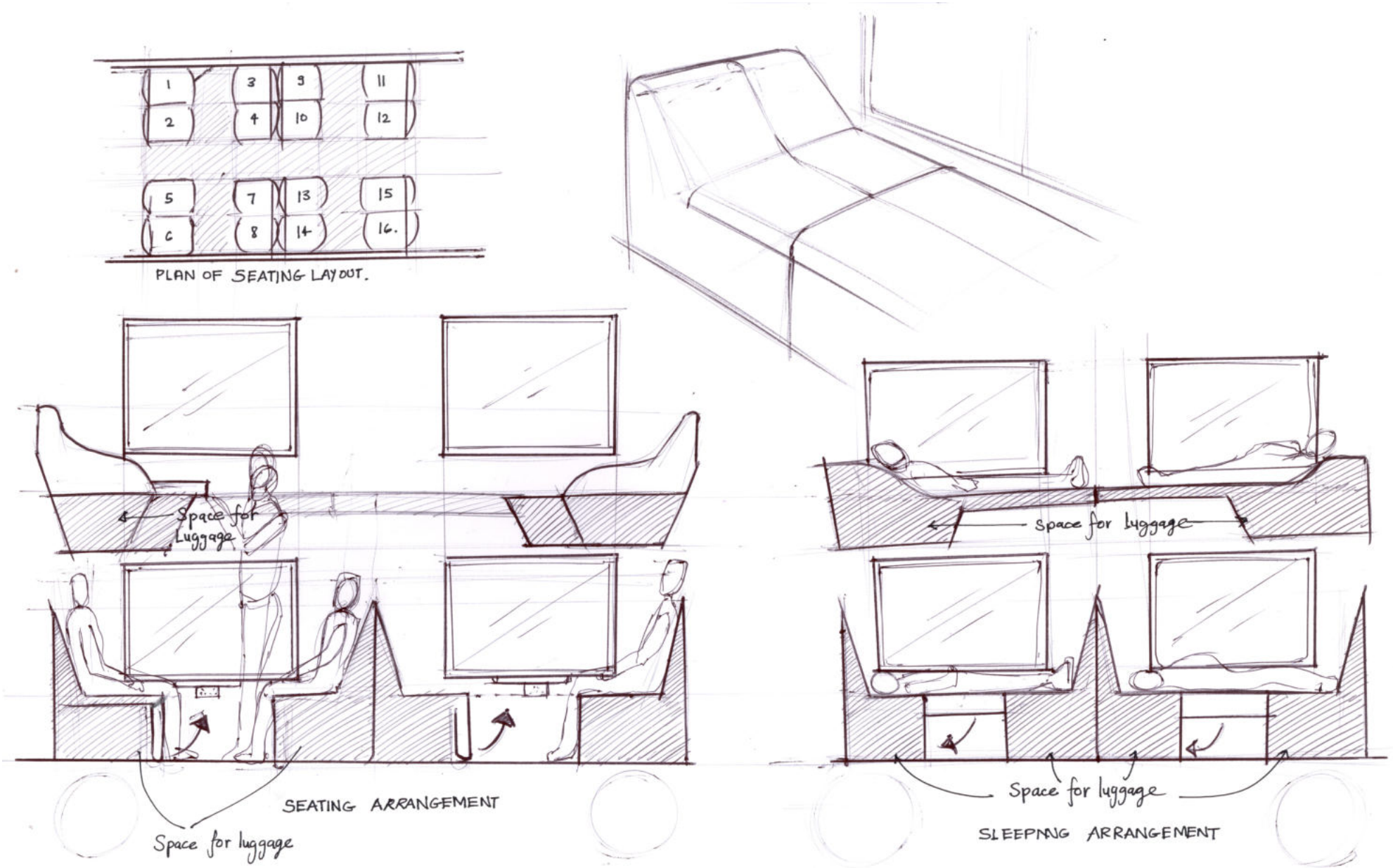


Fig 65 Individual / Nuclear journey concept

Concepts

Concept 1a

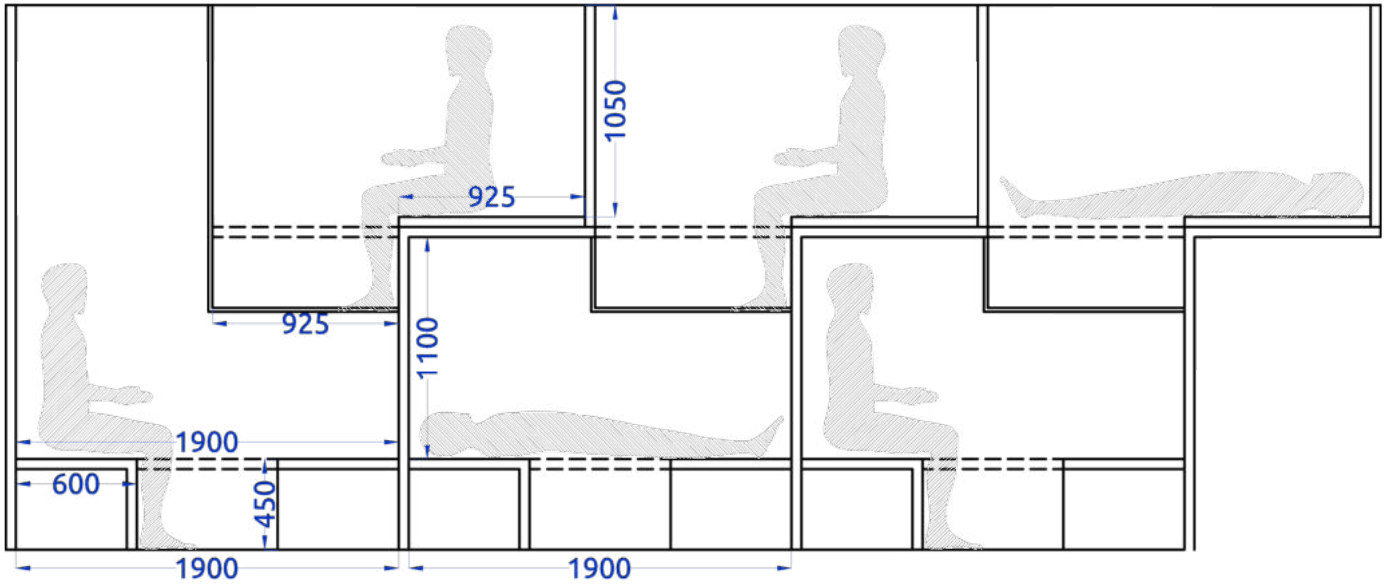
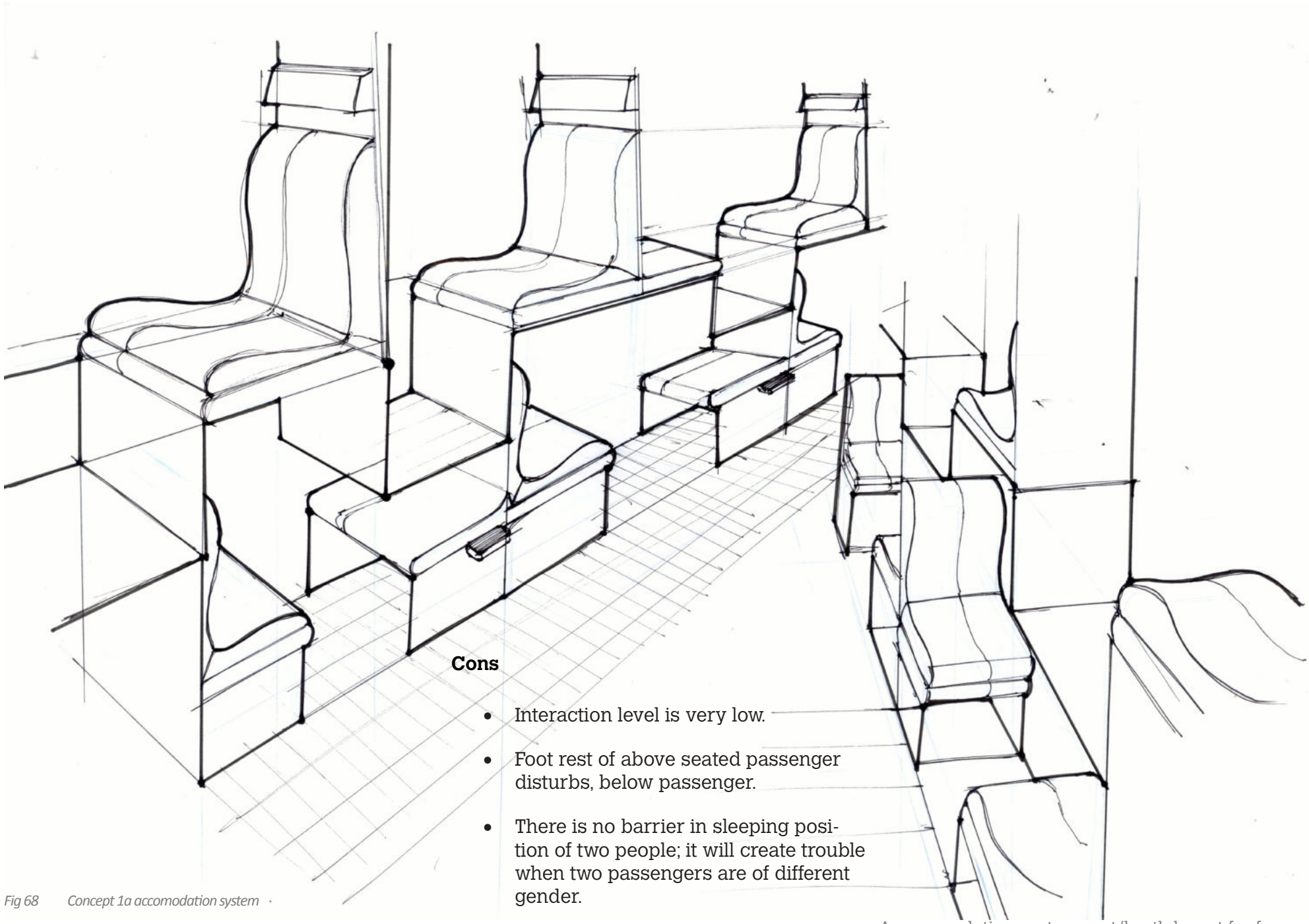


Fig 66 Concept 1a side view layout

Pros

- Privacy level is very high.
- People with open ticket, daily office travelers can be accommodated to seat.
- 60 passenger (seat/sleep) and 30 (seat only) can be accommodated at a time.

Fig 67 Concept 1a mockup models



Cons

- Interaction level is very low.
- Foot rest of above seated passenger disturbs, below passenger.
- There is no barrier in sleeping position of two people; it will create trouble when two passengers are of different gender.

