Product Design Two

Project Report

REDESIGN OF SEATING FOR INDIAN RAILWAYS - AC CHAIR CAR

FOCUSING ON INDIAN PASSENGERS NEED FOR RELAXING AND WORKING DURING TRAVEL

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APPROVAL SHEET

The Industrial Design project titled

"Redesign of Seating for Indian Railways - AC Chair Car, Focusing on Indian Passengers needs for Relaxing and working during travel"

by Edwin Mendes (05613803)

is approved for the partial fulfilment of the requirement for the post graduate degree in Industrial Design.

PROJECT GUIDE: _____

EXTERNAL EXAMINER: _____

INTERNAL EXAMINER: _____

CHAIRPERSON: _____

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ACKNOWLEDGMENTS

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Furthermore, I wish to express my gratitude to thank Mr. Anand Hingne and the design team at GE Plastics for their valuable inputs at the initial stages of the project. Also, Mr. Ritesh Gohil for his critical feedback in the right time of the Design process.

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1.ABSTRACT

The project aims at enhancing the comfort level of the passengers traveling by Second Class AC Chair Car coach. Most of the Budget Airlines offer very affordable rates, connecting most of the major cities in India and are providing stiff competition to the Indian Railways in this concern. With extra comfort and luxury offered for a slightly higher price, air travel has become more feasible in a developing country, like India, today.

Hence, the need to enrich the experience of traveling by the AC Chair Car was identified and developed by the design team. Seating was one of the crucial area for a comfortable journey.

1.1 CONCERNS OF THE INDIAN RAILWAYS (IR):

- Increasing the capacity of the coaches - even one extra passenger per coach would generate more revenue on all the AC Chair Car routes

- Using the existing skeletal frame of the coach produced by either the RCF (Kapurtala) or ICF (Perambur)

- Adhering to the safety standards employed by the IR

- Creating fire-resistant, wear-resistant design that is vandalism proof

2. INTRODUCTION

The Indian Railways have a fairly large number of AC Chair Car coaches plying on many Inter-city routes all over India, particularly in the northern and western sectors. Most of these journeys are short-term ones ranging from 3 hours (Mumbai - Surat Shatabdi route) to maximum 9 hours duration (Mumbai- Goa Jan Shatabdi route).

A brief study of the existing system and experience of traveling on these routes not only reiterated the need for a re-design of the environment to provide a more comfortable journey for all travelers on these routes, but also demanded. a radical solution for attracting more travelers.

A few of the typical routes are listed below:

SOURCE STATION	DESTINATION	TRAVEL TIME	TRAIN NAME
MUMBAI	PUNE	4 HRS	INTERCITY EXPRESS
MUMBAI	AHMEDABAD	7 HRS	SHATABDI EXPRESS
MUMBAI	MARGAON	9 HRS	JAN SHATABDI EXP.
DELHI	BHOPAL	8 HRS	NDLS SHATABDI EXP
DELHI	LUCKNOW	6.5 HRS	LUCKNOW SHATABDI EXP
DELHI	AMRITSAR	6 HRS	SWARNA SHATABDI
BANGALORE	CHENNAI	5 HRS	SHATABDI EXPRESS
ERNAKULAM	TRIVANDRUM	4 HRS	ERNAKULAM SHATABDI EXP

The Indian Railways faces stiff competition from the Budget Airlines with discounted *APEX* airfares along with faster time travel and added comfort and service. Most of the traveling business professionals prefer air travel for the very reason that more comfort and time saving journeys are viable on most flights connecting important destinations.

Hence, the need to enrich the experience of traveling by the AC Chair Car was identified and developed by the design team.

3. USER STUDY AND ANALYSIS

User 1

User 2

User 3

ACTIVE PEOPLE WATCHING

For the User Study, we observed and recorded behavioral responses within the given context, without interfering with the user's activities

SET UP FOR OBSERVING USERS

A mini-DV was placed incognito on the folding tray and was used to record minute by minute change in responses of the user to his immediate environment.

This was useful to see what people actually do within real contexts and time frames, rather than accept what they say they did after the fact.

USERS STUDIED

User 1	35 M	Software consultant
User 2	23 M	MBA student
User 3	30 M	Sales personnel

ROUTES STUDIED

A study of four typical routes were carried out initially to understand the user's needs and behaviourial patterns within the given context.

- Mumbai- Pune Intercity Express,
- Mumbai - Ahmedabad Shatabdi Express,
- Mumbai- Margaon Jan Shatabdi Express and
- Chennai - Bangalore Shatabdi Express

The following observations were recorded as part of the user study:

3.1 STRATA OF SOCIETY:

High income professionals (management personnel, businessmen, doctors)

Upper class individuals who are concerned about luxury & safety

3.2 AGE GROUP OF USERS:

AGE GROUP	PERCENTAGE OF TRAVELERS *
0 - 17 years	9%
18 - 30 years	22%
31 - 45 years	40%
46 - 60 years	14%
Above 60 years	15%

3.3 PURPOSE OF TRAVEL:

Business trips
Leisure
Tours (foreigners, NRIs)
Reservation for National Awardees
Company sponsored trips
One- day trips (short trips)
Vacation trips

3.4 REASONS FOR CHOICE OF AC CHAIR CAR:

Safety (especially for women traveling alone)
Comfort & luxury
Psychological aspects of comfort like less crowd, no beggars or other disturbances
Can work during travel hours and still feel fresh.

** All figures stated have been collected from CRSE, Western Railways, courtesy Census of Indian Railways - 2005*

3.5 LUGGAGE

3.5.1 TYPES OF LUGGAGE:

Air bags & duffel bags
Rucksacks
Trolley bags
Briefcases
Laptop bags
Cardboard cartons
Plastic bags

3.5.2 PERSONAL LUGGAGE CARRIED BY PASSENGERS

Personal handbags
Laptops
I-pods
Mobile phones
Walkman
Foodstuff apart from their heavy luggage

3.5.3 ISSUES FOR LUGGAGE SPACE:

- Safety of luggage storage
- Accessibility of luggage stored
- Every passenger carries at least 2-3 bags.

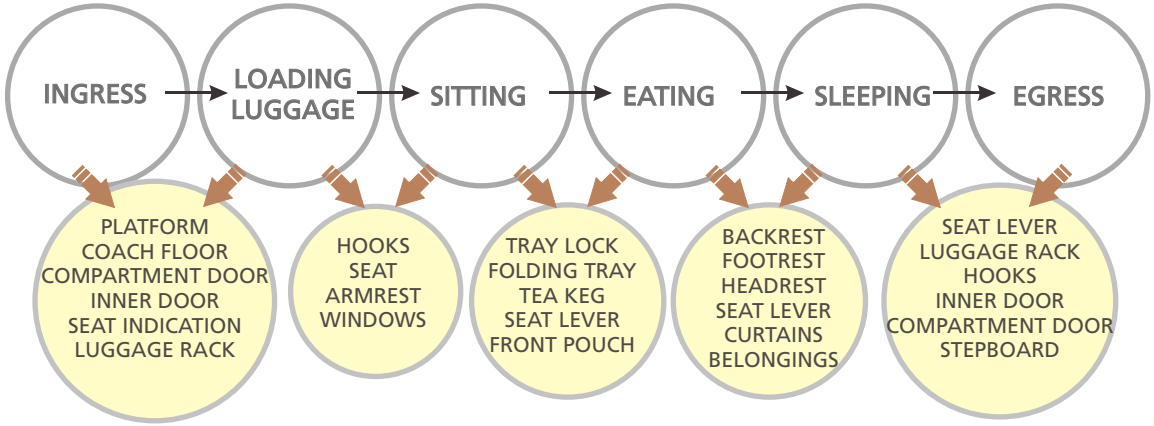
** All figures stated have been collected from study carried out by the design team over four different routes in the same season*

3.6 ACTIVITY AND ERROR ANALYSIS

Listing/ representing in detail, all tasks, actions, objects, performers and interactions involved in the process.

Listing all things that can go wrong when using a product and determine the various possible causes

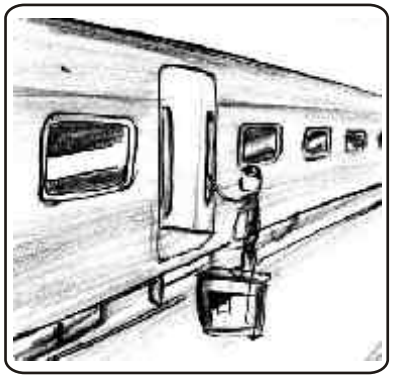
3.6.1 ACTIVITY FLOW DIAGRAM



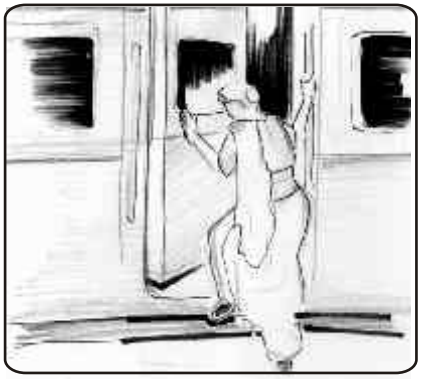
3.6.2 ADVANTAGE

Understanding how human features mitigate or contribute to inevitable human errors and other failures and to identify what issues to address

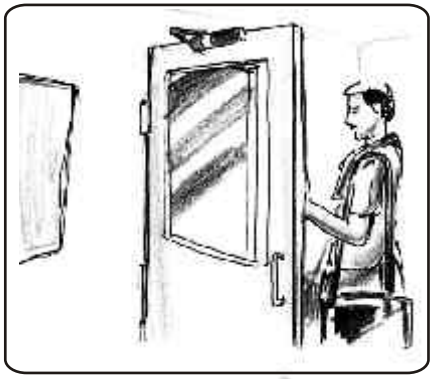
3.6.3 INGRESS



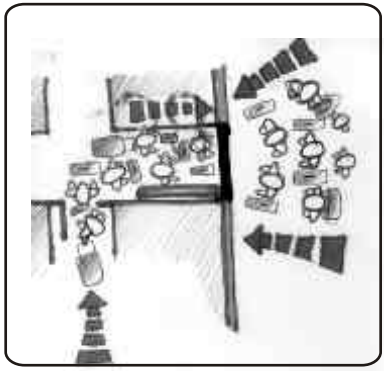
Steps to board the train are vertical and height of platform varies



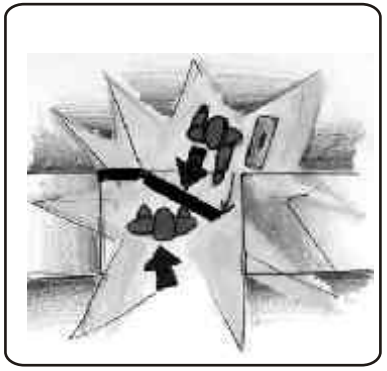
Elderly people find it difficult to board the train and the heavy door Shuts halfway



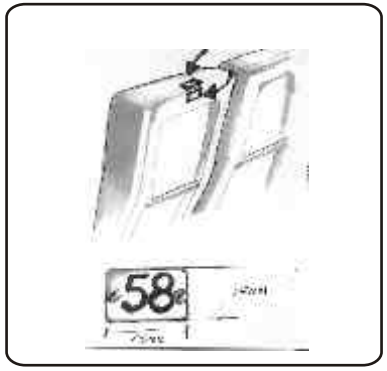
AC compartment door shuts immediately because of hydraulic hinge



Rush between people boarding and alighting



People standing behind door creates obstacles



No uniform, legible sign age system for locating seats

Passenger carrying lots of luggage cannot enter at one time and the door width is insufficient

3.6.4 LOADING LUGGAGE

Difficult to haul heavy luggage onto top rack; not accessible to short users. Need to access luggage during journey.