Fig 68 Concept 1a accomodation system

Concept 1b

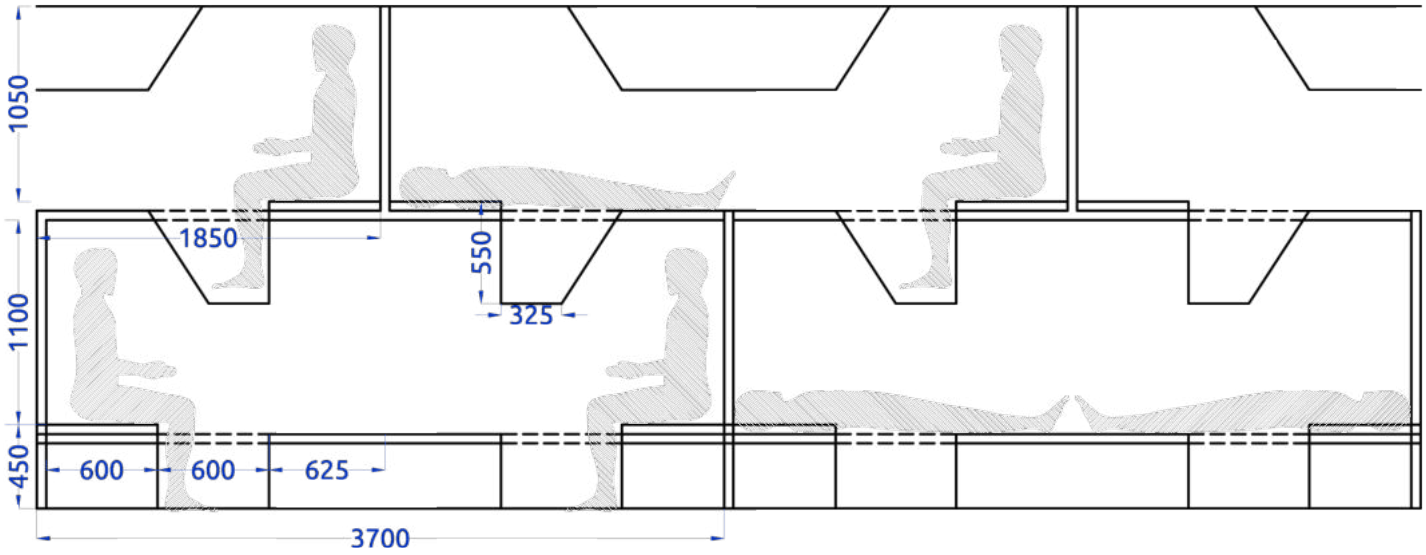


Fig 69 Concept 1b side view layout

Fig 70 Concept 1b Mockup models

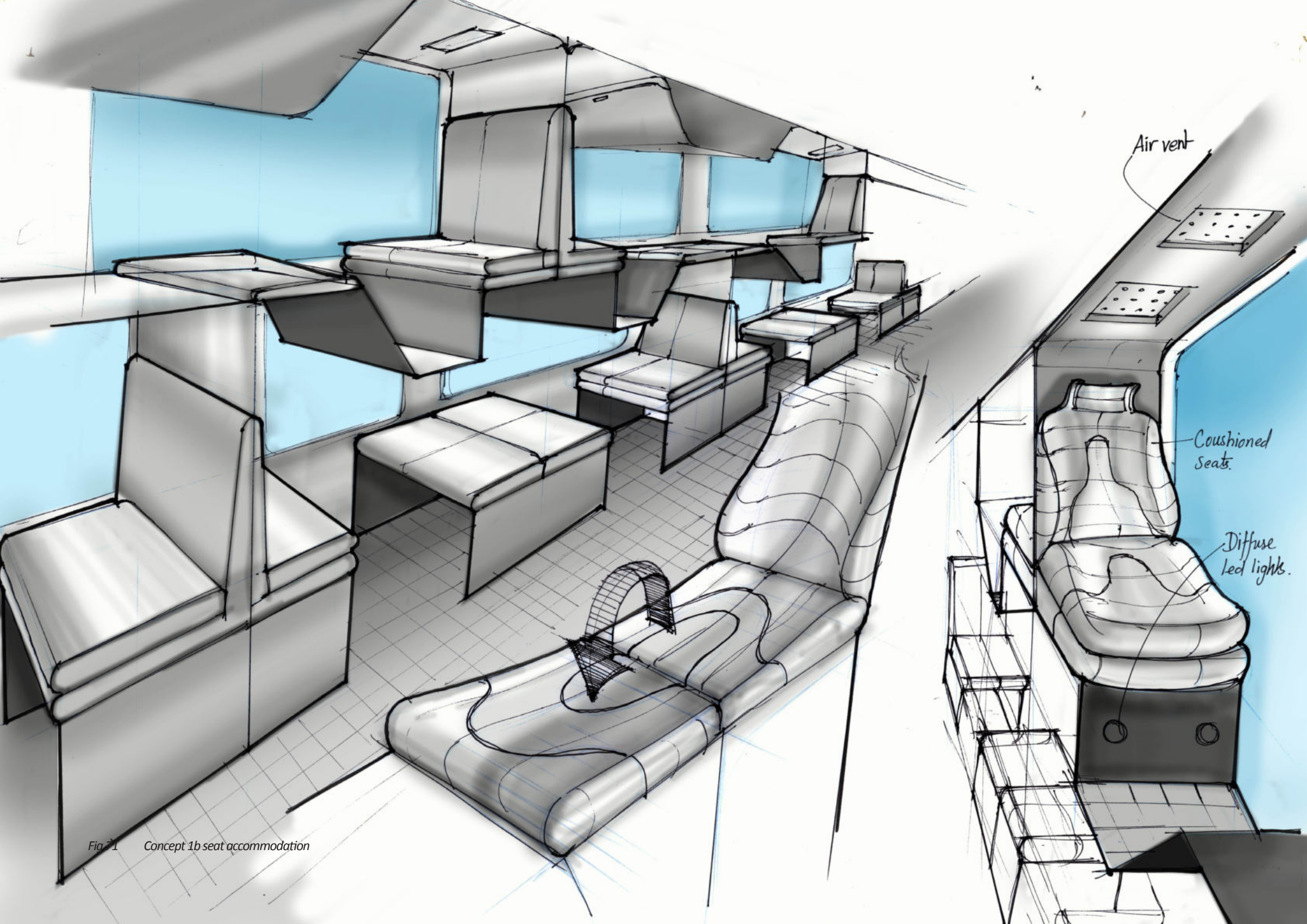


Figure 1 Concept 1b seat accommodation

Concept 2

Pros

- Cleanability of coaches is easy.
- Ease of use.
- Decent space for circulation and movement
- Flexibility of usage.
- Plenty of natural lighting and ventilation.
- 60 passengers (seat/sleep) can be accommodated at a time.
- Adequate hygiene.
- Easy evacuation during disasters.

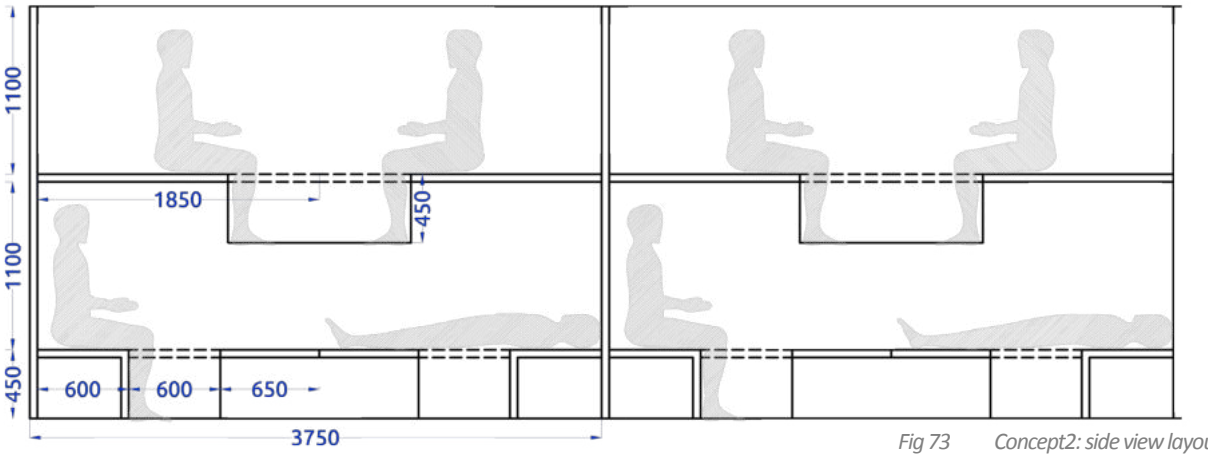


Fig 73 Concept2: side view layout

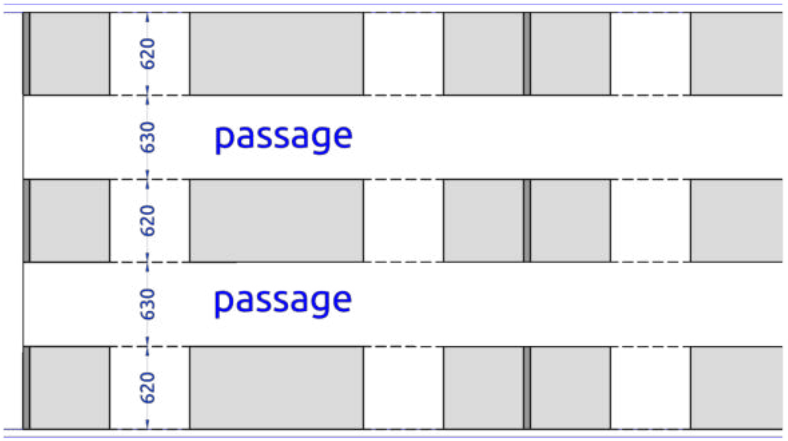


Fig 72 Concept 2 :plan of seat layout

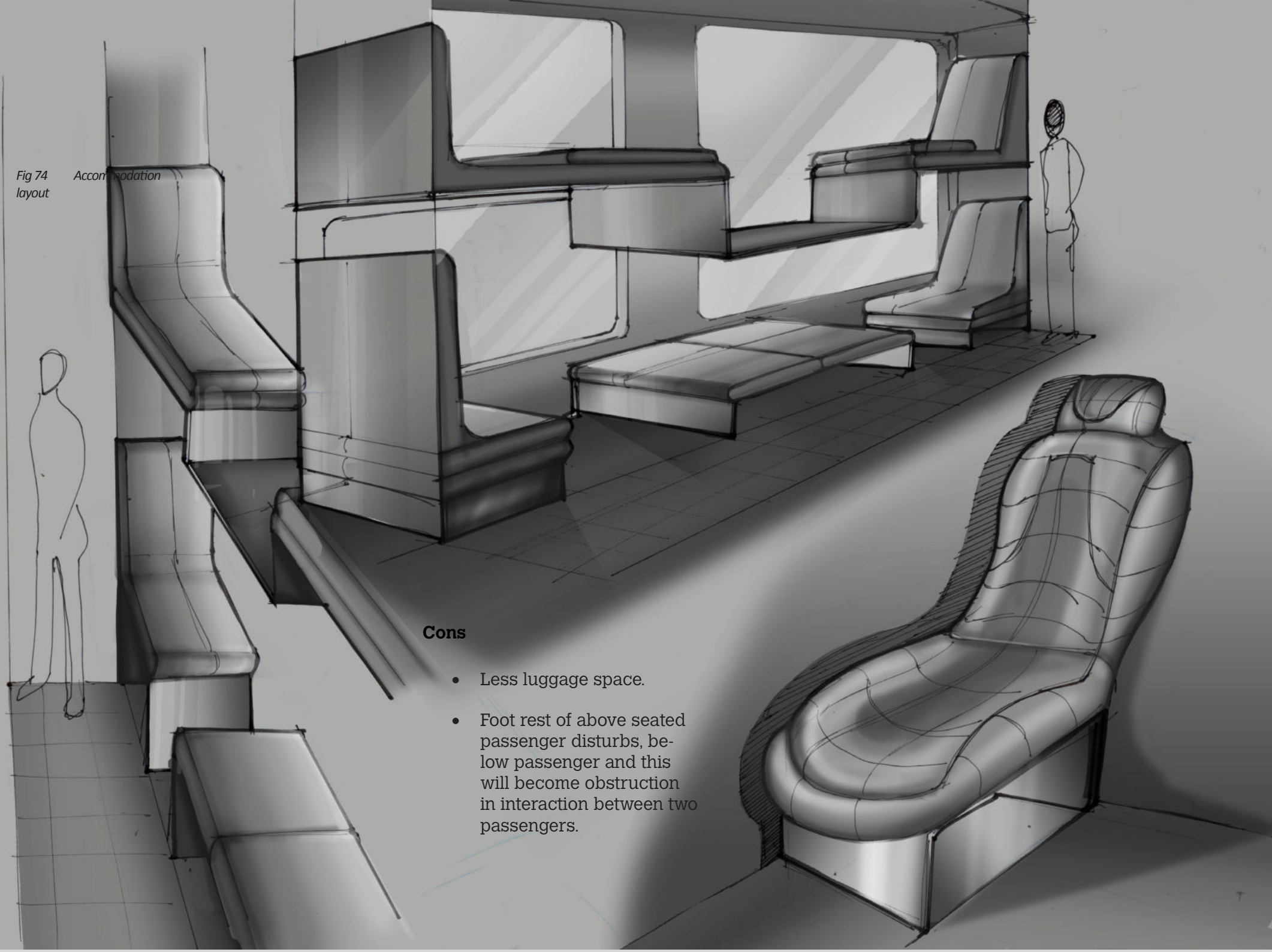


Fig 74 Accommodation layout

Cons

- Less luggage space.
- Foot rest of above seated passenger disturbs, below passenger and this will become obstruction in interaction between two passengers.

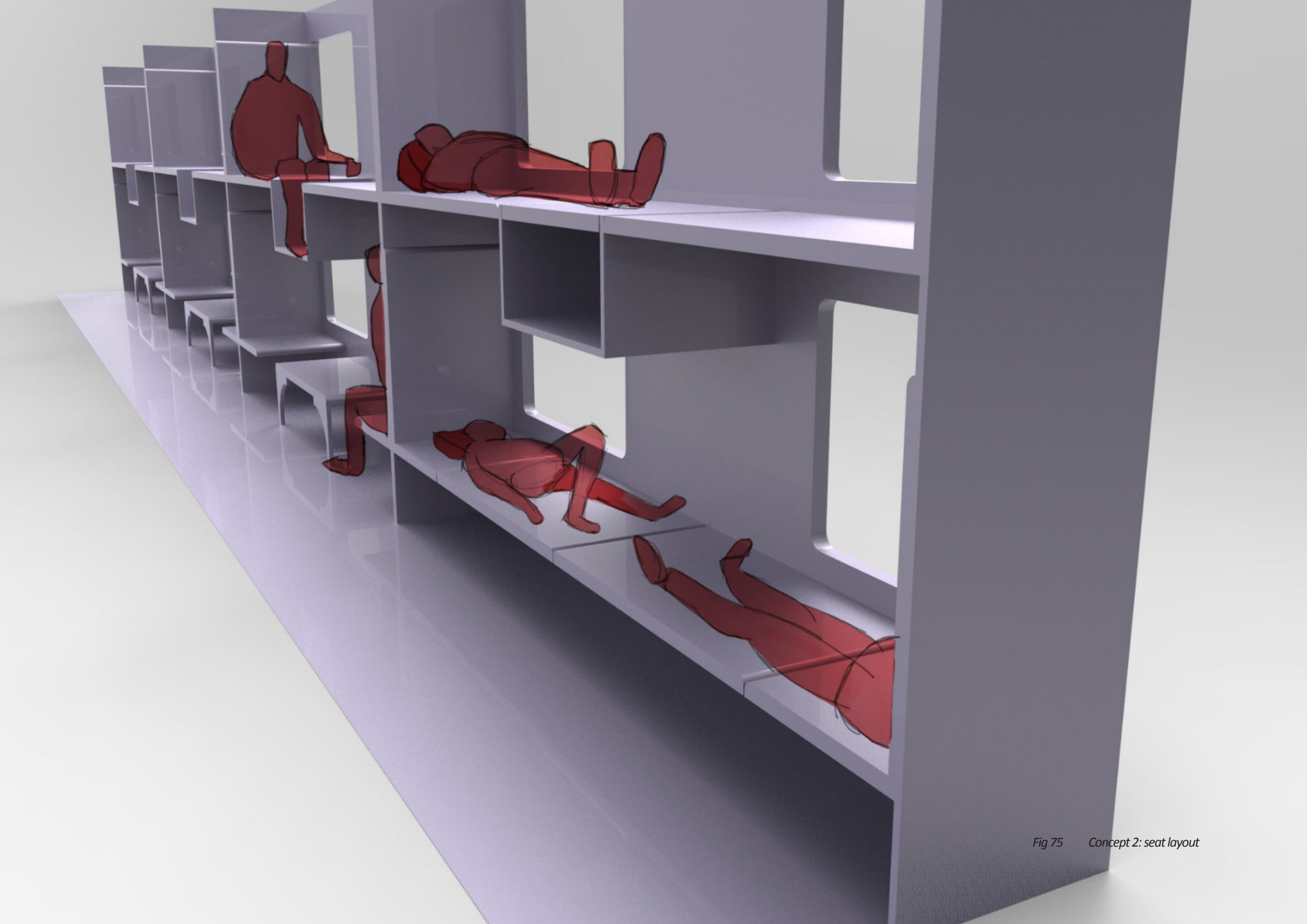


Fig 75 *Concept 2: seat layout*

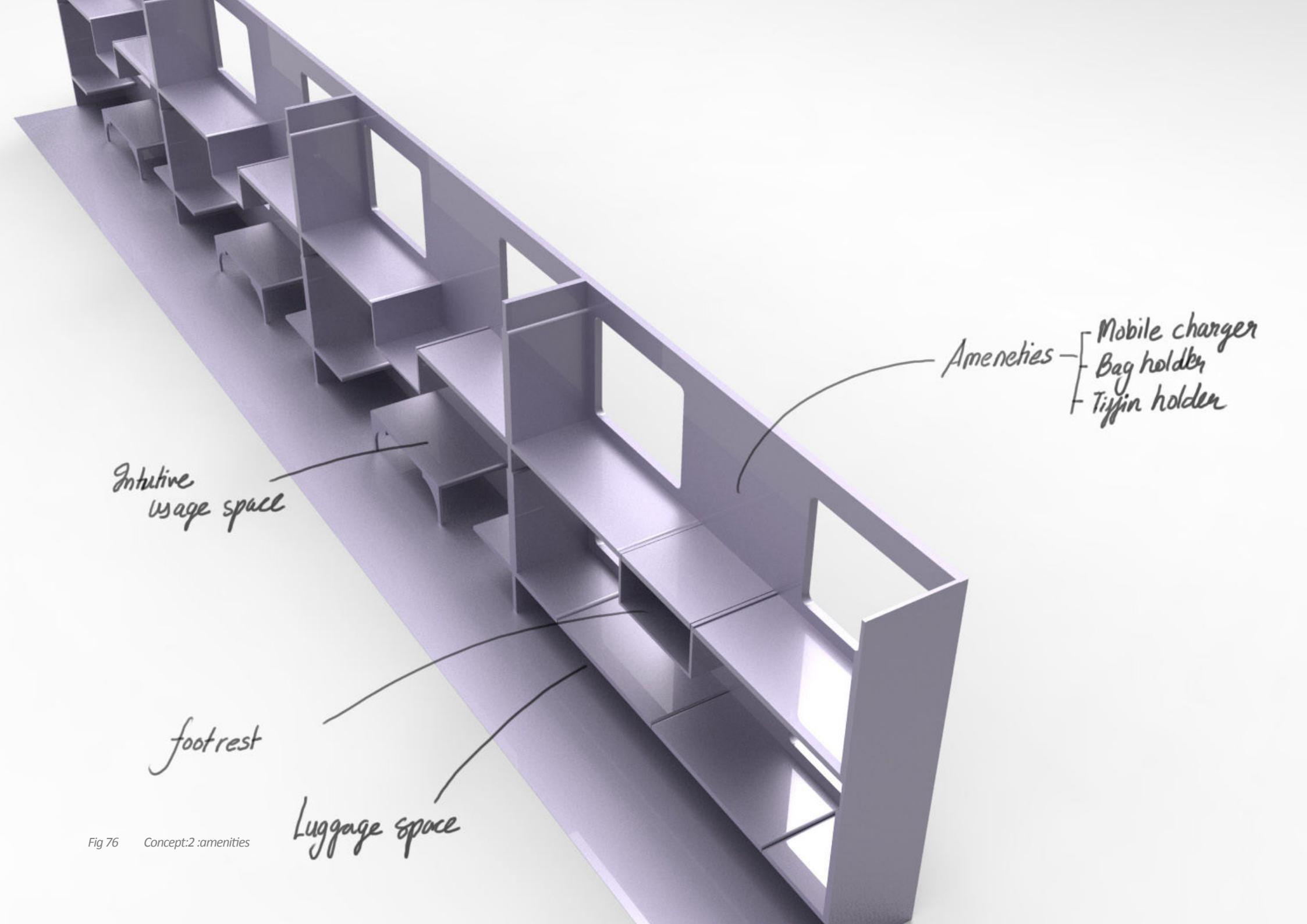


Fig 76 *Concept:2 :amenities*

Concept3

Pros

- Private space for every one
- Decent luggage space
- Space for amenities and waste disposal sytem
- 1:1 interaction level.
- Security level is high.
- Easy to clean and low maintenance.
- 60 passengers (seat/sleep) can be accommodated at a time.
- People having open ticket can be accommodated by mutual understanding of passengers.
- Adequate hygiene.
- Fast circulation and movement of passenger.
- Easy evacuation during disasters.

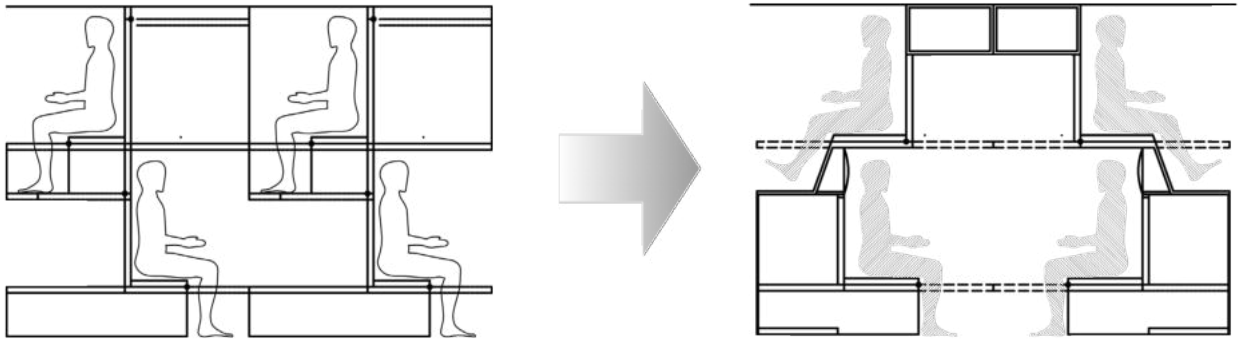


Fig 77 Concept 3: Seat layout concept development

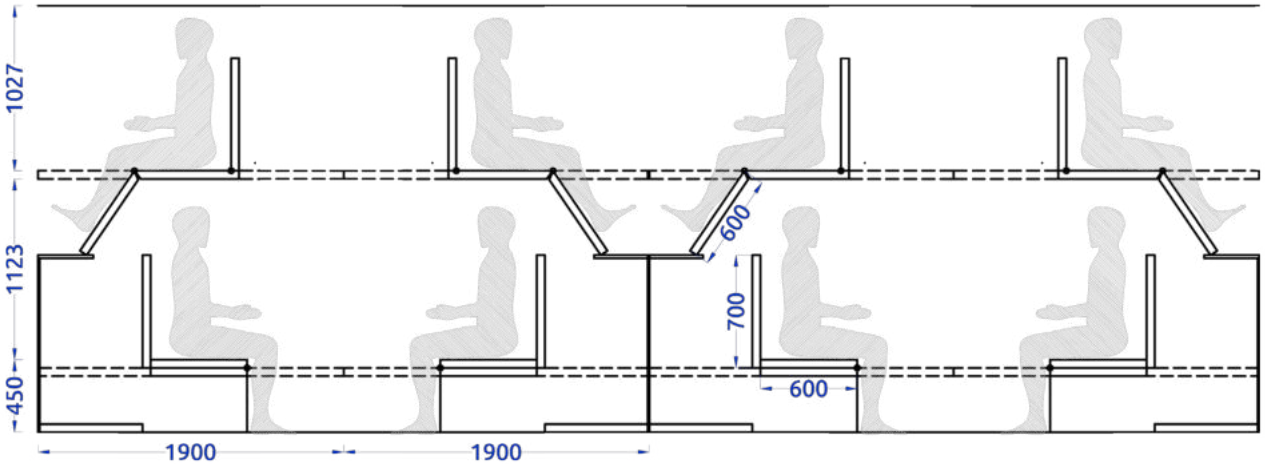


Fig 78 Concept 3 : Side view of seating layout

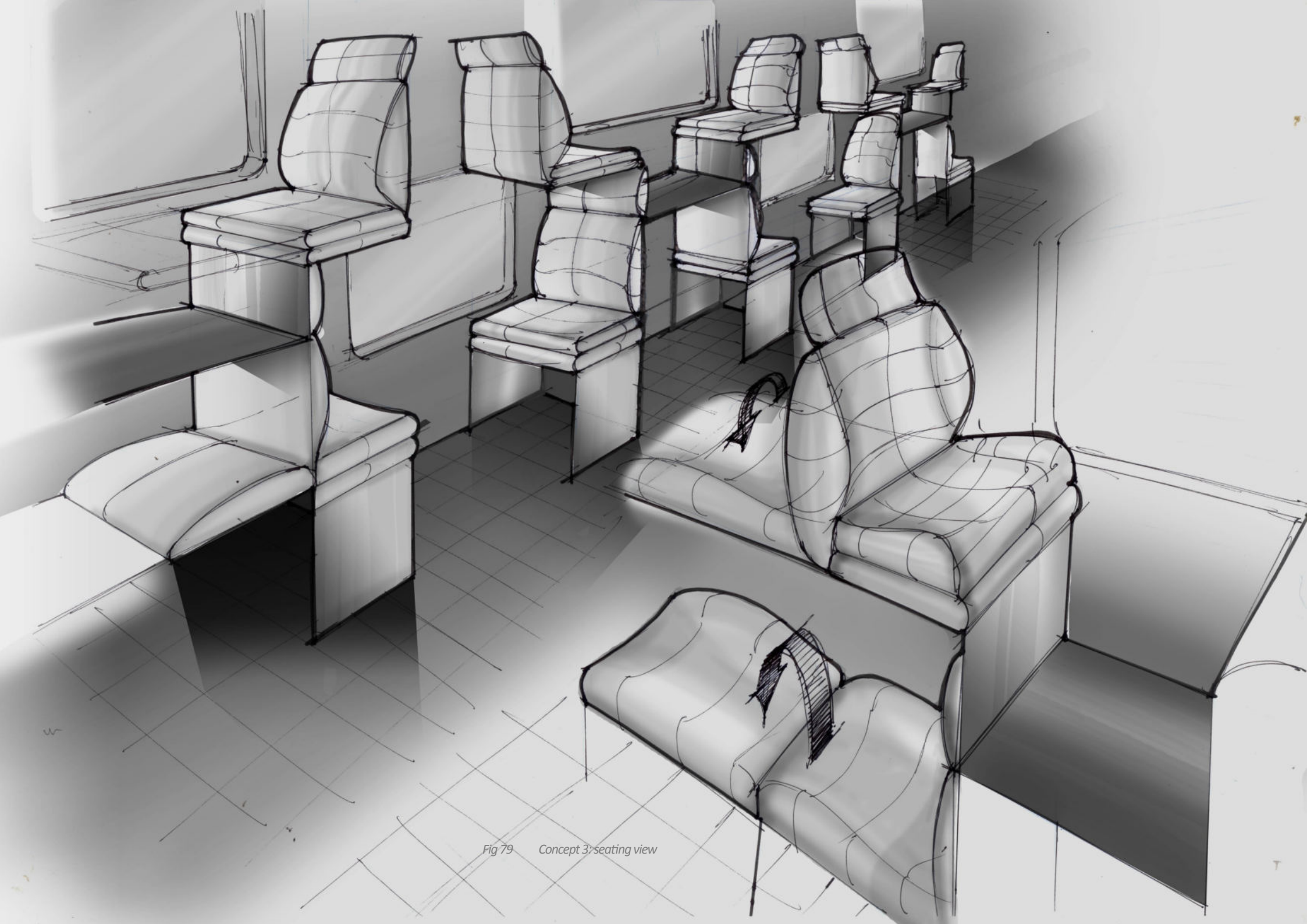


Fig 79 Concept 3: seating view

Fig 80 *Concept 3:Plan of seating layout*

Cons

- Multi mechanisms in seating.
- Time consuming to understand the conversion of seat to berth.
- Complex layout system.