Users prefer keeping the luggage close to them and female passengers do not like to place their handbag on the hook

2 hooks for 3 passengers

In absence of space, the user keeps his bags on the floor near his seat

The front pouch does not easily accommodate newspapers with magazines and water bottles

3.6.5 SITTING

Footrest operation is hard

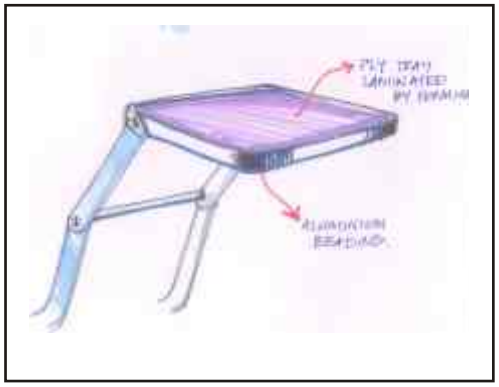
Footrest accessibility is low

Absence of neck support for short people

Armrests are shared by two users each

Users respond differently with interesting postures for sitting. Middle passenger has problems in movement.

3.6.6 EATING



Tray is too small and vibrates too much – hot drinks spill
The metal tray gives the factor of cold touch in the AC Compartment

Once the tray is down, the inner passengers cannot egress easily

The tray is used for eating, sleeping and working

Passenger has to remove the wallet to pay the pantry server

The tray is used for working during travel

Waste disposal systems are not provided

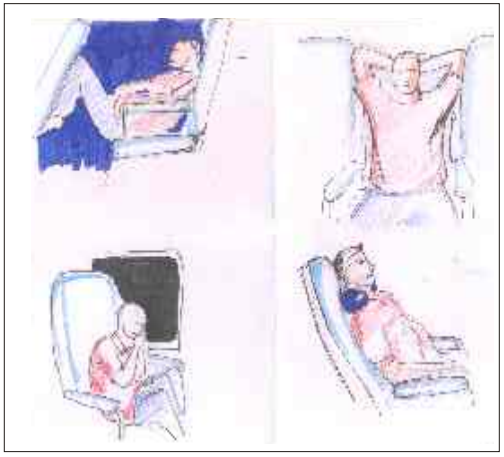
3.6.7 SLEEPING

Need to support legs at higher position

Seeks for head support in different ways

Change in Backrest position is a hindrance to user sitting behind

User sleeps lying flat using adjacent unoccupied seats



Acquires different postures for comfortable sleep

3.6.8 EGRESS

Passengers look around to see if they have left any of their personal belongings behind

People tend to groom themselves before leaving

Space in the aisle is inadequate

Difficulty with exiting through the door with luggage

3.7 SECONDARY STUDY

The design team had reviewed published articles, papers and other pertinent documents to develop an informed point of view on the design issue

"Results indicate that horizontal linear acceleration in a car, such as experienced during multiple braking maneuvers, is an effective motion sickness provoking stimulus. Negative X-axis stimulation is more nauseogenic."

- Article on Dependence of motion sickness in automobiles on the direction of linear acceleration - SpringerLink

"The cause of motion sickness is generally considered to be a mismatch of vestibular and visual sensations. However, actual movement of the body is not necessary to produce symptoms. Purely visual stimuli, such as those from flight simulators, panoramic movies, or even the movement of slides under a microscope, can produce symptoms more effectively than does actual physical motion The degree of motion sickness appears to be directly related to how well the visual stimulus simulates motion."

- Post-graduate Medicine Online

This was a useful way to ground observations and to develop a point of view on the product in study

3.7.1 OTHER CHAIR STUDY

Study of Volvo Bus Seating

In order to understand the constructional detail of the seats a study was done in Volvo buses. The reclining mechanism of the backrest was clearly understood and details were noted. It also helped to under the details of the supporting structure.

Study of Executive Office Chair

A detail study of executive office chairs was also done. Various features such as the adjustable armrest in three dimensions was studied. The plastic detail of the seat structure gave a better understanding of the possible use of plastics.

3.8 SURVEY

Asking a series of targeted questions in order to ascertain particular characteristics and perceptions of users. Users were also asked to prioritize the following factors for design considerations:

COMFORTABLE RELAXING SEAT
COMFORT SPACE PER PASSENGER
LUGGAGE STORAGE SPACE
ACCESSIBILITY OF STORAGE
SECURITY OF LUGGAGE STORED
INDIVIDUAL USER CONTROLS
CAPACITY OF PASSENGERS PER COACH
MAINTENANCE AND SERVICING
MODULARITY IN DESIGN
ADAPTABILITY TO INDIAN RAILWAYS

3.8.1 USERS INTERVIEWED

Total 10 users were directly interviewed to get their requirement and understand problems faced by them.
The evaluation of different criteria for design of interiors were also carried out by 30 other individuals from different backgrounds and professions.

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3.8.2 ADVANTAGE

This was a quick way to elicit answers from a large number of people

3.9 ANALYSIS OF USER STUDY

This stage involved Clustering the design elements according to intuitive relationships such as Similarity, Dependence, Proximity, etc.

3.9.1 METHOD

Rapidly group ideas that seem to belong together.

Clarify any ideas in question.

Copy an idea into in more than one affinity set if appropriate.

Look for small sets. Should they belong in a larger group?

When most of the ideas have been sorted, you can start to enter titles for each affinity set

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3.9.2 ADVANTAGE

This method was useful to identify connections between issues and reveal INNOVATION OPPORTUNITIES

3.9.3 DESIGN ISSUES

All the observations were tabulated in a format. The corresponding insight for each observation was noted against them. These insight helped to develop first stage design ideas

3.9.3.1 INGRESS

OBSERVATION	INSIGHT	DESIGN IDEA
Movement of luggage in and out of the inner door is very inconvenient	- Width of the door is too small - No space for a hinged door at the end of the aisle	- Door should be sliding - Door could have sensors at entry
Opening the door with luggage in hand is tough	- Poor detailing in door hinge design - Delayed shutting of door creates a problem for AC environment	Designed for ergonomic considerations for easy opening
Difficulty of loading luggage onto train	- Platform heights vary from station to station - Bogey floor height is too high from the platform	- Platforms could be built up to uniform height all over India - Sloping ramps could ease in the luggage into bogey
Entry area is not clean with the stench of the lavatories	- Close proximity of lavatories to the entry area is not a good solution - Cleaning facilities for maintenance of toilets is absent in the current coaches	- More hygienic facilities provided in toilets and wash areas - Entry could be provided from the middle of the coach just like in the EMU Mumbai local trains

3.9.3.2 LOADING LUGGAGE

OBSERVATION	INSIGHT	DESIGN IDEA
Luggage on top rack is inaccessible	Height of most of the Indian users is not considered in existing design	- Rack could be lowered for access - Floor could be stepped up from aisle level
Passengers prefer to keep luggage close to them, even hand luggage is kept close to the body	- Security of luggage is of utmost importance - Passengers prefer luggage visibility while seated during the journey hours for assurance	- Cubby holes can be provided for personal luggage storage - Luggage could be stored at floor level for better visibility & access
Fights for luggage space occur between passengers , specially those traveling on longer journeys	- No demarcations are provided for individual luggage storage per passenger - Bigger luggage cannot be stowed away for longer journey hours	- Individual allotment for luggage storage like in airplanes - Big suitcases could be stowed away under the attendant's supervision at the entry areas.
Barely any luggage fits under the seat; small luggage is placed in front of the seat	- People hesitate to store bags under the seat owing to unhygienic conditions - Clearances below the seat are cut by the support structure of the seating onto the floor	- More hygienic storage spaces could be provided on the floor level - Cantilevered or raised seating to be provided
The top rack is too small for most suitcases, worry of falling down during journey	- For lack of hygiene on the floor surface, passengers insist on storing all their big luggage on the top rack - Top rack depth is not efficient for storage capacity of luggage.	- Even 4" increase in rack depth could make storage safer & efficient - Overhead enclosed luggage cabins could be provided for safer storage

3.9.3.3 SEATING

OBSERVATION	INSIGHT	DESIGN IDEA
Lack of freedom for middle passengers	When the tray is down, the middle passengers have restricted movement	- Tray should be detachable - Tray could pivot around to allow passenger sitting on the inside to exit
Hates sharing armrests - too small for two users	- Passengers demand for privacy in their individual comfort zones - Unforeseen areas of comfort zones overlapping	- Split level armrests should be provided - Inverse seating could be introduced for middle passengers
Water Bottle stored in front pouch hits the knee	- Risk of hurting oneself in times of sudden impacts with bottle hitting the knee - Bottle storage should be accessible and yet placed in a safe proximity to the body	- Bottles could be stored horizontally on sides of passengers - Depth of Back rest could accommodate for depth of bottle storage
Headrest cover is a good solution	- People with oily hair leave stains on the cloth covers - Maintenance personnel do not replace the head covers too often	- use and throw suggestion for head covers - Use of plastic covers that can be wiped easily
All mechanisms used in the interiors should perform consistently	- Hinges wear out over time and excess use - Locks do not hold trays in place, reclining seats stop working, armrests get jammed	- Durable and smple hinges can avoid problems - Easily replaceable hinges can suffice for smooth & better functioning

3.9.3.4 EATING

OBSERVATION	INSIGHT	DESIGN IDEA
No proper cup holder in the tray	No opening or depression in tray to hold cup firmly during journey	- Tray has hole to fit in cups of all sizes - Cup holder not attached to tray - independent fixture
Tray vibrates so much; hot drinks spill	- Hinges of tray are weak - Serious accidents could occur if child is seated on mother's lap when hot drinks spill	- Hinges should be sturdy - Tray could stop spillage by use of smaller depressions around the cup area to hold spilled drink
Tray obstructs movement while in use for both passenger and co-passenger	- Need to exit out of coupe for visit to lavatory - Tray is fixed in position, once unlocked and brought down	- Detachable tray design - Pivoted tray for easy movement into aisle without disturbance
More space required on tray for thermos flask, food tray and cutlery	- Too much food is provided on these routes - All food is served together in one time	- Food service could be broken up into two or three sessions - Tray size could increase by an inch on either side for better placing.

3.9.3.5 SLEEPING

OBSERVATION	INSIGHT	DESIGN IDEA
Footrest is not always accessible - needs to be higher	Indian anthropometric data is not considered in the existing design	-Adjustable footrest to suit user's height - Provision of slumberitt to eliminate foot rest completely
Uncomfortable to sleep with the tube lights on	- Ambient lighting levels are too high - No cover for the eyes while sleeping	- Ambient lighting could be diffused - Task lighting is to be provided for reading purposes which can be individually controlled
User is uncomfortable with the head supports	- Adjustable head support to be provided	- Provide a moving hand operated adjustable head supporting element

3.9.3.6 HVAC & VENTILATION

OBSERVATION	INSIGHT	DESIGN IDEA
Temperature variations within the coach - not evenly distributed	- Cold Air is fed into the bogey from the two extreme ends - Air outlets are placed in close proximity to the RMPU's and are not circulating air within interior	- Centralised HVAC system can be introduced with air outlets all along the aisle length of the bogey '
Cooling controls are not individually operated	-Overall temperature cannot be controlled individually - Air draft in vents can be channelised and controlled individually	- Provide individual air-blowing jets for every passenger - Air outlets can then be controlled individually to set the airflow.

3.9.3.7 LIGHTING

OBSERVATION	INSIGHT	DESIGN IDEA
Task lighting is required	Ambient lighting too bright for sleeping and yet too dim for reading purposes	- Task lights should be provided for every user - Ambient lights can be diffused
Film on windows is required for privacy	- Cuts down dependence on natural lighting - intensity of light filtering in keeps changing; can be a disturbance for reading purposes	- natural light can be filtered in to provide ambient light through other openings - Use polychromatic filters on windows
Some seats do not have access to windows	- Seats are not placed on basis of window positions - Modularity in design of side panels for windows and user amenities is not addressed	- Continuous strip of day-light openings - Modular design introduced in side panels for regularized seat layout
Power consumption is too much for lighting	- Lights are not replaced soon as they stop working - No concern of conserving energy with the Indian Railways, all CFL lamps are employed	- LED lamps can be used for lamps - more long lasting and energy consuming - LED lamps will have to be replaced less frequently

3.9.3.8 USER AMENITIES

OBSERVATION	INSIGHT	DESIGN IDEA
No proper provision for waste disposal	Waste is thrown into the nylon wire pouch in the front	- Waste disposal systems could be incorporated under each seat with disposable bags
No place for storing mobile phones while charging	- Charging sockets are only at either end of the bogey - Most passengers are unaware of the provision of charging facility	- Mobile charging sockets could be repeated in the side panels for every passenger - Signs must indicate charging facility
No PA systems informing about station arrival or stoppage time	- Passengers are anxious to know about the details before approaching the destination - Sometimes, the systems are installed but do not function regularly	- PA systems could provide information regarding - Stoppage time in next station - Train speed - Warning not to leave luggage - Time to arrive at next station
Seat number indication is very poor	- Stickers are very often replaced be passengers - Too many signs in different places can confuse the passenger (both on the side panel and on the seat front face)	- More legible system for seat signs is required - Digital display of seat numbers so that it can be changed depending on capacity of train compartment.
No provision for storing small items like wallet and walkman	- Personal luggage storage is required with security - People prefer to keep the wallet to the side especially before sleeping	- Cubby holes with secure openings canbe provided on the side

3.9.3.9 EMOTIONAL / PSYCHOLOGICAL ASPECTS

OBSERVATION	INSIGHT	DESIGN IDEA
Factor of cold touch in most elements used	Too much use of metal in design of elements creates problem of cold touch	- Need to introduce plastic in design - Self colored plastics are easy to maintain and break visual monotony
Passengers are unaware of amenities provided or just don't know how to use them	- Visual positioning of user amenities is lacking - Passengers may feel hesistant to use unknown or alien features in a new surrounding.	- Design of amenities should be intuitve - user amenities should be visually coded to identify position and use
When person in front reclines, the passenger sitting behind feels uncomfortable	- No indication or warning of reclining position - Passengers using laptops on the tray for work are at risk of damage to equipment	- Glowing signs to indicate slow change in reclining angle - Tray could move back with the seat to avoid damage to laptops
Unhygienic conditions - floor is dirty, curtains stink	- Indian Railways invests little time in maintaining the coaches - Minimal maintenance design is invited by both the Railways and the end user	- Plastic is ideal for easy maintenance and serviceability - Lesser the number of surfaces to be cleaned, the better the travel experience
Noise level from trains to be reduced	- Silence /minimal noise is required during sleep hours on train and is constantly disrupted by external / ambient noises - Too much vibration from use of metal parts creates lot of noise inside compartment	- Use of plastic parts and dampeneners to reduce vibrations - Acoustic materials on cladding of interior elements can cut down the noise levels

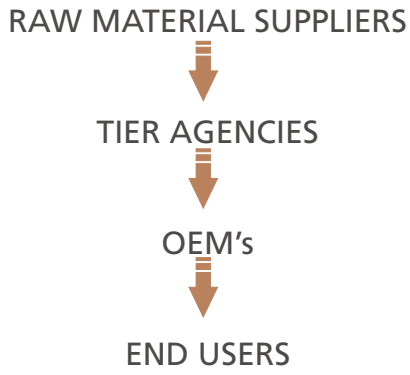
4. INDUSTRY FEEDBACK

Meetings were held with the design team at GE Plastics in Gurgaon to discuss the user study and design concerns that would be taken up for study basis during conceptualization.

The design team helped in redefining the product brief in accordance with understanding the process of design employed by the Indian Railways. Further light was shed on design for ease of manufacture and durability in design by Mr. Ritesh Gohil at Harita Seating, Bangalore.

4.1 GE PLASTICS, GURGAON - MR. ANAND HINGNE & DESIGN TEAM FEEDBACK

HIERARCHY OF PARTIES INVOLVED IN THE DESIGN PROJECT



4.2 HARITA SEATING, BANGALORE - MR. RITESH GOHIL

1) Ease of manufacture for plastic productions and detailing - structural PP (injection molding) was suggested for use in elements owing to the existing huge dependence of the automotive industry on this production process

2) Safety issues in case of Fire, Derailing and other Emergency situations

3) Durability and Design for Vandalism, owing to the context of use

4) Ease of replaceability and repair - on the spot replaceability as well as yard servicing, understanding the attitude towards assembly scheme and fixing.

5) Joinery and details ideal for Indian conditions - sliding details do not last as long as the pivoted joints over extreme use and load.

5. PRODUCT BRIEF

5.1 PRODUCT BRIEF STATEMENT

Design of Seating for AC Chair Car

- which caters to Indian passenger needs of relaxing/working during travel between cities.

5.2 DESIGN REQUIREMENTS

Sitting

- Footrest to be provided addressing to Indian seating /Sleeping Postures.
- Footrest Should be easy to access and operate
- Head support should be provided for resting head
- Should cater to different postures that the passenger takes when s/he is alert or relaxing
- Better utilization of space

Sleeping

- Reclining the backrest should cause minimum hindrance to the passenger occupying the rear seats.
- Adjustability for the user to support head in different ways
- Allow the user to get his/her comfortable sleeping posture

Safety & Maintenance

- should be safe in case of accident, have good serviceability and reliability with robust detailing.

6. IDEA GENERATION

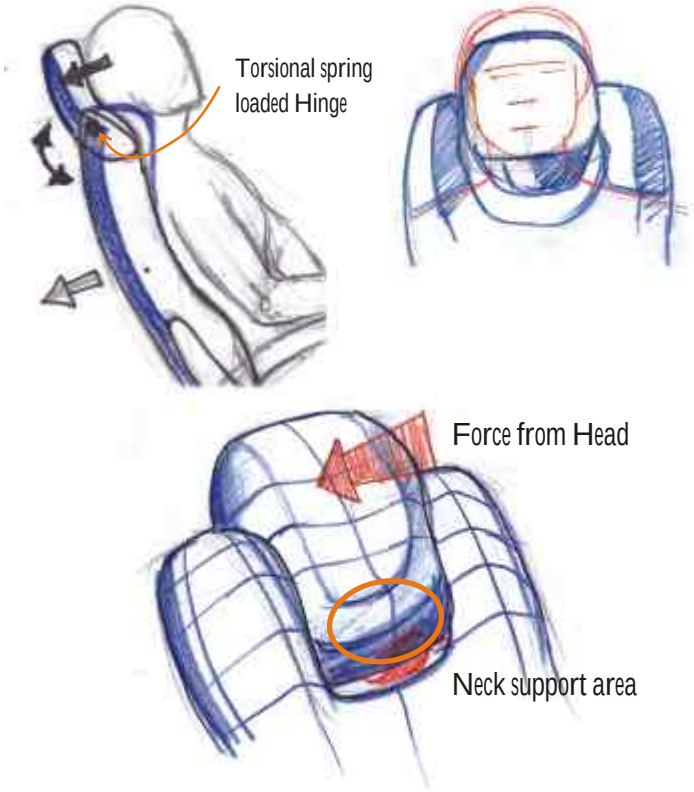
6.1 IDEATION

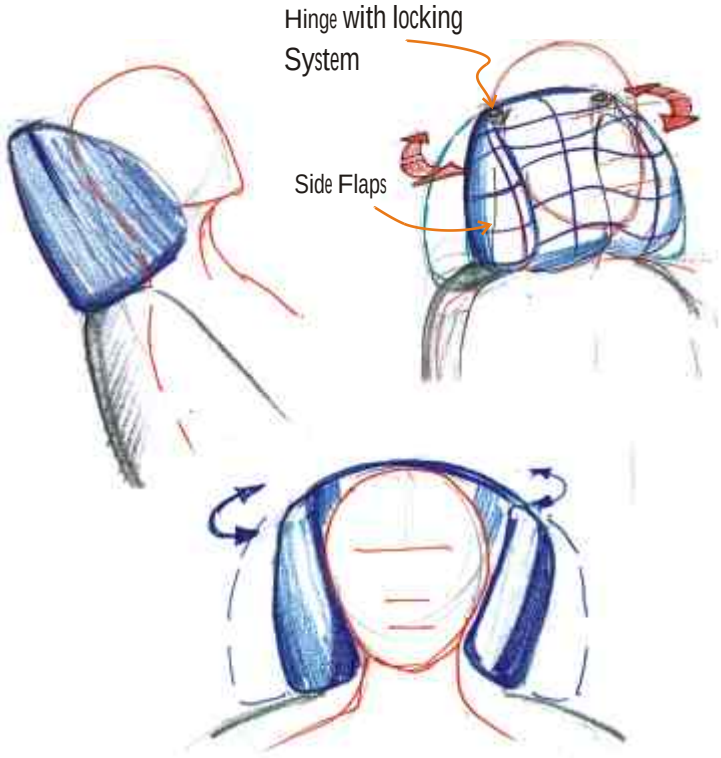
The process of idea generation was ongoing throughout the data collection phase. Free ideation was done based on the observation, idea sketches were made focusing on specific issues. The intention was to come up with new ideas as and when a problem was identified during the data collection.