Fig 81 *Concept 3: Mockup model*

Fig 83 Concept 3: View of seating layout

Fig 82 Concept 3 : Mock up model 2

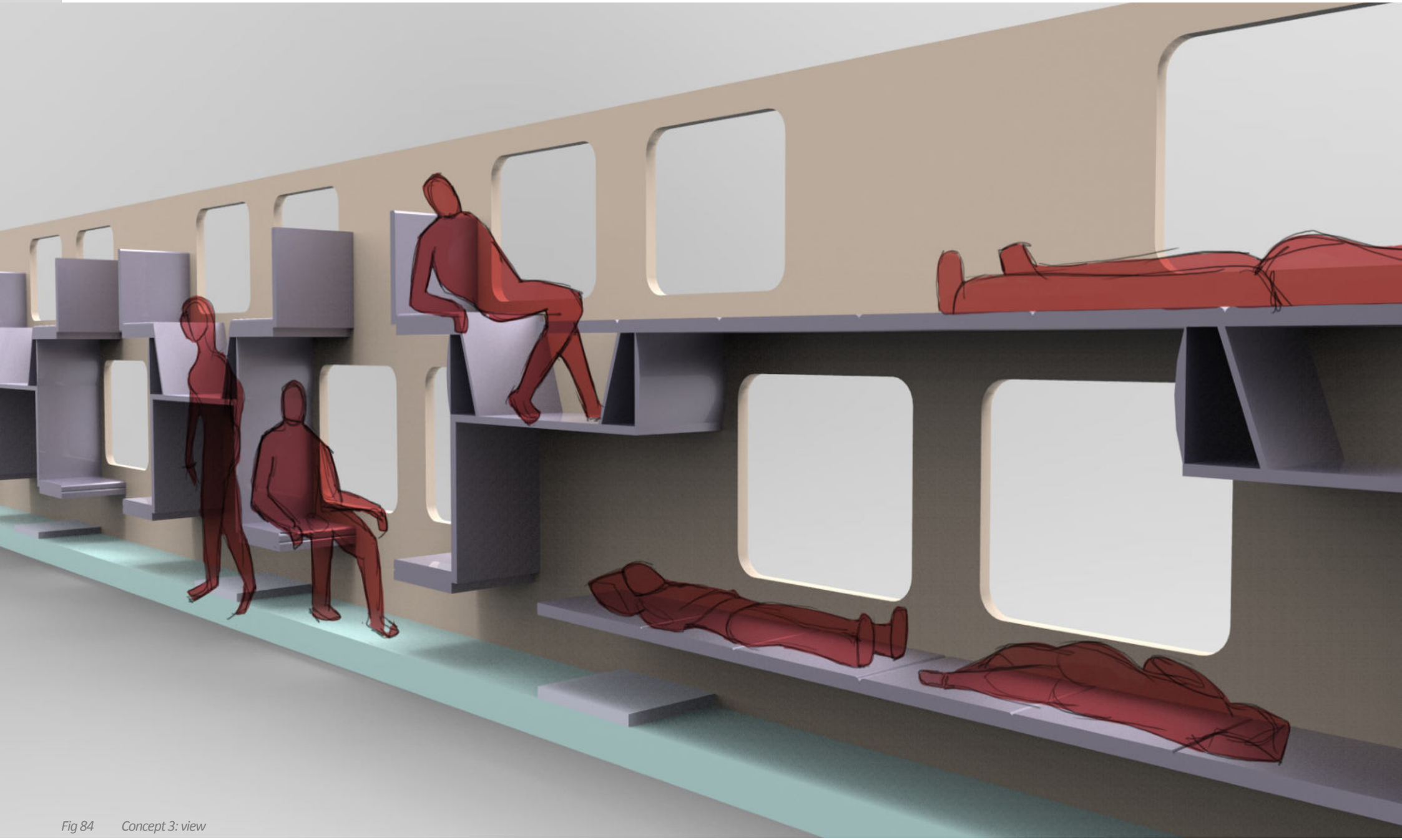


Fig 84 *Concept 3: view*

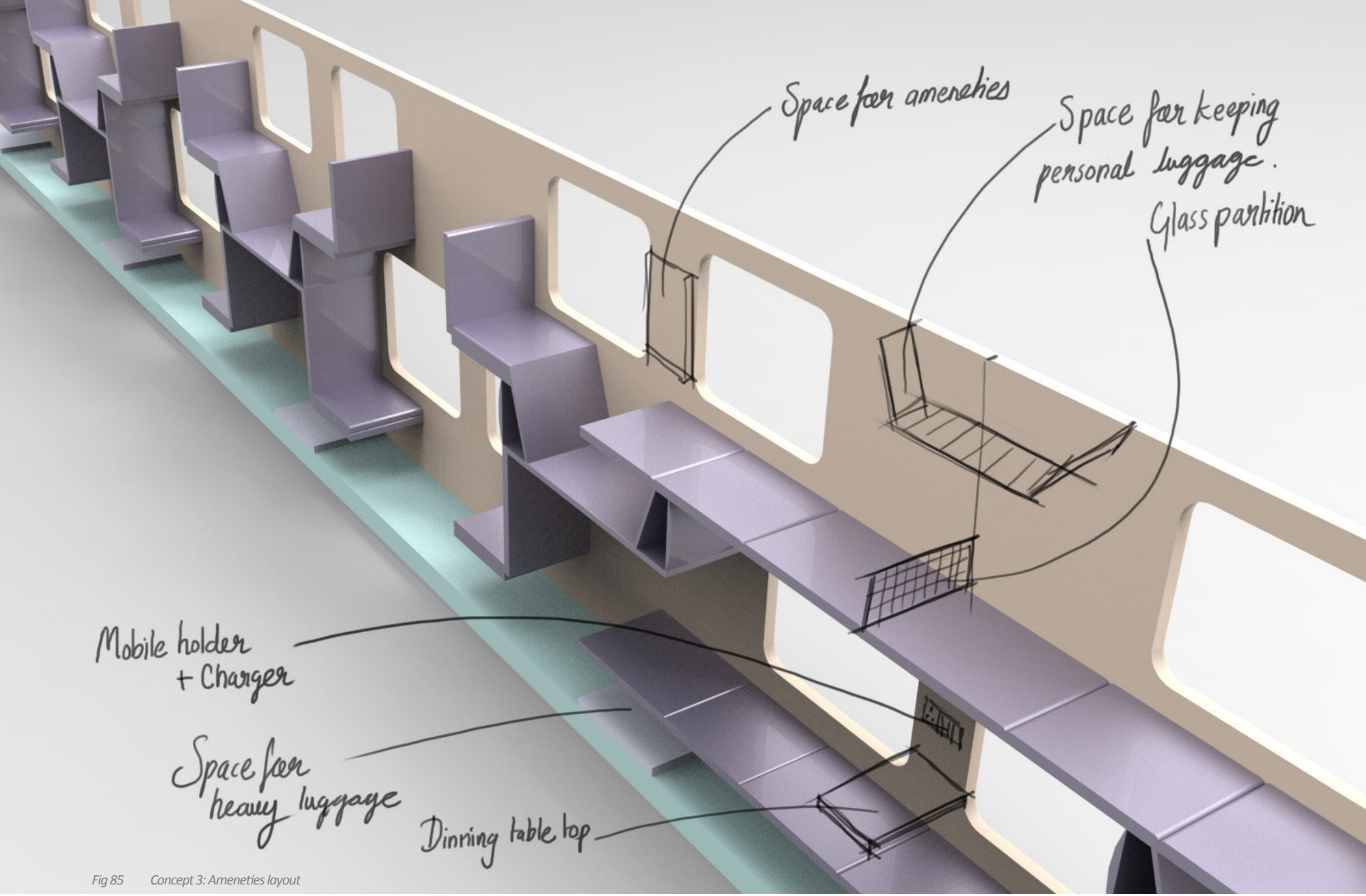


Fig 85 *Concept 3: Amenetie layout*

Concept 4

Pros

- Adequate space for each passenger.
- High security for passenger accommodated towards windows, best for females.
- Increased passenger width by 800 mm.
- 1:1 interaction level.
- Personal space for each traveler.
- 72 passengers (seat/sleep) can be accommodated in a coach.

Cons

- Unavailability of footrest for above seated passenger.
- Cleanability of floors is hard.
- High maintenance and services.

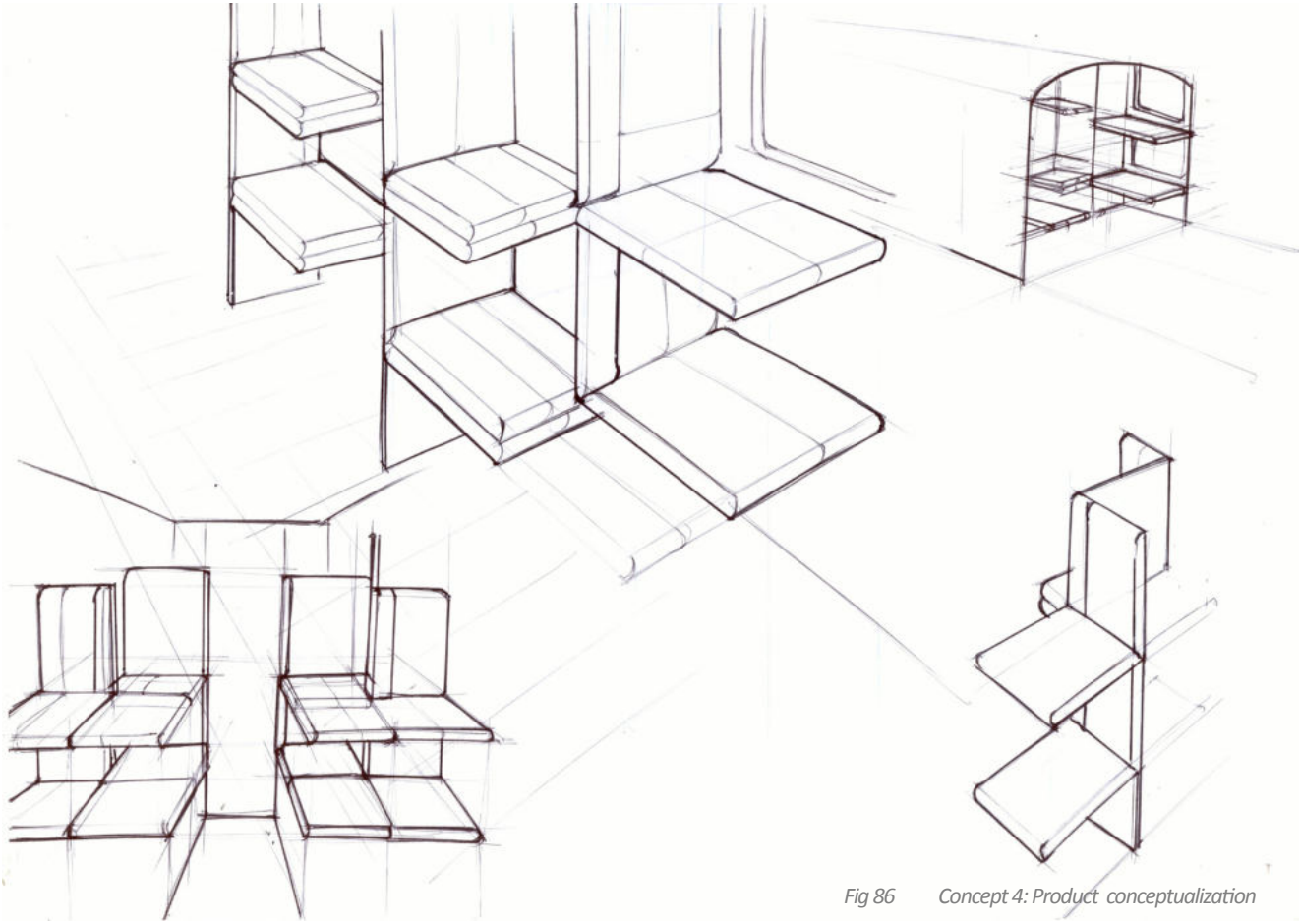


Fig 86 Concept 4: Product conceptualization

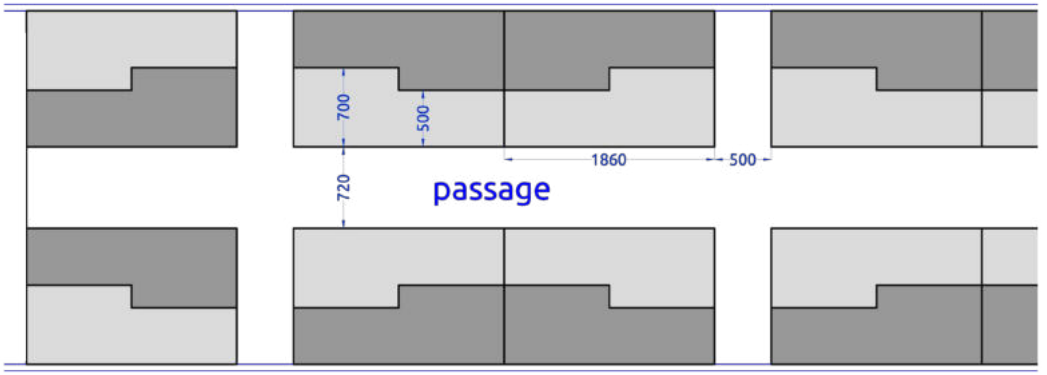


Fig 87 Concept 4: Plan of seat layout

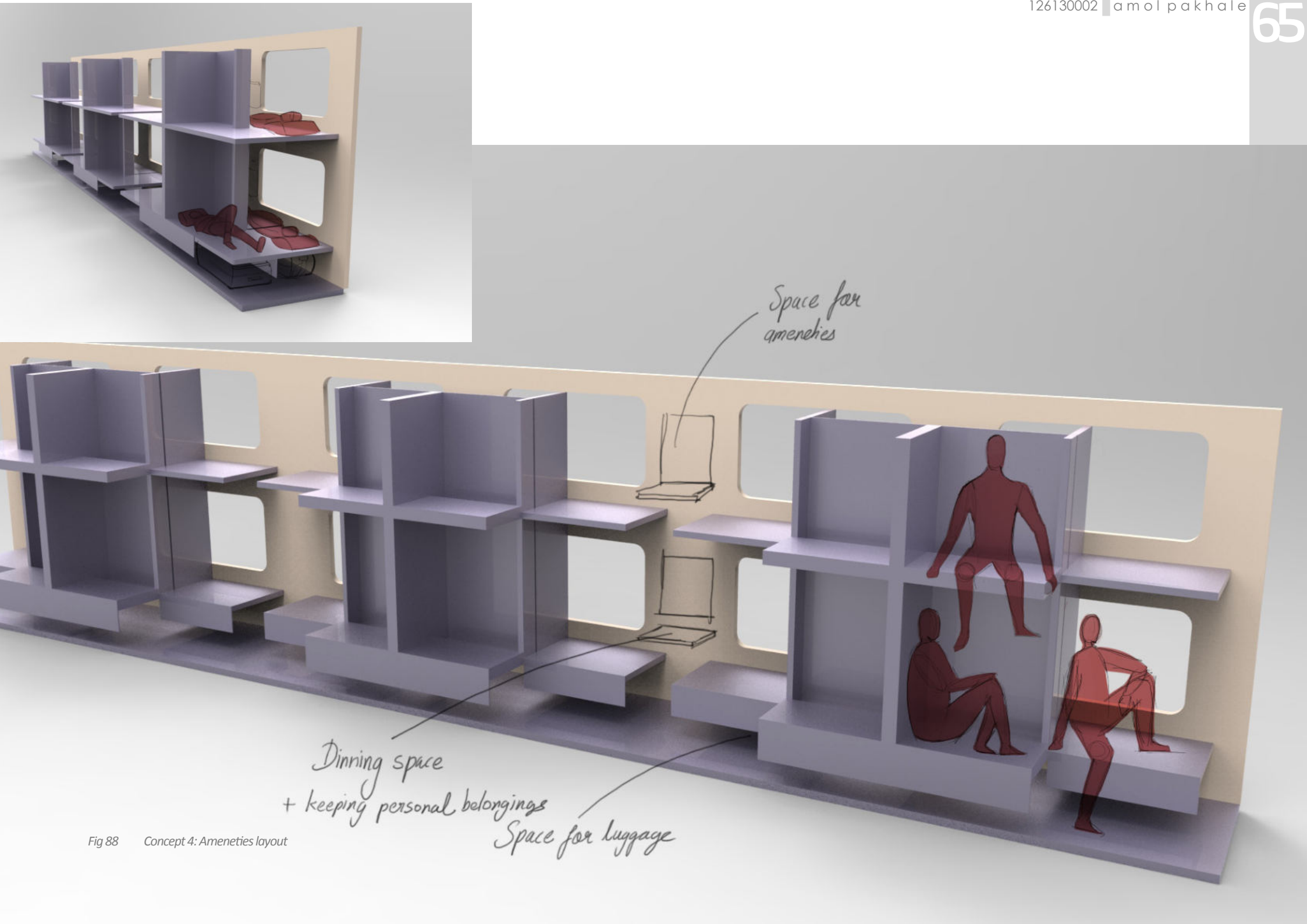


Fig 88 *Concept 4: Ameneties layout*

Concept 5

Pros

- Personal dinning and amenities space with waste disposal system.
- When berth is in seating mode the passage area is expanded by 850mm and the total width will become 1450mm so it is three times of existing passage width.
- Adequate sleeping conditions.
- 1:1 interaction level.