6.2 IDEA SKETCHING

From this stage on, idea sketching was done taking into consideration the various requirements that are listed in the product brief. Clusters of ideas were generated based on user's needs and requirements of the Indian Railways. In the following pages the idea sketches have been explained.

6.3 IDEA LOG:





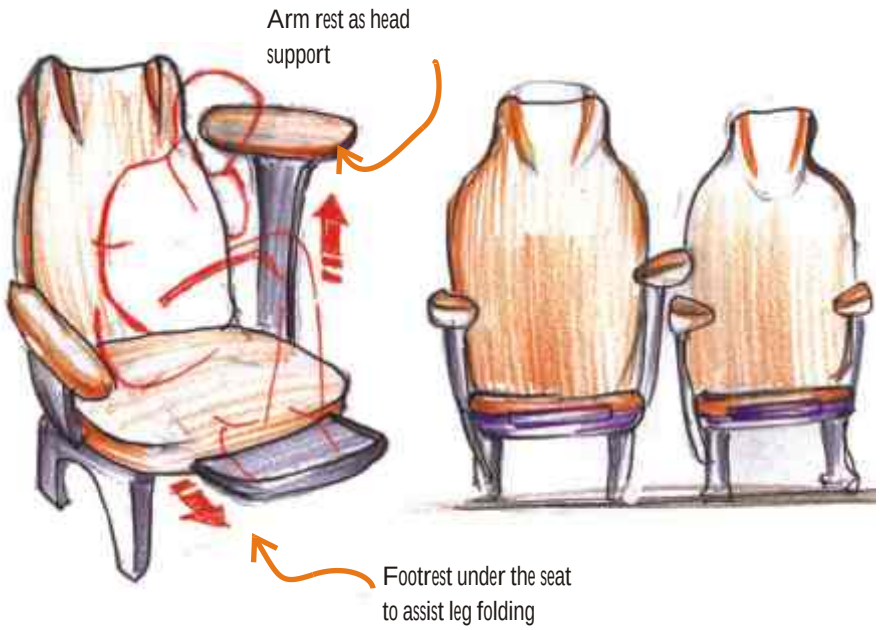
Idea 1

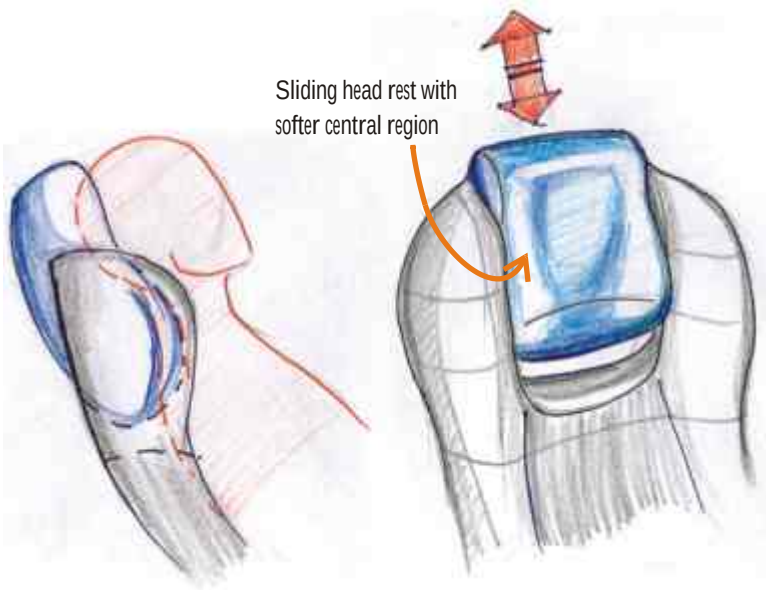
The Head rest is hinged just below the head contact area and above the neck. The hinge has a torsional spring. As the user rests his head on the head rest the area below the hinge moves forward and supports the neck.

Idea 2

This has two hinged side flaps which can be locked at the desired position. Each flap can be individually controlled, so it allows the user to decide the side where he wants to rest his head. The flaps are cushioned with breathing material.

6.3 IDEA LOG:





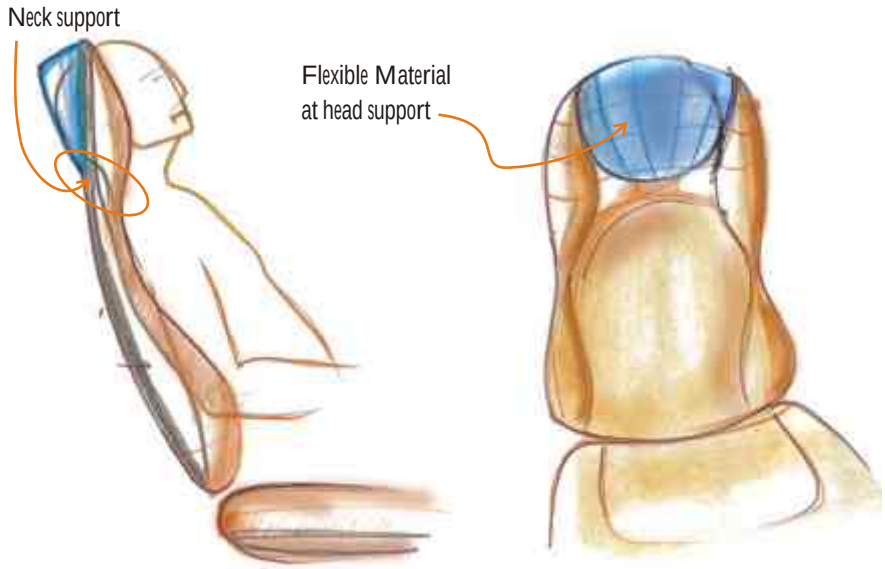
Idea 3

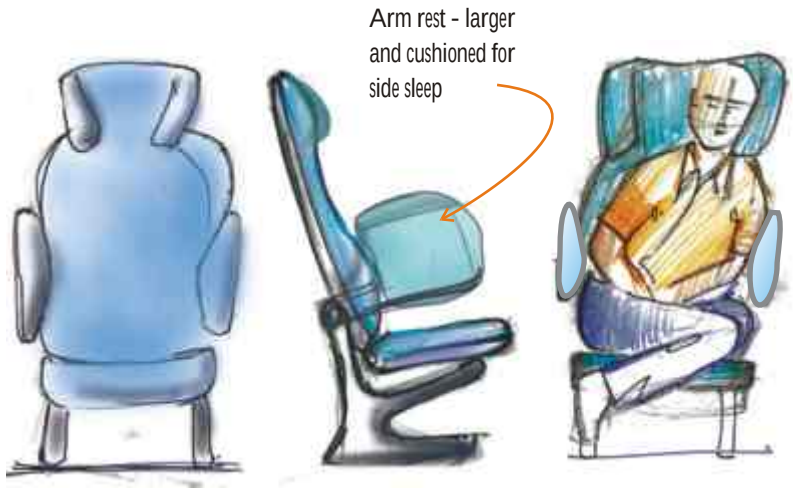
In this the armrest of the chair slides to desired height to support the head when sleeping. It also has a sliding footrest just under the seat which can be used to support legs in folding.

Idea 4

The head rest can slide within a certain range to consider the variation in user heights. The softer central area sinks in with the head pressure and the harder region below supports the neck.

6.3 IDEA LOG:





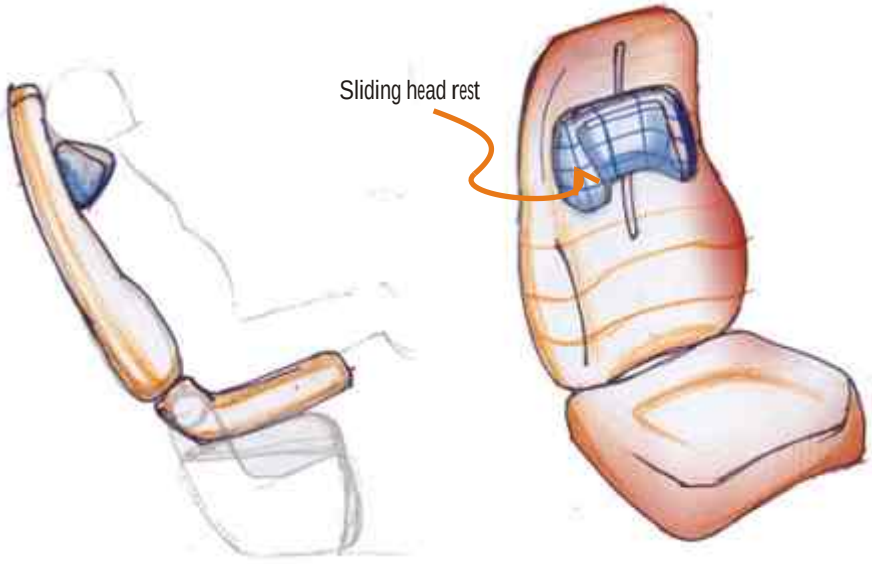
Idea 7

The thin flexible material provided at the head resting area stretches and sinks in to accomodate the head like a bucket. The lower region below the flexible material is harder and would support the neck.

Idea 8

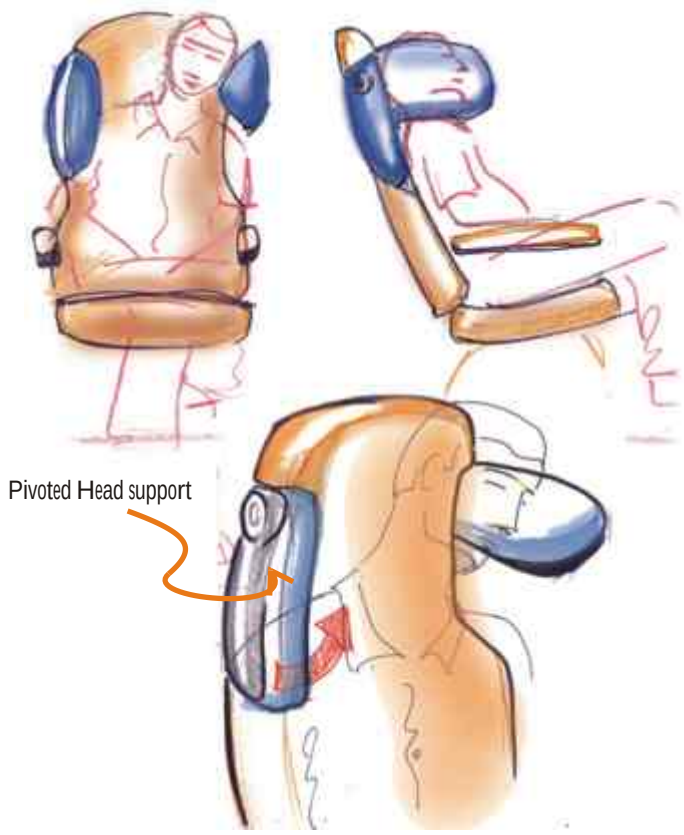
This has two fixed side flaps which act as cocooning of the head. The arm rests are larger and cushioned which acts to support the body in side sleeping.