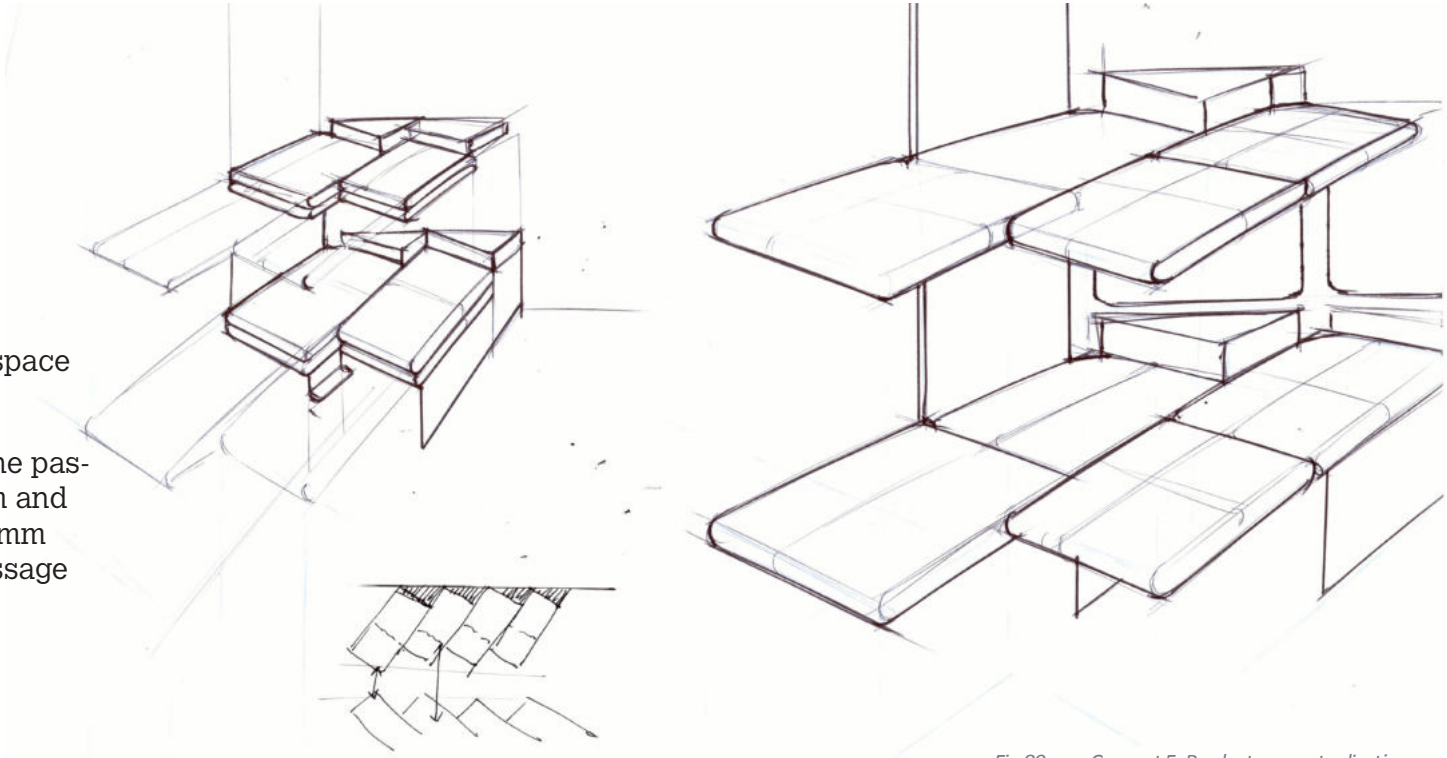


Fig 89 Concept 5: Product conceptualization

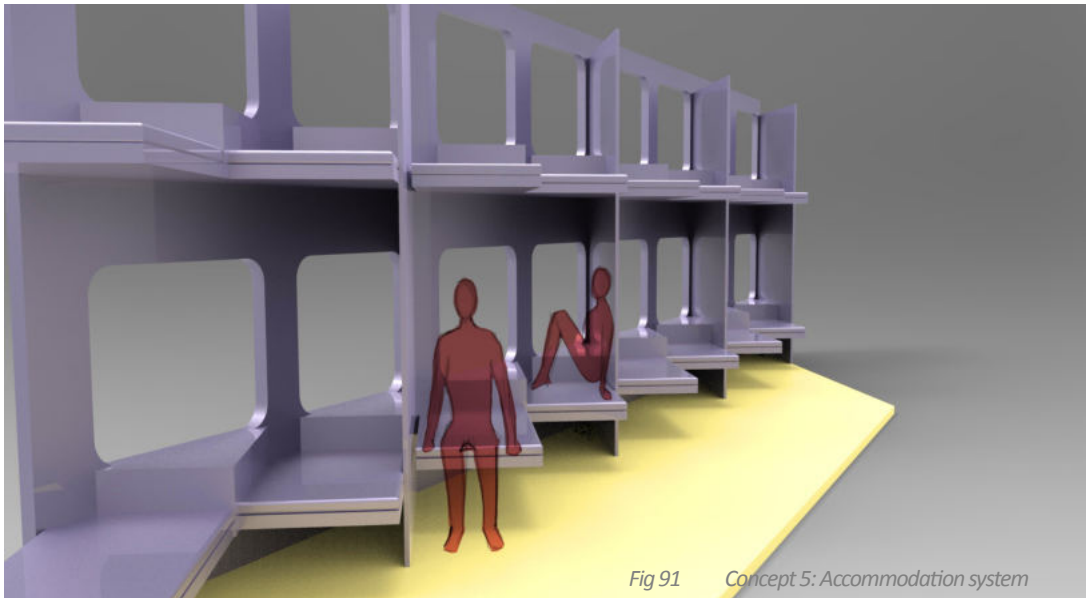


Fig 91 Concept 5: Accommodation system

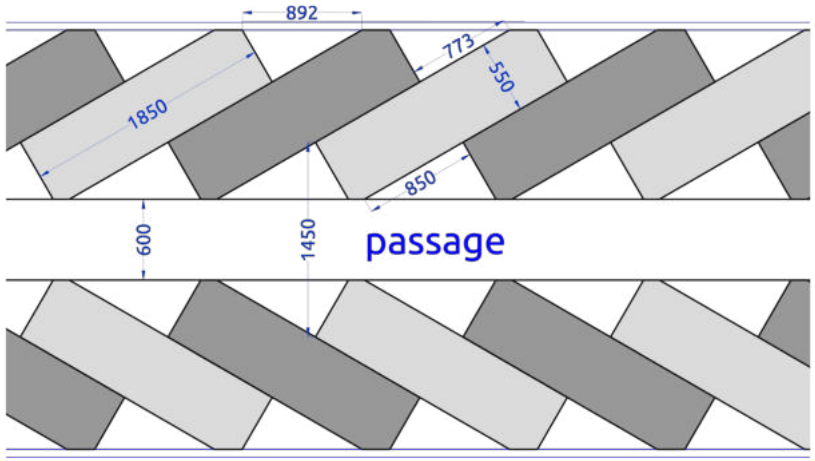


Fig 90 Concept 5: Plan of seat layout

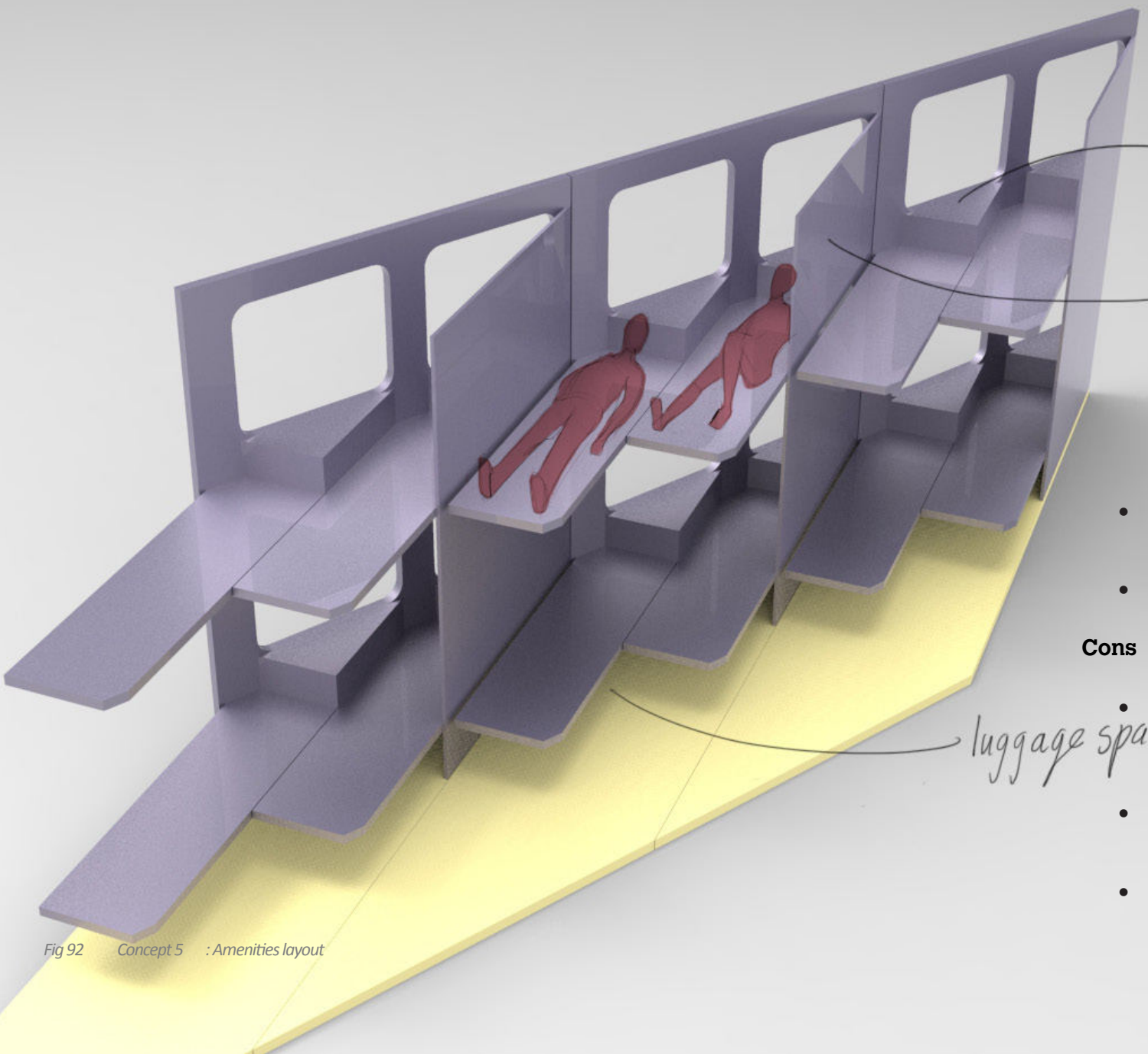


Fig 92 Concept 5 : Amenities layout

- Easy movement of passengers and vendors.
- Fast circulation with heavy luggage.

Cons

- Though the seats are facing towards the passage area, so the security level is low in this concept.
- Seat partition disturbs the natural lighting of the coach.
- Unavailability of footrest for above seated passenger..

IDC
IITB

Concept 6

This concept is based on the combination of two classes which is sleeper class and chair class. In this type of class the chair is designed in such a way that passenger can sleep at an angle. The backrest of the seat is inclined at 120 degree so that saves the space and doesn't allow people to lie down.

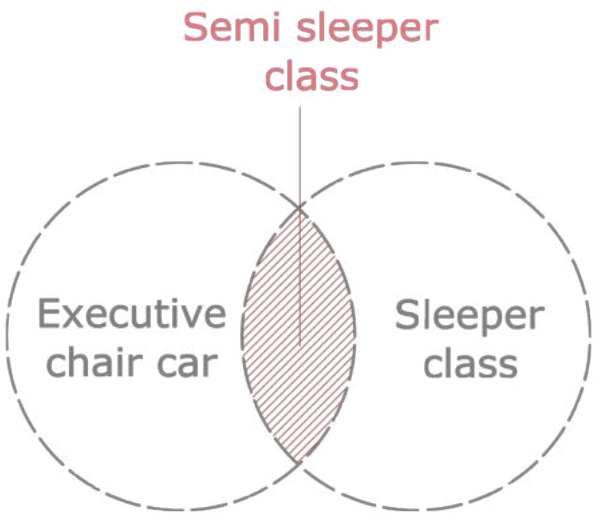


Fig 95 Concept 6 : Product conceptualization

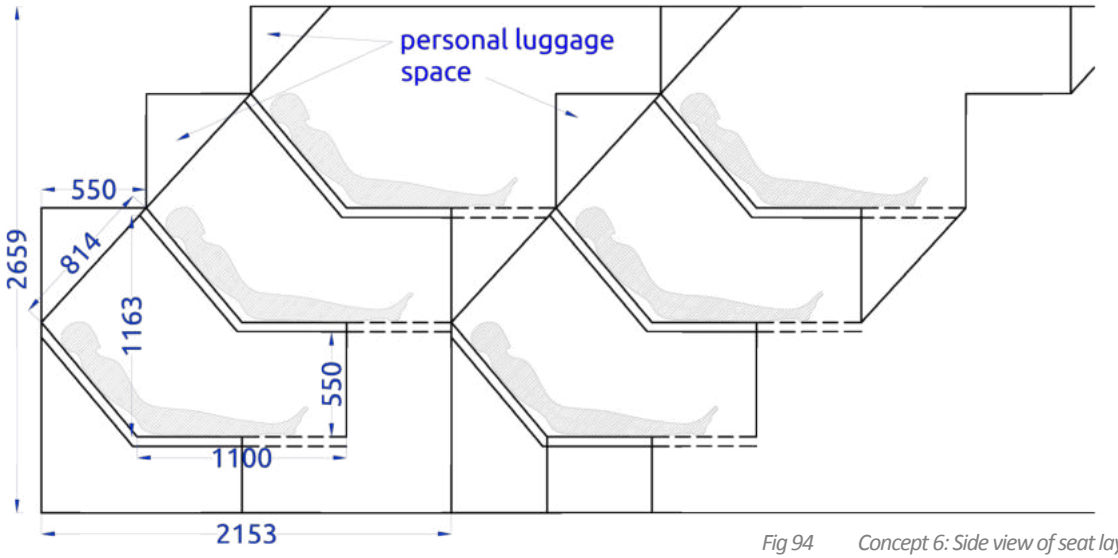


Fig 94 Concept 6: Side view of seat layout

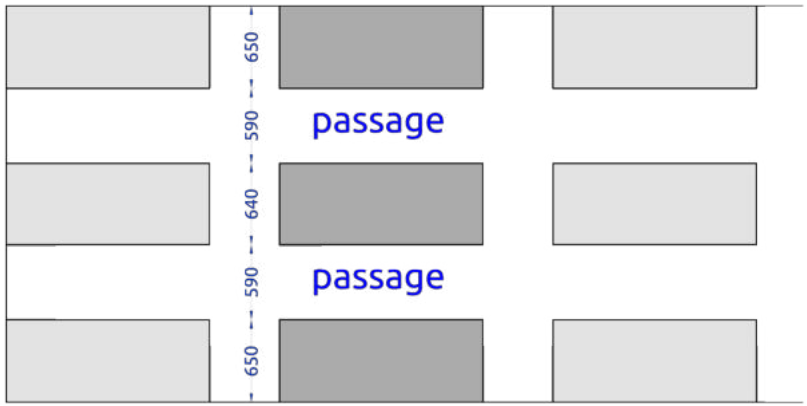


Fig 93 Concept 6: Plan of seat layout

Pros

- Suitable for short time journey.
- Opportunity to increase in capacity of the coach.
- Personal space for each passenger.
- Best for business, education and personal tours.

Cons

- Not suitable for long haul journey.
- Hard to accommodate old, handicapped and medical disabled passenger.
- Unsuitable for family and group trips.

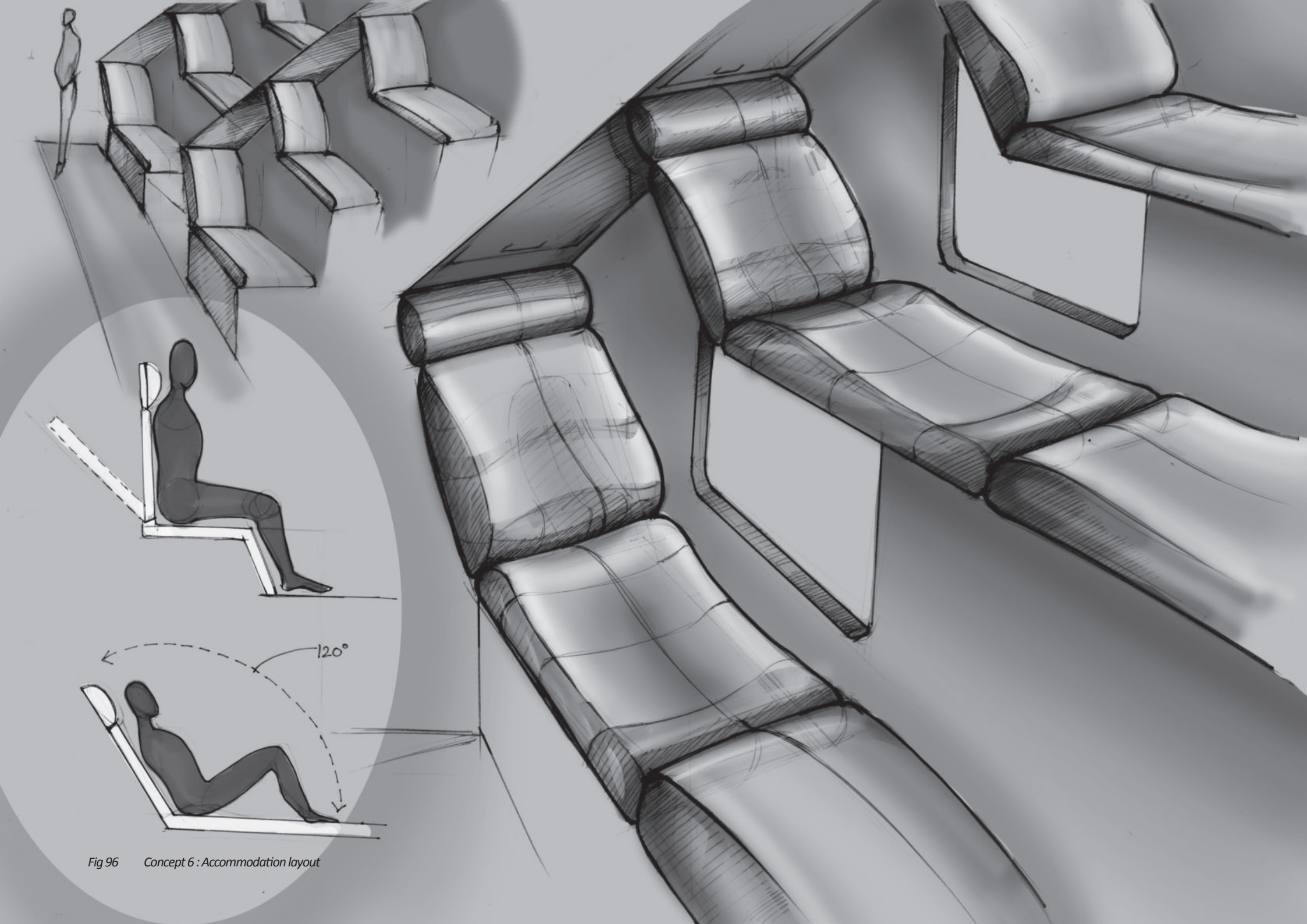


Fig 96 *Concept 6 : Accommodation layout*

Concept evaluation

	Existing Design	1a	1b	2	3	4	5	6
Capacity	4	3	3	3	4	4	3	6
Comfort	4	3	4	4	5	5	4	2
Safety	4	4	5	5	6	6	3	5
Sleeping conditions	4	4	5	6	6	4	5	6
Ergonomic	3	5	4	3	4	3	3	6
Hygiene	3	5	5	5	4	5	5	5
Ventilation	3	5	5	5	6	2	3	4
Lighting (Artificial/Natural)	3	6	5	6	6	3	4	4
Ameneties	2	3	5	5	5	3	6	5
Antispace	4	2	5	3	6	2	5	4
Interaction level	4	3	4	2	7	3	5	1
Privacy	2	6	4	5	5	5	3	6
Noise reduction	2	4	4	5	5	4	3	6
Cleanability	3	4	5	6	5	3	5	4
Ease of use	4	5	4	6	4	5	5	3
Ititutive usage	4	3	3	5	5	5	5	2
Maintenance & services	3	3	3	5	4	4	5	5
Security	5	4	4	4	5	5	3	5
Lifestyle	2	6	5	3	6	3	5	6
luggage space	4	6	6	4	6	2	6	6
circulation space	6	4	4	5	6	6	6	6
Disaster evacuation	2	5	4	5	6	5	5	4
Total	73	93	96	100	110	87	97	101

Design

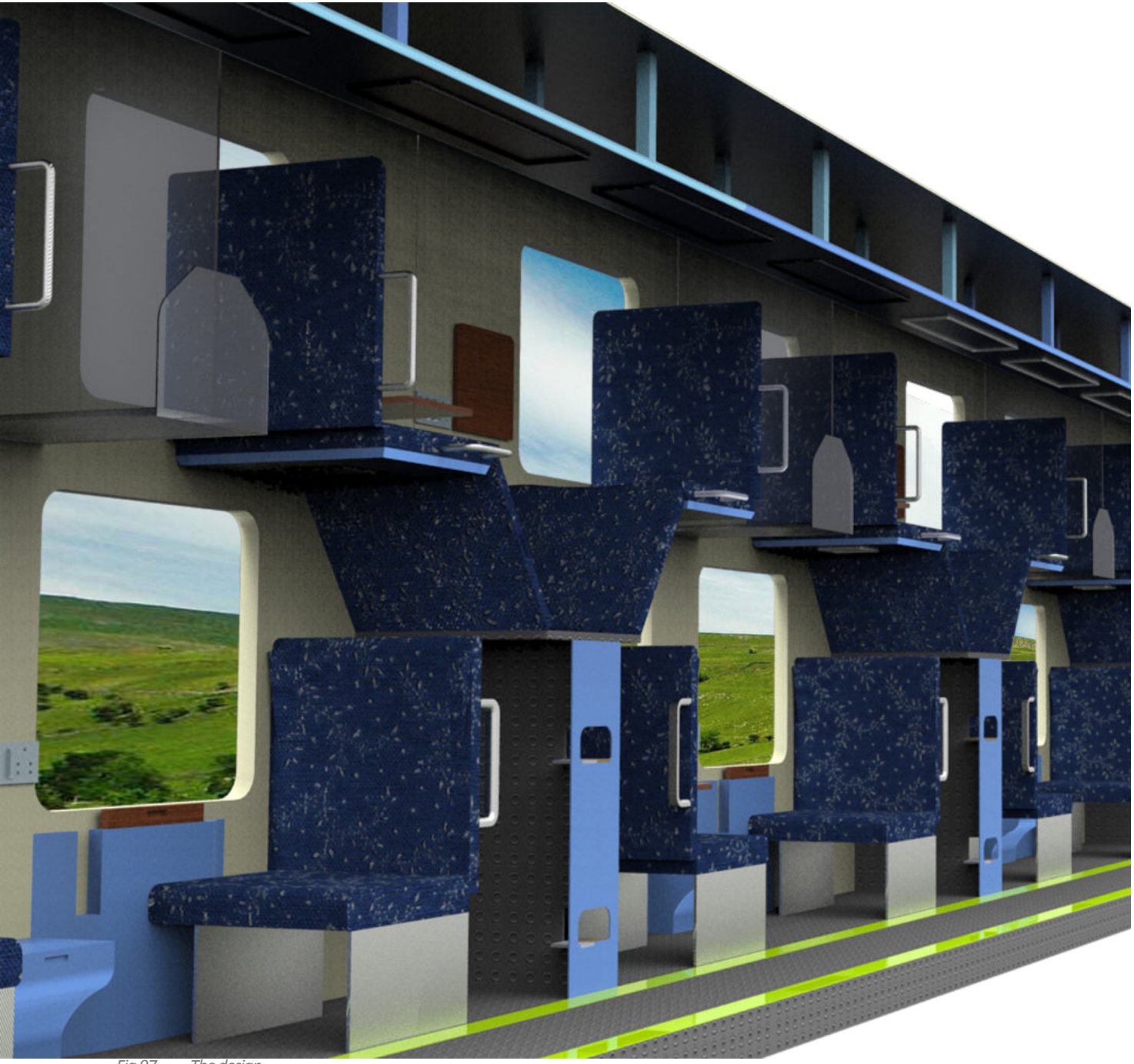


Fig 97 The design

Higher-End force ventilated air cooled sleeper coach offers private space with a comfortable seating during the day. This seat can be is converted into a full size bed at night, while another above it is folded down from the wall. Sleepers have open berths along the coach wall on either side of a central aisle, luggage racks beside the berths. During the day there are two facing seats, which at night are pulled together to form the bottom bunk. An upper back rest folds out from above and curtains are hung up to give you privacy. In both First and Second-Classes the beds are around 1.84m in length, and attendants assemble and make up the beds for you.

Eager to improve the passenger experience – particularly for those seated in high-density seating configurations, which are becoming standard in economy – Houssard began researching all the sensory aspects of aircraft cabins – “all the materials that surround the passenger, like the plastic, the leather, the seat fabrics, the table, and also how passengers work inside the cabin”. What she discovered was that “sensory design was a specialty”, whose time had come in the aircraft cabin.