6.3 IDEA LOG:



Idea 5

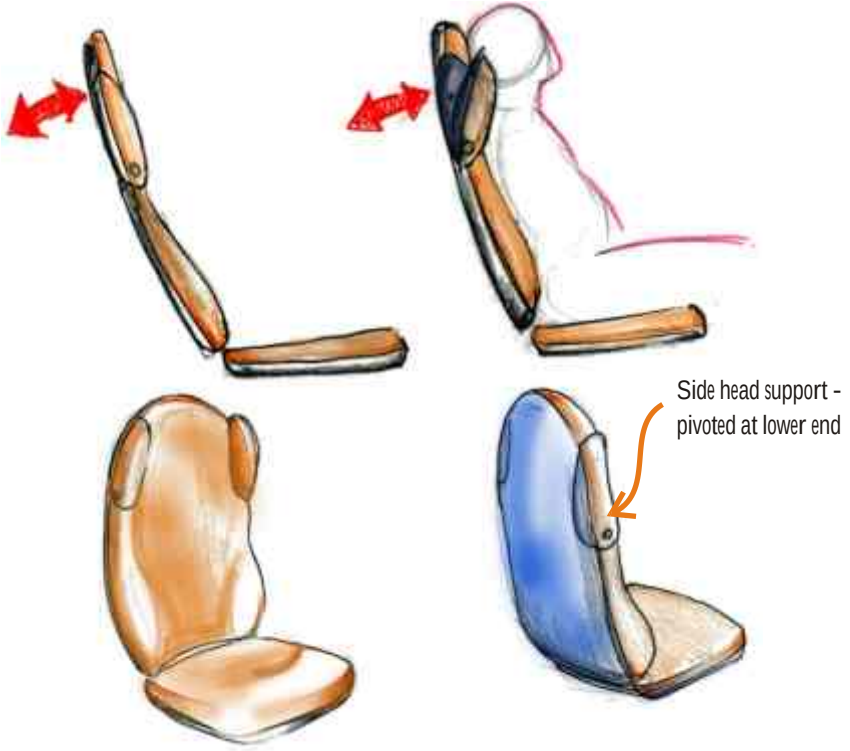
The Head rest has is a movable unit and has side supports. This head rest slides on the back rest. It can be adjusted and locked at the desired height by the user. It can also be cleared off from the head region if the user wants to have a different sleeping posture.



Idea 6

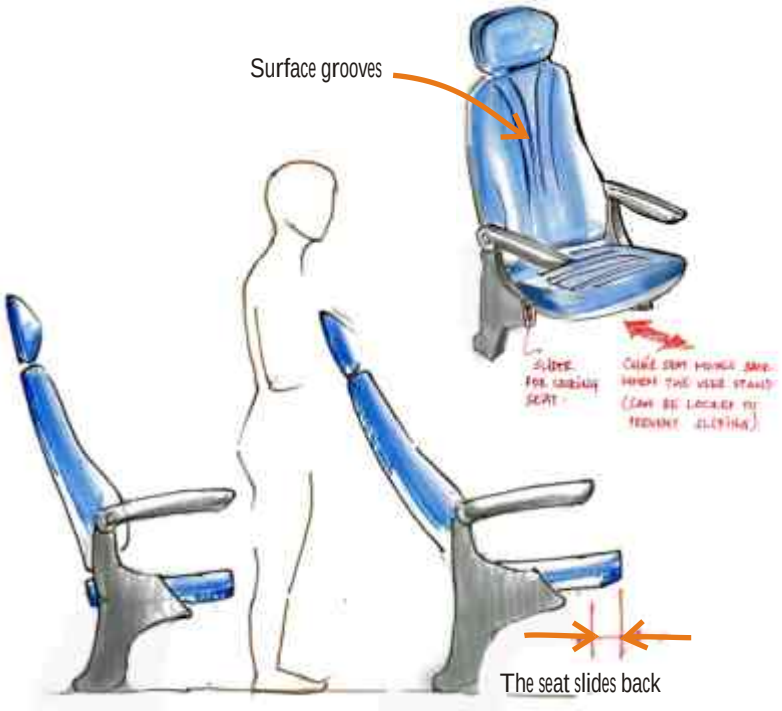
In this there are two side flaps which are pivoted just above the shoulder. The flaps can be individually rotated about their pivot and locked at desired heights. These can be used as head supports while sleeping.

6.3 IDEA LOG:



Idea 9

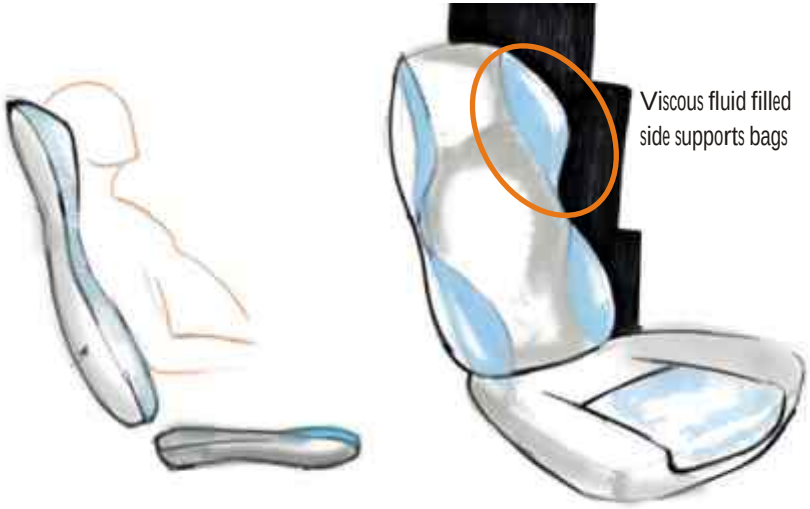
In this the head support is pivoted at the lower end. This support flaps can be swivelled to support the head.



Idea 10

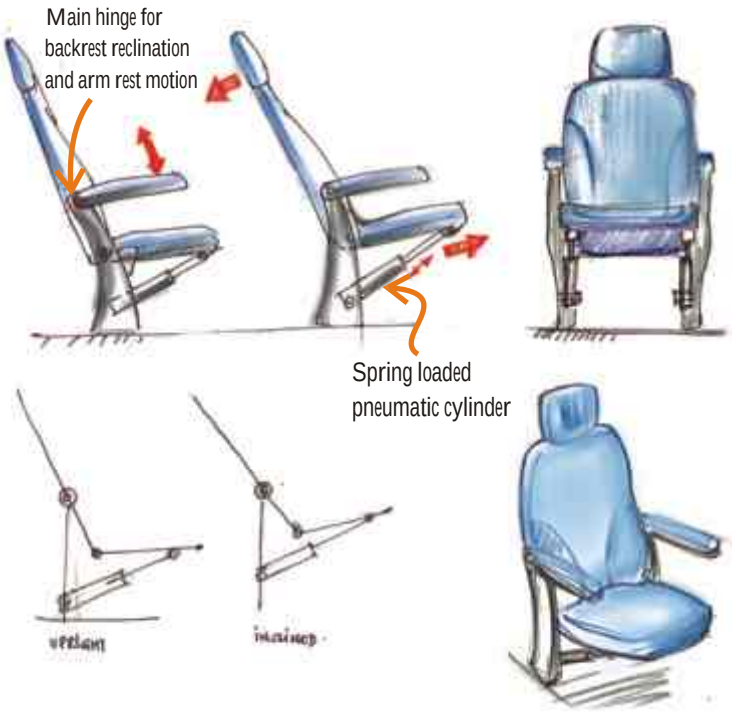
Here the seat would slide back when the user stands and pushes it. This would increase the space for the user to stand and move about the place. The chair surface are provided with grooves for better air circulation over the user skin.

6.3 IDEA LOG:



Idea 11

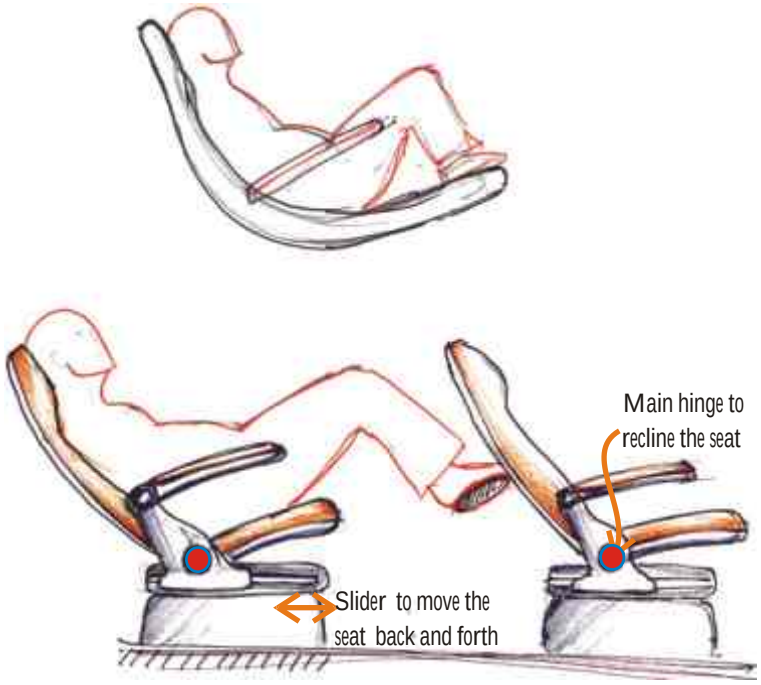
In this the back rest and side support bags are filled in with a viscous fluid which adjust according to the user body type.