Dimensional Drawing

Overall layout

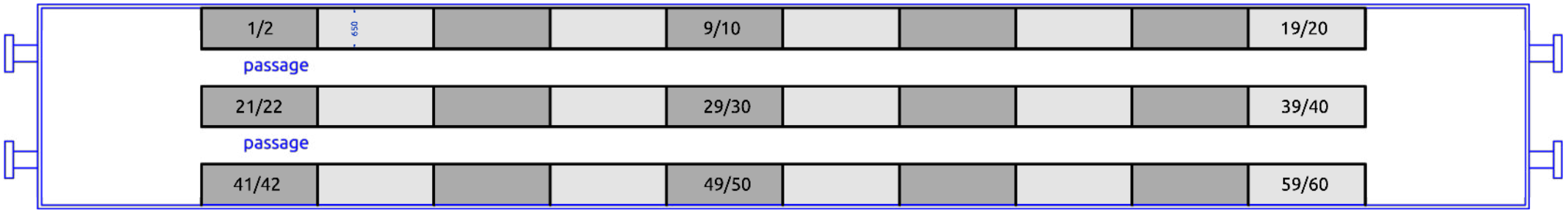


Fig 98 Overall layout of Railway coach interior

Detailed plan

Level I

Fig 99 Level I detail

Level II

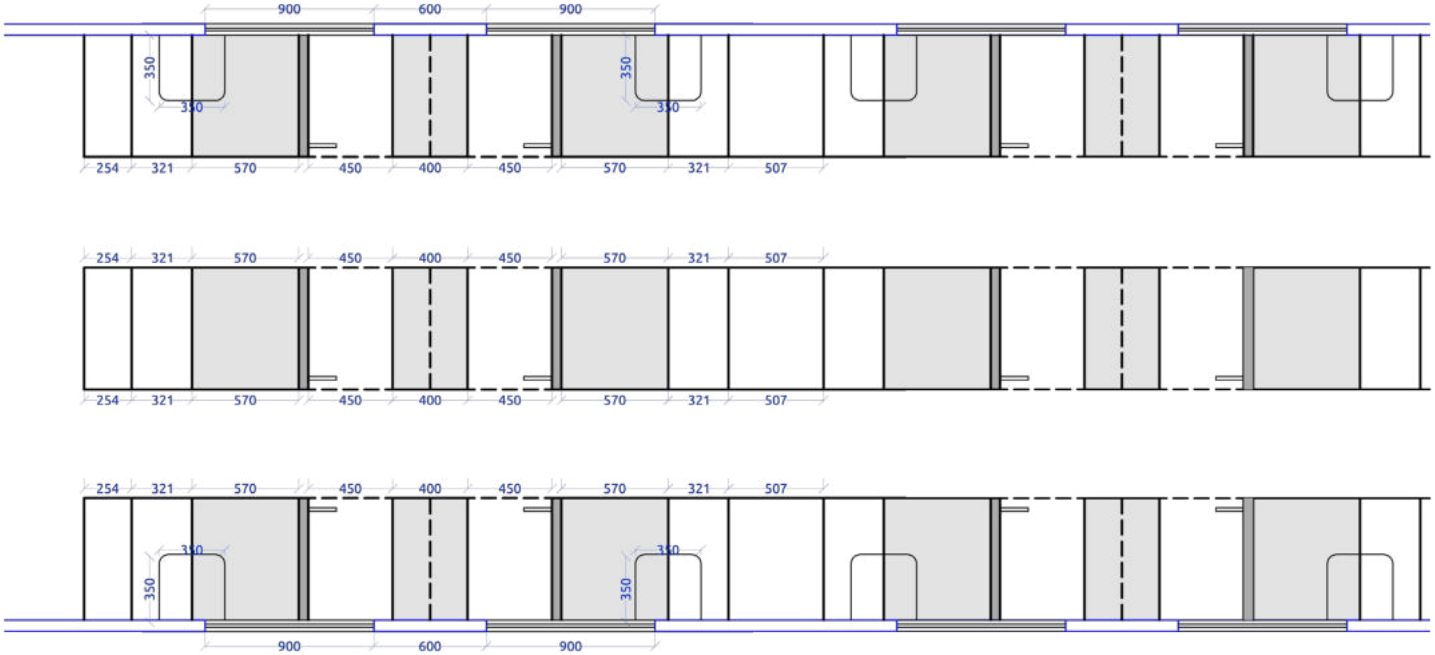


Fig 100 Level II detail

IDC
IITB

Side view detail

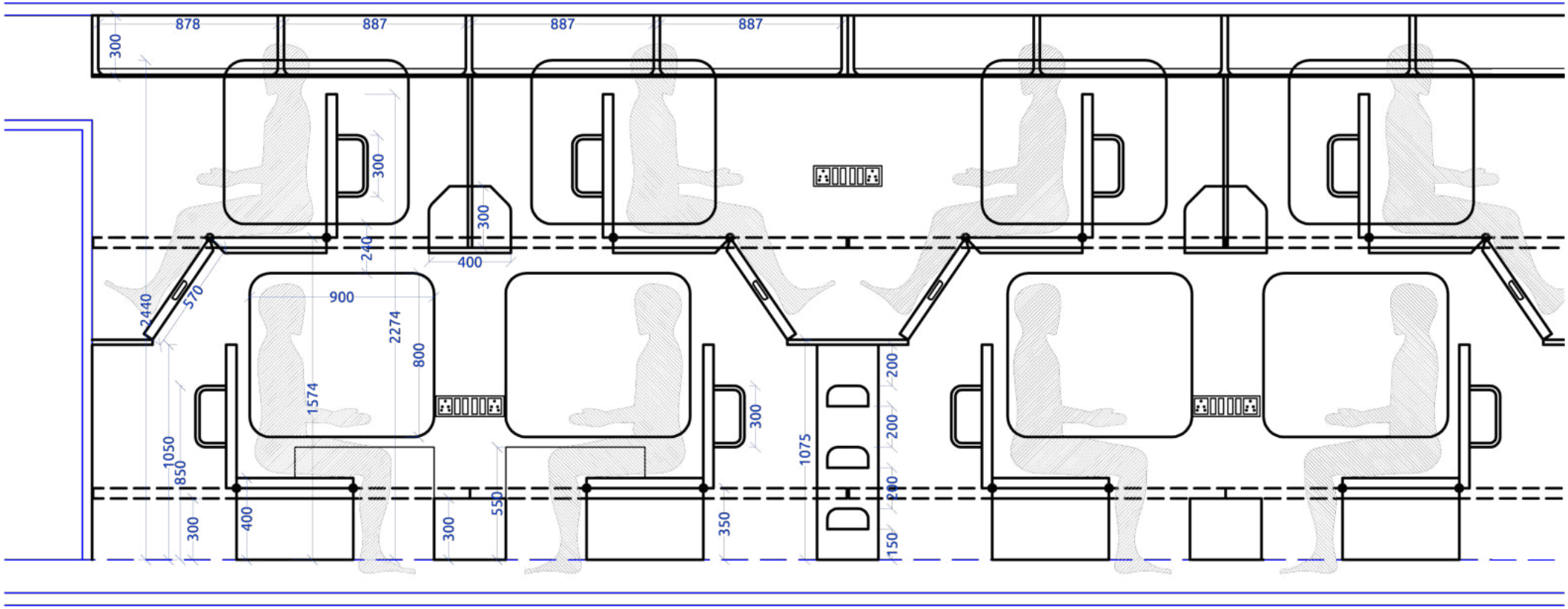


Fig 101 Side view detail

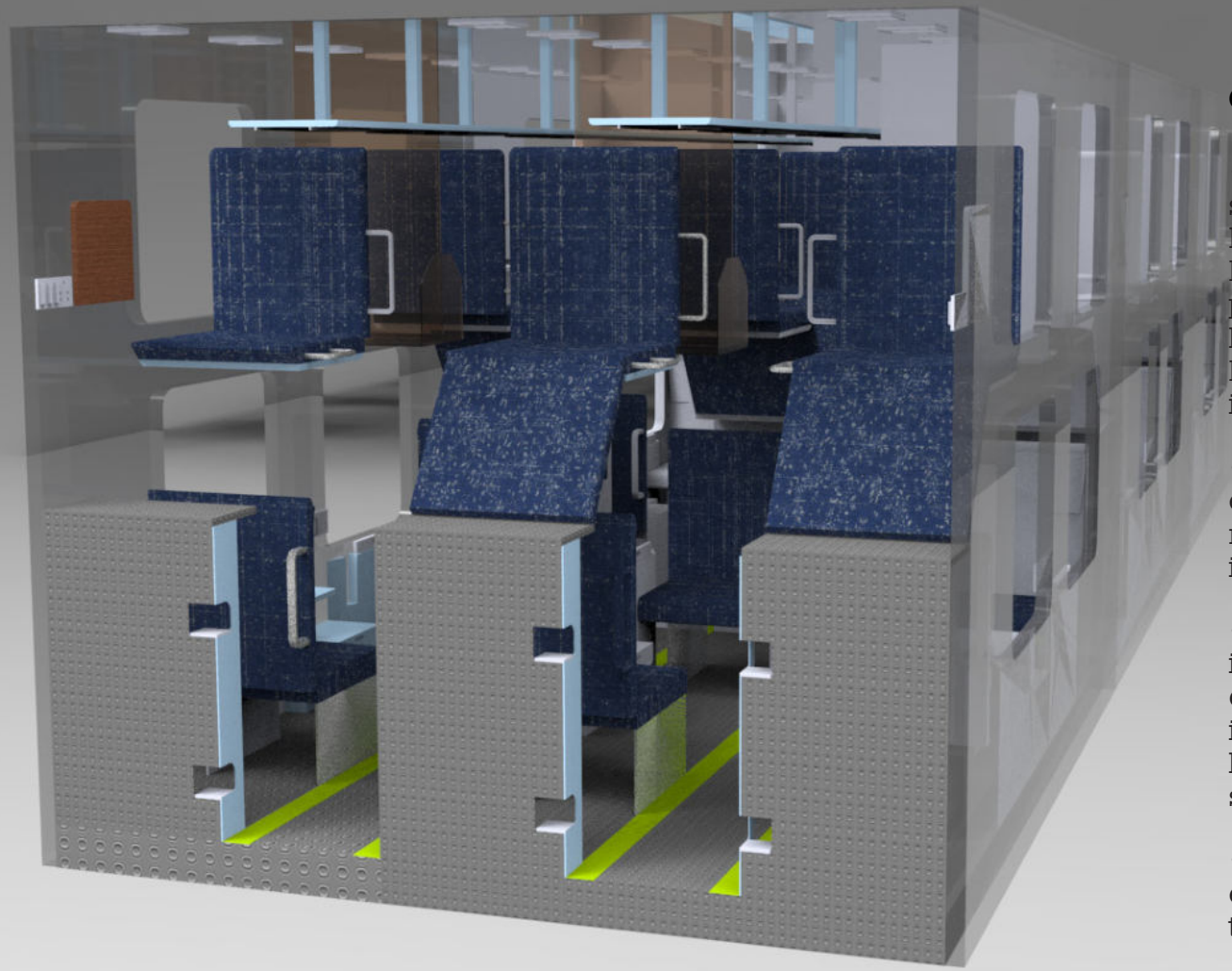


Fig 102 Sectional view

Features

Comfort

- The overall layout of coach built in such a way that there are only two levels of birth (two tiers) having upper berth and lower berth without a middle berth. Upper berth is placed at the height of 1500 mm from floor level. So it is easier to climb on the upper berth especially for elderly and persons having some health issues.

- Crampon (to climb upper berth) reduces the effort of climbing to the upper berth, by reducing distance between steps and placing it on the same surface.

- Length of the berth is increased and it is 1840 mm so taller people can be accommodated easily on each and every berth. (Now in the current railway sleeper coach it is very hard to recline fully for taller people on the side upper and side lower berths.)

- Berth size is increased to create adequate comfort for elderly, tall, fat and people traveling with their infants.

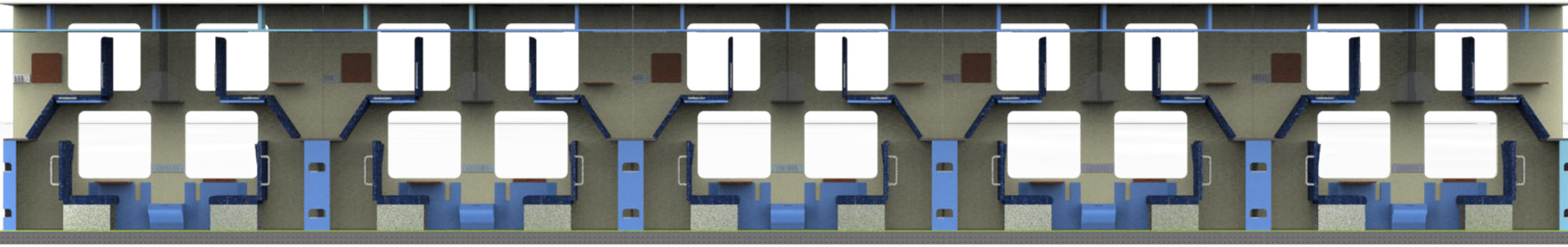


Fig 103 Side view sitting mode

Privacy

Each passenger has its own personal space so he/she doesn't have to depend on other passenger activities:

- They can sleep anytime.

(Now in the existing sleeper coach middle berth owner cannot sleep at the noon time, if he/she want to convert berth in sleeper mode, then people sitting at the lower berth get disturbed by these activities)

- They can have food anytime.

(If middle berth owner wants to have food then he/she has to adjust timing with the other passengers activities).

Amenities

- Space for keeping valuable luggage and accessories e.g. Wallets, spectacles, head-phones etc.

- Space for keeping footwear.

- Personal table top for each and every passenger.

Passage

- In the new layout here we have two passages which will help in faster circulation, and passenger can board and alight train much faster way. Since this design belongs to high speed train and the halting time will be less to normal trains so there is need of faster

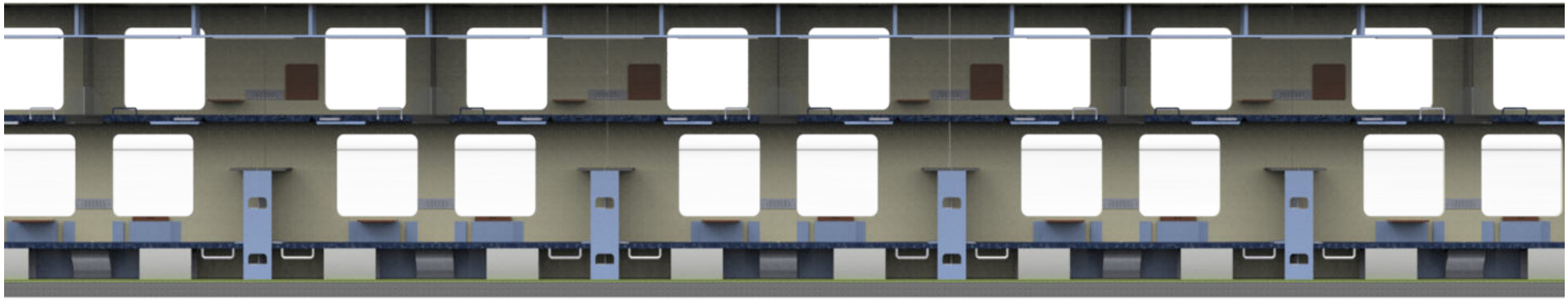


Fig 104 Side view sleeping mode

circulation among the passenger without any obstacle. Another benefit of two passages is- it is easy to evacuate coach in very less time during disaster and hazards.

• There will be two strips on the side of the passages; these strips will light up in condition of less light inside the coach. If any passenger is boarding train at night these guide lines will help passenger to reach their seats.

Windows

Window size and number of windows is increased so that interaction between passenger and outside world is heightened. It also enhances the natural light and ventilation inside the coach.

Lighting

Led diffused lighting is used throughout entire coach to provide pleasant ambience inside the coach. Personal light for each and every passenger is provided to read books and operate activities anytime without disturbing another passenger.

Waste disposal

There is provision for interconnected waste disposal system for two pair of seats, for maintaining cleanliness inside the coach, all these waste can be drained at outskirts of town. So it will help to maintain railway platforms clean and hygiene.

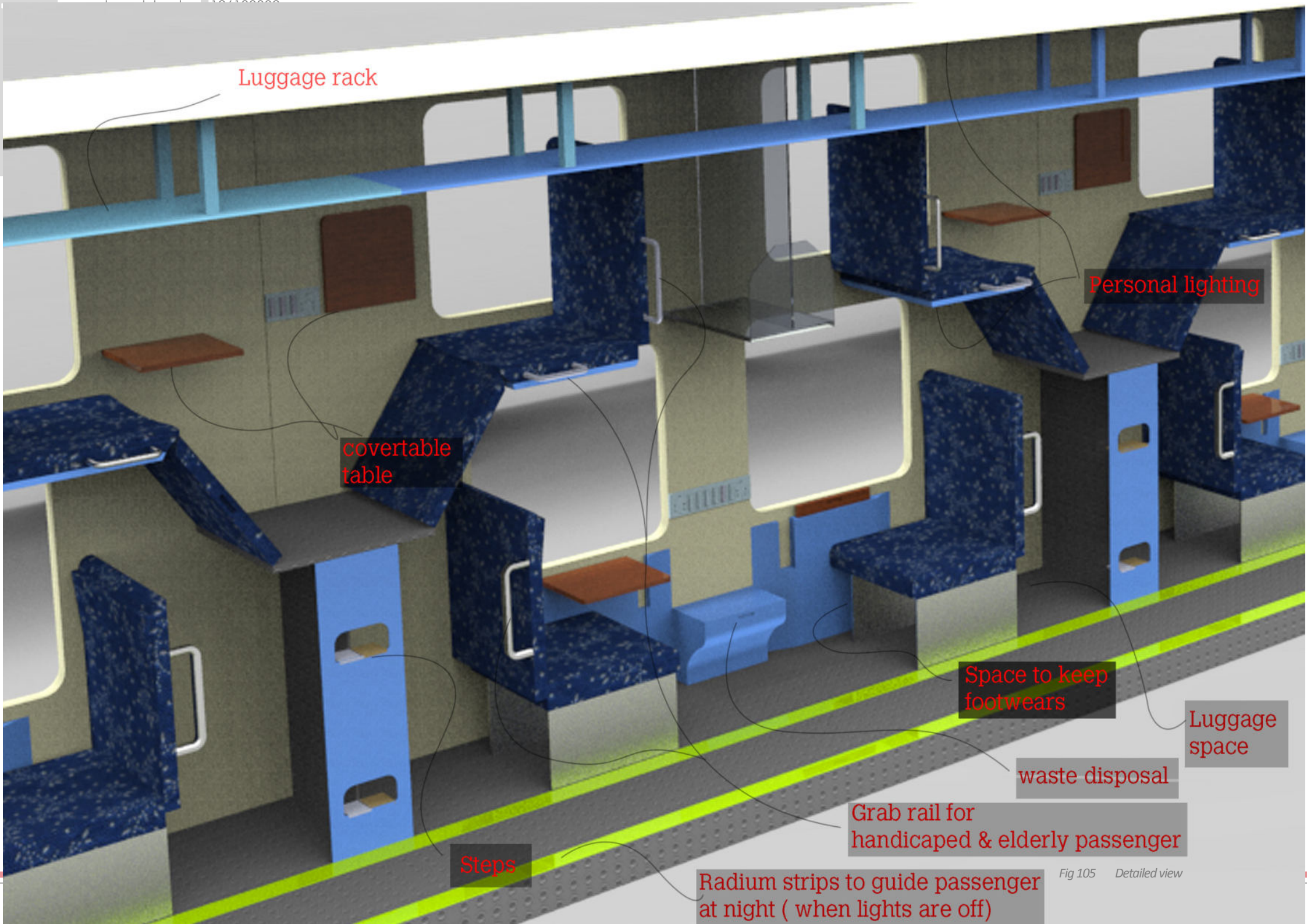


Fig 105 Detailed view

Luggage and safety

• Separate space for luggage is provided behind the seat, and when the back rest is turned down and seat is converted into a berth, the luggage will be locked by grab rail and nobody can steal your luggage while you are sleeping.