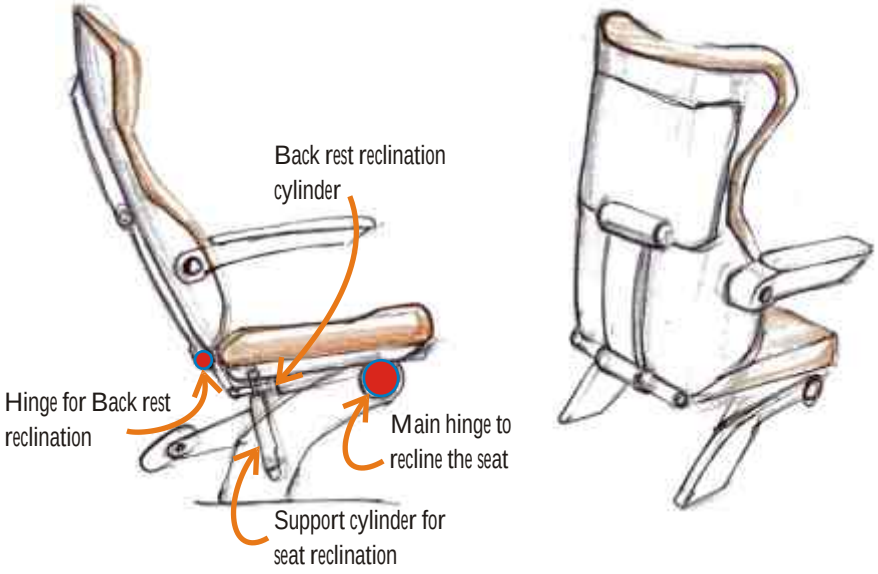


Idea 12

This seat is based on different mechanism for reclination. The linkage diagram is shown in the above sketch. The user operates a lever which releases the air from pneumatic cylinder, he then pushes the backrest to recline it back about the main hinge. With this reclination the seat moves forward and up. This would give a kind of stressless back angle.

6.3 IDEA LOG:





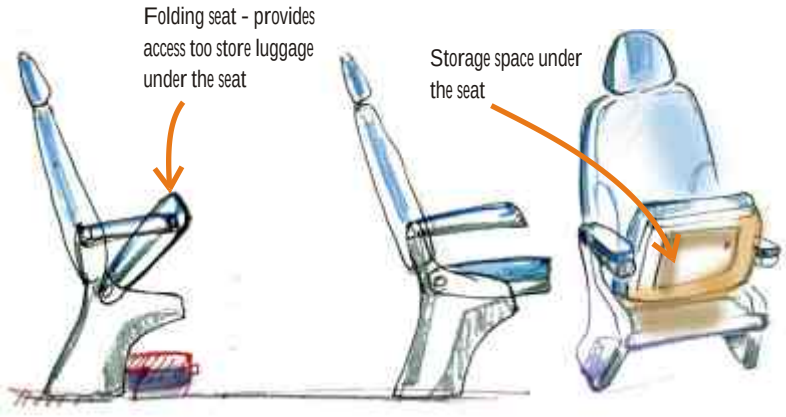
Idea 13

In this the back rest reclines along with the seat moving up. Here the whole seat slides back with the reclination of the backrest. This combined motion of the back reclination and seat motion would tend to reduce the pressure on the buttock and lower back.

Idea 14

This seat has two hinges. About the main hinge the back rest and the seat recline together. The back rest reclination can be further controlled by the second hinge. This system will allow the users to control the seat as per their comfort.

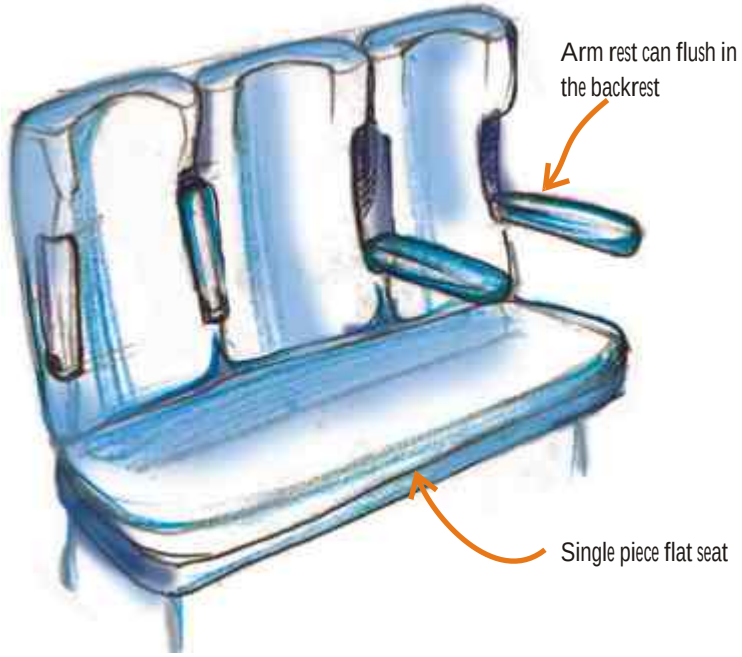
6.3 IDEA LOG:



Idea 15

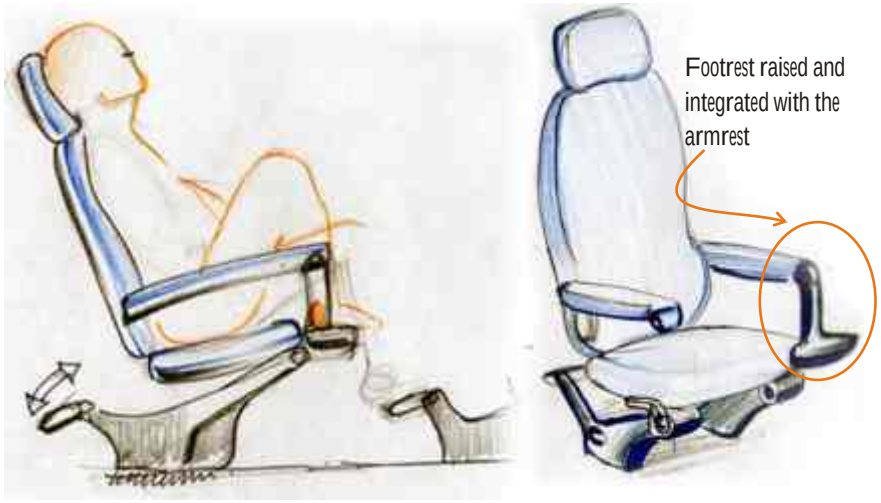
Here the seat folds up when the user moves out from it. This will provide more area for the user to move about the seat area. Storage space may be provided for small luggage below the seat.

6.3 IDEA LOG:



Idea 16

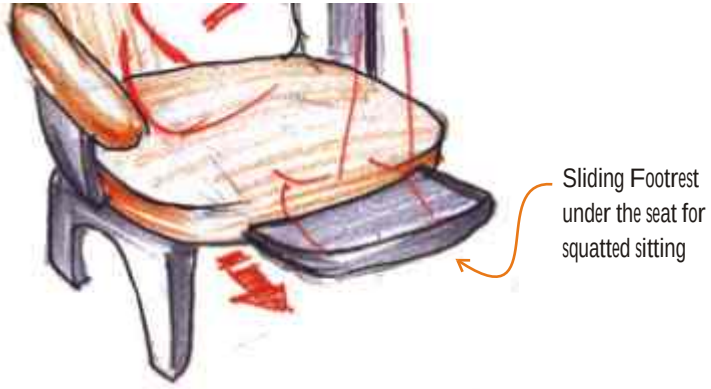
This is a bench kind of seating. Here the armrest flushes into the back rest, and the seat is a single flat surface. So when the users are traveling with family members they can seat comfortably without the armrest obstructing them. Also the single flat seat would permit the user to lye on it flat when the adjacent two seats are unoccupied.



Idea 17

The footrest is integrated in the arm rest. This footrest is closer to the seat so that the user can rest his legs at raised height. It can the folded back when not in use. The lower footrest can be rotated about its hinge so that user positions it as per his/her requirements.

6.3 IDEA LOG:



Idea 18

In this seat a sliding footrest is provided just below the seat. This permits the user to seat/sleep in folded leg posture or keep his legs at raised position.

Idea 19

This seat has two footrest at two positions. the sliding footrest can be used without having to use the foldable footrest. The user can open up the foldable footrest and use as shown in sketch.

7. CONCEPTUALIZATION

7.1 IDEA CLUSTERS:

The idea sketches were then clustered according to the core functions they addressed. This was done to facilitate extraction of key attributes that would help in building complete concepts. Different concepts evolved as they addressed different attributes of the product brief to varying degrees of importance. Three clusters were made out of the numerous ideas generated:

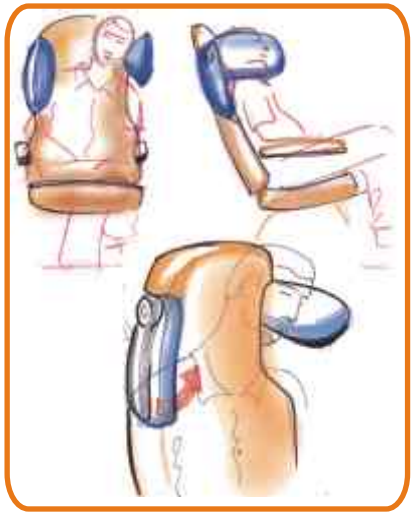
HEAD/NECK SUPPORT - Cluster One

FOOTREST ARRANGEMENT - Cluster Two

SEAT RECLINATION SYSTEM - Cluster Three

7.1 IDEA CLUSTERS:

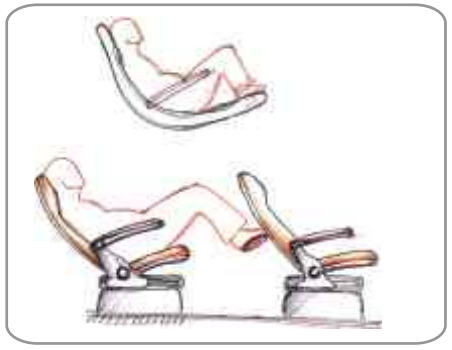
HEAD/NECK SUPPORT CLUSTER

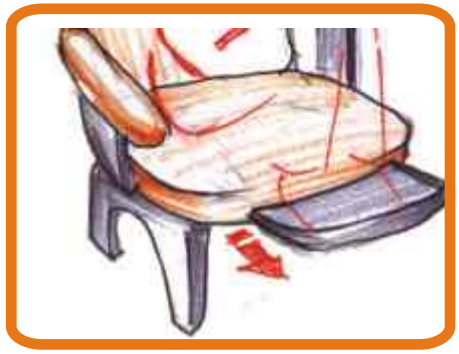


Cluster Representative

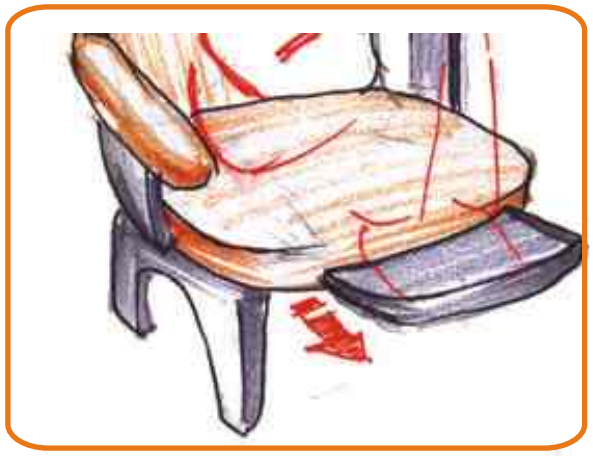
This cluster is group of ideas which address the neck/head support problem by various means as shown in the figures. Out of this cluster one representative was chosen which represents the requirement of head support while sleeping best, as studied during the user observation. The cluster representative was further evolved to possible reflect all the aspects of product brief.

7.1 IDEA CLUSTERS:





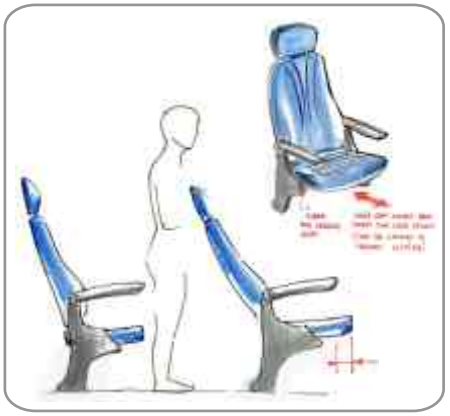
FOOTREST ARRANGEMENT

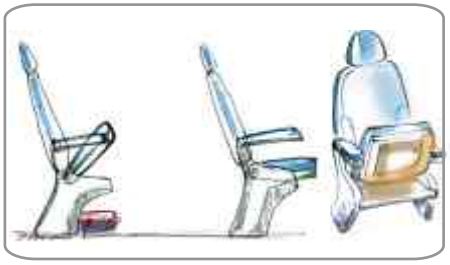


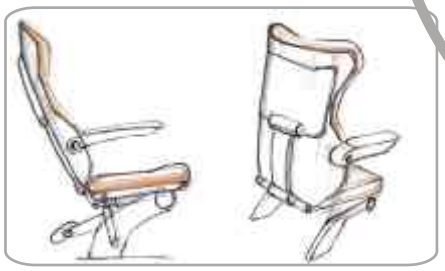
Cluster Representative

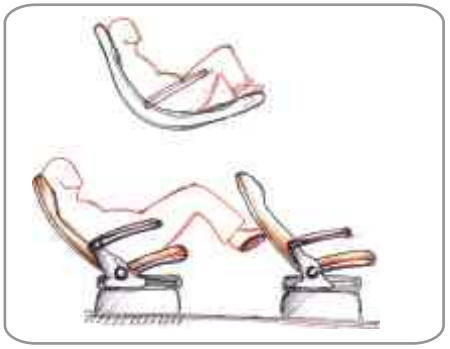
This cluster is group of ideas which address the footrest and seating posture problem by various means. The main concern was to take into account the Indian way of sitting which was observed during the user study.

7.1 IDEA CLUSTERS:









SEAT RECLINATION SYSTEM

Cluster Representative

This cluster is a group of ideas which address the reclination mechanism that is incorporated in the seat. These ideas also consider the space utilization around the seat. Out of these ideas a representative was chosen which best solved all the user requirement and was considered for further development.

7. CONCEPTUALIZATION

7.2 CONCEPTS

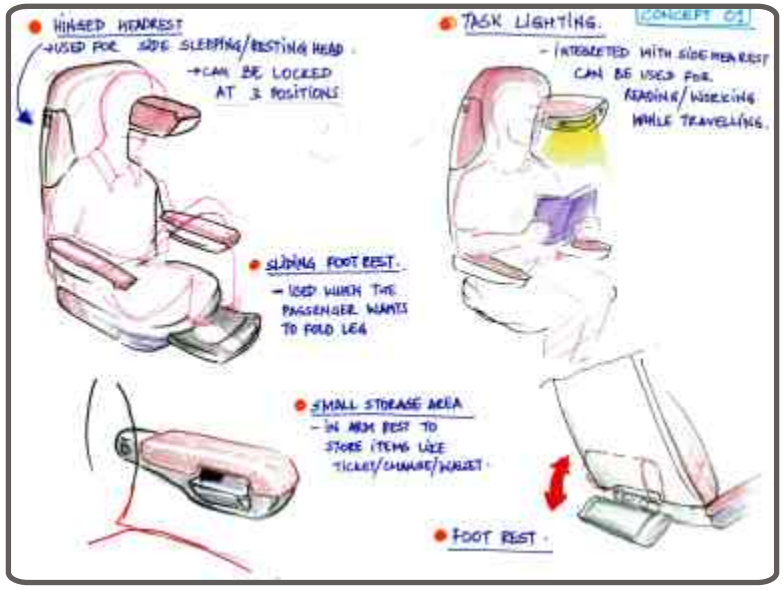
After the clustering of ideas the main representative ideas were selected and worked on further with addition of other ideas from the same or other clusters.

Thus the cluster representative evolved to give rise to an individual concept which addressed the core issues listed in the product brief. Thus each cluster representative developed into final concept proposals.

The three concept proposals are explained in the following chapter.

7.2 CONCEPTS

CONCEPT ONE

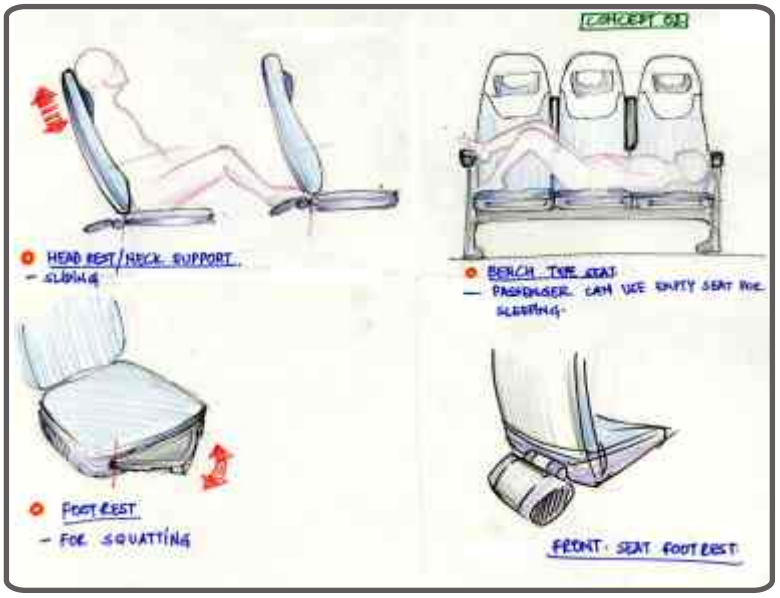


Concept One:

This concept addresses to the problem of head support during sleeping with the two slide head supports provided. The footrest is just under the seat which addresses the folded/raised leg seating postures of the user. The side head supports has user controlled task lighting. A wider arm rest has provision for storage of small personnel items.

7.2 CONCEPTS

CONCEPT TWO

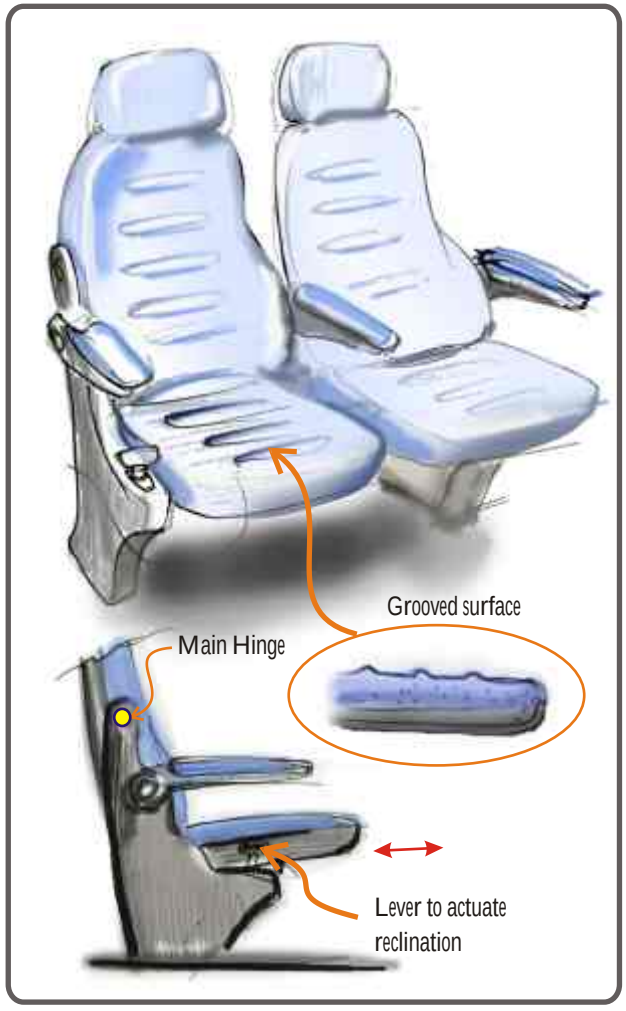


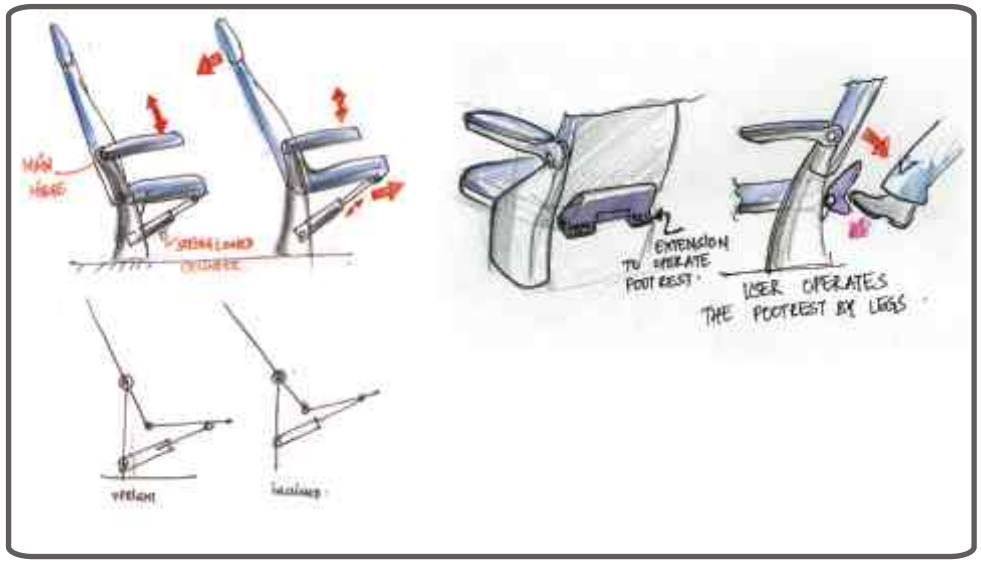
Concept Two:

This concept has a main feature of bench type sleeping. The seat would be flat so that if the other seats are unoccupied a user can sleep lying flat. Also when the adjacent users are family members they can sit close to each other without the arm rest obstructing them. The adjustable neck/head support would be contoured to accommodate the user neck properly. The adjustability in the neck support would allow users of different heights to fit in without discomfort. Here the footrest provided would be swivelling kind. The front footrest would be spring loaded so that it closes up immediately when not in use.