• If above seated passengers are keeping valuable luggage they can put it on the luggage rack providing just above to passage and near to upper seats, so would be visual connectivity between passenger and luggage bag. It gives an assurance to the passenger travelling at upper berth without having any incertitude.

Expected materials

- Cushioning of seats with fire retardancy features by use of PU foam to RDSO specification RDSO/2007/CG-04 with fire barrier cloth to IS
- Aesthetically appealing superior polycarbonate luggage racks without interference with normal passenger movement.
- Use of polycarbonate windows with roller blinds like LHB coaches with scratch resistant coating.
- Use of diffused lighting with LEDs.
- Use of suitable insulating material like resonaflex used in LHB coaches along with noise absorption paint.
- Use of metallic finish exterior paint for enhanced paint life and better aesthetics.
- Provision of passenger information system.
- Provision of dustbin of adequate capacity.
- Provision of automatic fire/smoke detection and alarm system and use of fire retardant coating and mastic sealing compound.
- Use of automatic AC entrance door operating mechanism.
- Use of vestibule door operating mechanism.
- Automatic odor and hygiene control systems.
- Use of LED based destination boards .

The need for composite applications arises from the following:

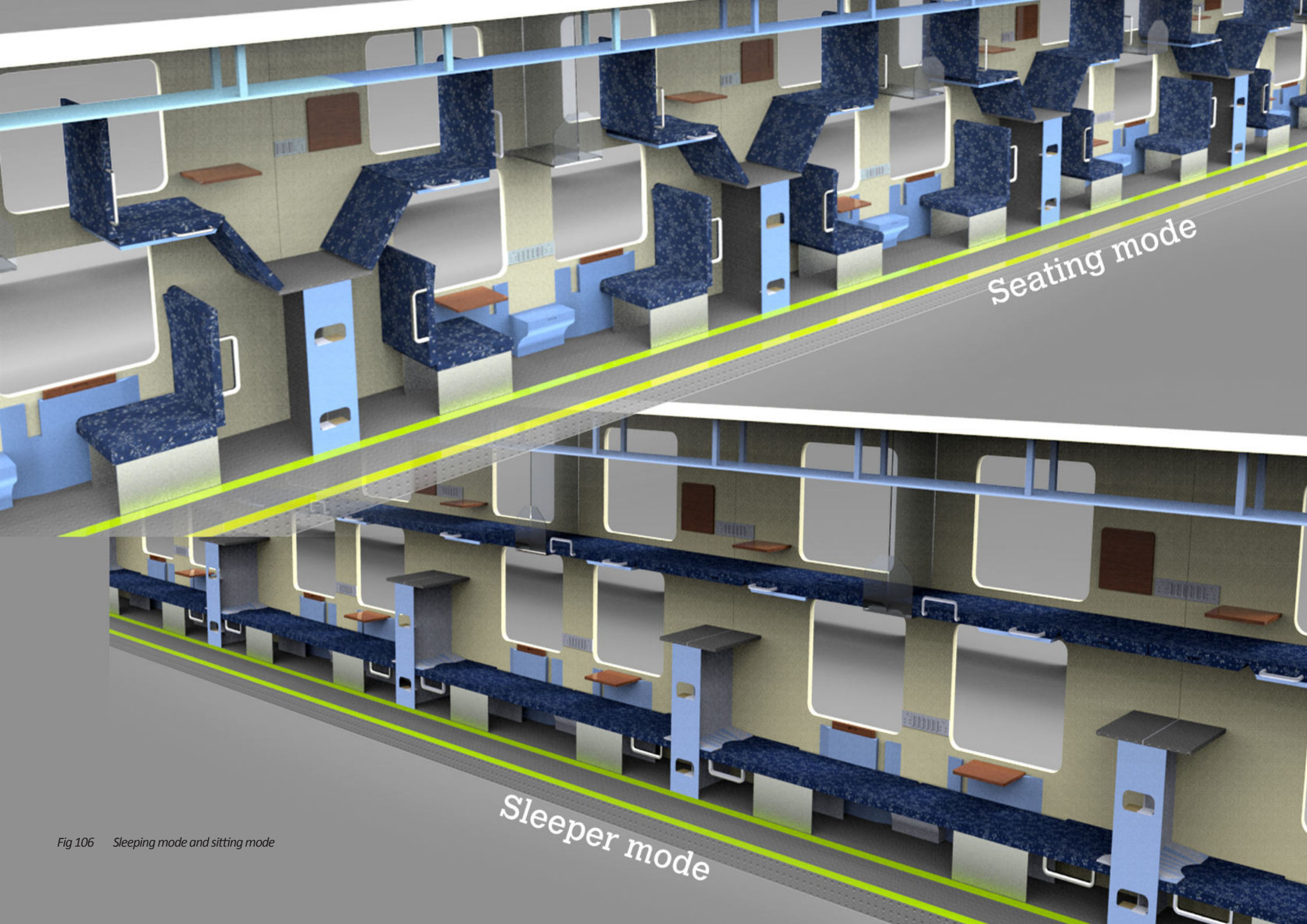


Fig 106 Sleeping mode and sitting mode

- Higher train speed warranting lighter rolling stock
- Lower energy consumption
- Vibration dampening resulting into lower noise level
- Improved passenger comforts & aesthetics
- Lower operation & maintenance cost
- Longer service life and improved life-cycle cost implications
- Prevention of pilferage of recyclable metal parts
- Minimal environmental impact

Safety concerns

Chain.

The emergency brake, popularly known as chain, in the compartments of the train, is meant to be used only during an emergency or danger. The chain system is interconnected to all the coaches of the train. Hence, when a chain is pulled in one coach, the brake system in the coaches jams to bring the train to an immediate halt. The train can only move if the chain is restored back to its original position.

Emergency light.

Every passenger car shall be equipped with automatic battery supplied emergency lighting of sufficient capacity to enable quick evacuation, by providing a minimum of lighting in vestibule areas, at end doors, in the galley, washrooms and isle ways as provided.

(Pulling chain to stop train worries railway officials 2012)

- Yellow emergency passenger assistance strips, when pressed notifying the train crew that assistance is required in your coach car.
- First-aid kits located next to the washroom in each coach car.
- Emergency equipment and posted instructions in every coach car.
- All passenger coaches are constructed of fire retardant materials.
- Luminescent stripping on the floor of every coach car, providing emergency exit paths when visibility is restricted;
- Emergency evacuation information posted near coach entry doors.

- 12 removable emergency exit windows on every coach.
- Emergency exit door release handles.
- Smoke and heat detectors.

Emergency window

- Locate red plastic handles on the window and pull handles toward you.
- Use both red handles and pull down to remove rubber strip from around the window frame.
- Locate the metal handles on window and pull towards you to remove window pane.

(Safety & Security n.d.)

Fig 107 Model picture 1

Scale Model

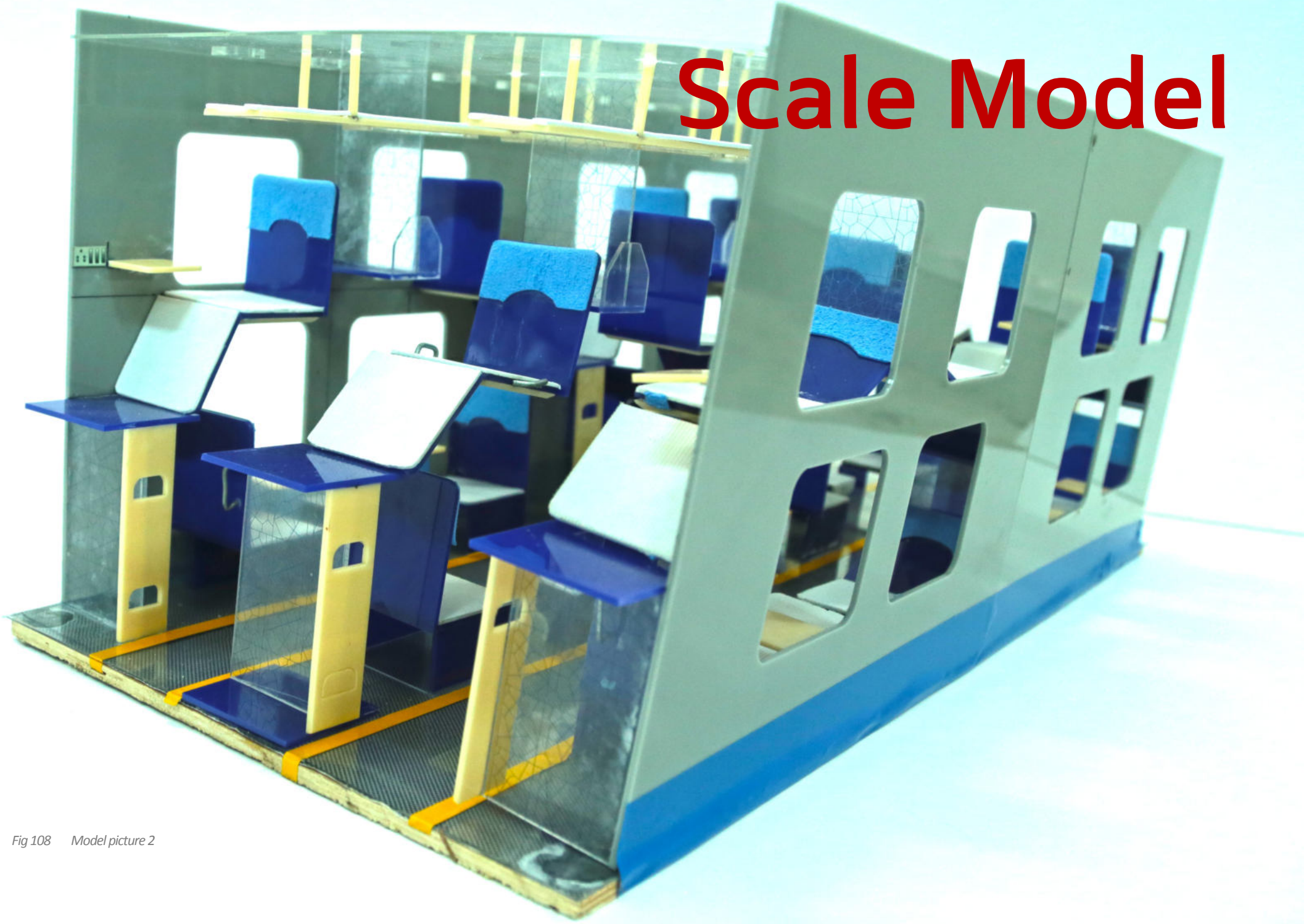


Fig 108 Model picture 2

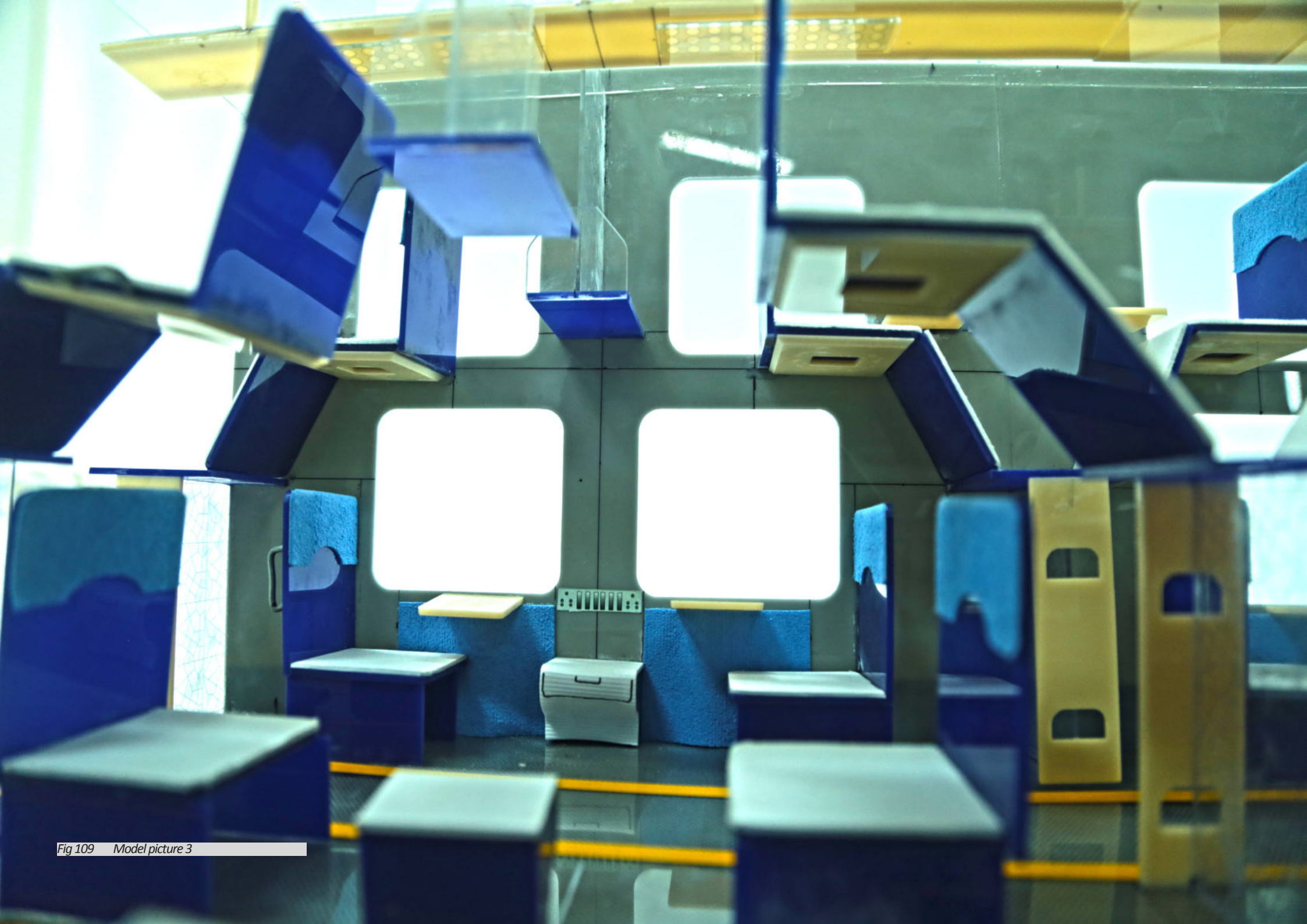


Fig 109 Model picture 3

Conclusion

Care should be taken in deciding the capacity requirements for rail vehicles. An ideal layout designed for a particular route will largely restrict the use of this vehicle for its whole life, particularly if large width or multiple layouts are to be chosen. A more versatile vehicle may end up as a compromise, not ideally suited to any route.

A forward looking and system orientated approach is essential to obtain the best result.

Fig 110 Model picture 4

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