7.2 CONCEPTS

CONCEPT THREE





Concept Three:

This concept has completely different system of reclination. The back rest would recline along with the seat about the main hinge. This reduces the space required for reclination behind the seat. Also the surface of the seat would have grooves/patterns on its surface which facilitates proper ventilation for body surface. This system of reclination would tend to raise the seat height.

8. CONCEPT EVALUATION

Each concept was then evaluated based on the product brief and the criteria of evaluation determined during the user study.

8.1 CRITERIA FOR EVALUATION

The selection of criteria for evaluation were mostly user centered. This was done so that the concept that is more comfortable to the passenger or one that closely meets the requirements of the passenger would be selected.

Cross leg sitting/ sleeping

How well the concept allows the user to sit with his legs folded? How easily the user can use this feature?

1 (does not allow) 10 (allows)

Raised leg rest

Does the concept permit the user to have his legs resting at a heightened position?

1 (does not permits) 10 (permits very well)

Head Support

Does the concept have proper head support which will allow the user to sleep comfortably? Does it have the adjustability?

1 (does not satisfy) 10 (satisfies)

Reclining position

Does the seat allow for reclination to the suitable angle?

1 (does not) 10 (does allow)

Bench sleeping

Does the concept permit flat surface sleeping?

1 (does not) 10 (does allow)

8.2 CONCEPT EVALUATION TABLE

Evaluation Criteria	Concept One	Concept Two	Concept Three
Cross leg	8	6	2
Raised leg rest	8	8	2
Head Support	8	6	2
Reclining position	6	2	8
Bench sleeping	6	4	4
	30	26	18

RESULT:

Concept One has scored above the other concepts and hence it is taken for further development.

9. FINAL CONCEPT

9.1 FINAL CONCEPT PROPOSAL

Having done the evaluation of all the three concepts, concept one was selected for further refinements and development. This concept was cross checked with all the requirements listed from the user study. An ergonomic study was undertaken. The ergonomic study was essentially required for the head support provided in this concept. To understand the feasibility and to get a overall feel of the dimensions a rig was made and users of different heights were studied.

9.2 RIG STUDY




Upright posture at 110 deg.




Relaxing posture at 130 deg.

Using the 1:1 mock-up rig the user interaction with various features of the seat were studied. Dimensions were marked on the wall as well as on th rig for testing user with different heights. The backrest of the rig could be moved from 110 deg to 130 deg.
Following aspects were studied:
- seat and back rest dimensions.
- feasibility of the head support and footrest under seat.
- leg room requirements and footrest requirements.
- armrest and seat height.
- reclination angle.

Note: The models used for rig study closely represented the anthropometric percentile groups in terms of their stature. The percentile group studied were 25th, 50th, 75th and 95th.

9.3 HEAD SUPPORT STUDY



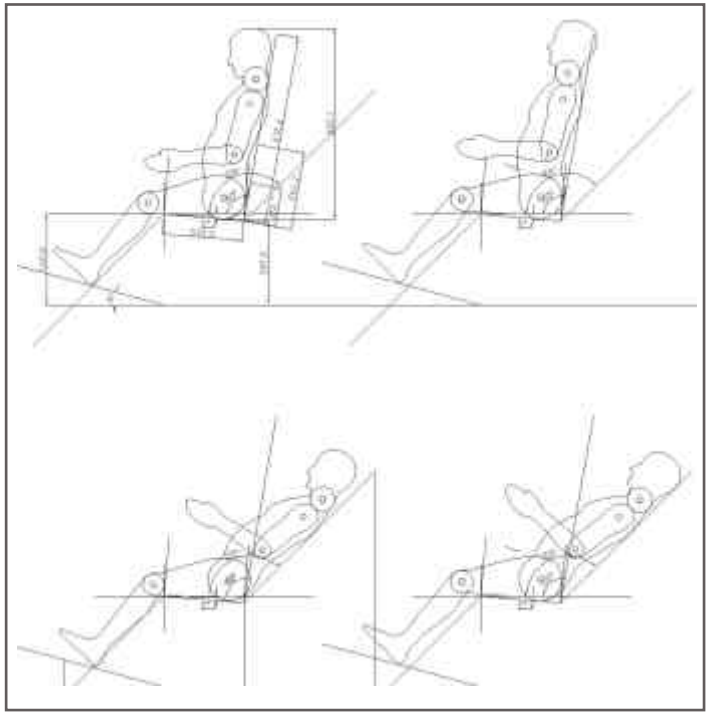



Note: The models used for rig study closely represented the anthropometric percentile groups in terms of their stature. The percentile group studied 50th and 95th.

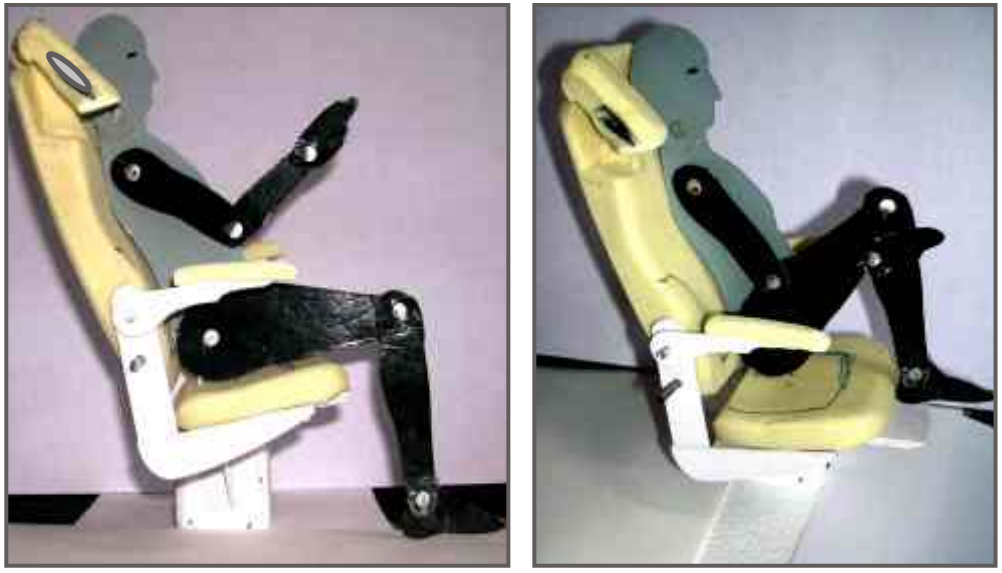
In another study the option of using a different mechanism of providing the side head support was tried out. During the process the mock rig was adjusted to different users height.

This study helped in refining the dimensional requirements for the head support and the hinge location. It also gave a better understanding of the user interaction with this new feature. Also changes were done in the form and shape of the head support by observing the users. The rig was adjusted to fine tune the dimensions.

9.4 MOCK UP MODEL



2D drawing using 50th and 75th percentile mannequin



Mock up model (1:5 scale)

With the help of dimensional data obtained from the rig setup, various dimensions were fixed and a 2D CAD drawing was made. This helped to fix other minor details of the seat.

Using these dimensions a mock up model of 1:5 scale was made to get a clear understanding of the new system developed. This mockup model also helped to clarify the structural requirements of the seat. Also the seat surface variations were understood from this model.

Front Perspective view of the final Concept proposal

9.5 FINAL DESIGN CONCEPT

The final concept selected after the concept evaluation was further refined based on the inputs from the rig study, mock-up scale model and study of similar product details.

To arrive at the final dimensions, number of iterations were made in the rig. At every iterations users of different body types were tested for their comfort and reach. Feedback was taken from the users and incorporated in the rig. Dimensions were then picked from the refined rig and cross checked with the anthropometric data. These dimensions were then plotted in 2D using a mannequins to get a clear idea of the constrains in space. Using this 2D dimensions a approximate 3D model was made to get overall dimensional feel and understand the arrangements of the seats. A number of minor changes were required at the 3D stage to get the assemble between various element right. Using the proportions from the 3D cad model final rendering of the Concept was made. This concept renderings included various other details anda overlay of other features was done.

The final concept and its various features are explained in the following chapters.

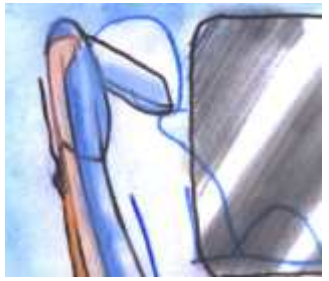
Front Perspective view of the final Concept

Side view of the final concept

9.5 FINAL DESIGN CONCEPT

The features incorporated in the final concept which meets the requirements as stated in the product brief are explained below.

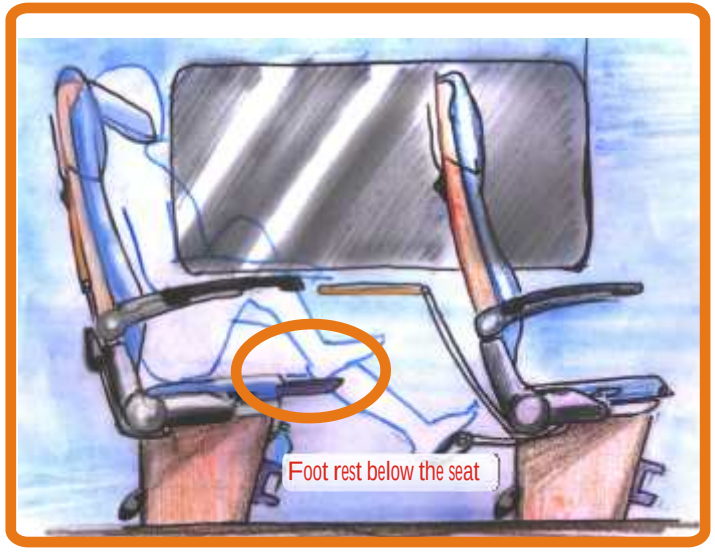
1. SIDE SUPPORT WITH INTEGRATED TASK LIGHTING



The side head support is pivoted at the top. This can be swivelled and kept at the desired height for resting the head when sleeping or even when relaxing. This swivelling of the head support takes care of the variation in user heights. In the rig study users with varying buttock to top head height were tested and the dimensions decided.

A LED task light could be provided in this head support, so the user can use it for lighting his space by rotating the unit. Each seat has two side head supports so that the user can use either one depending on their habit of sleep.

Front Perspective view of the final Concept



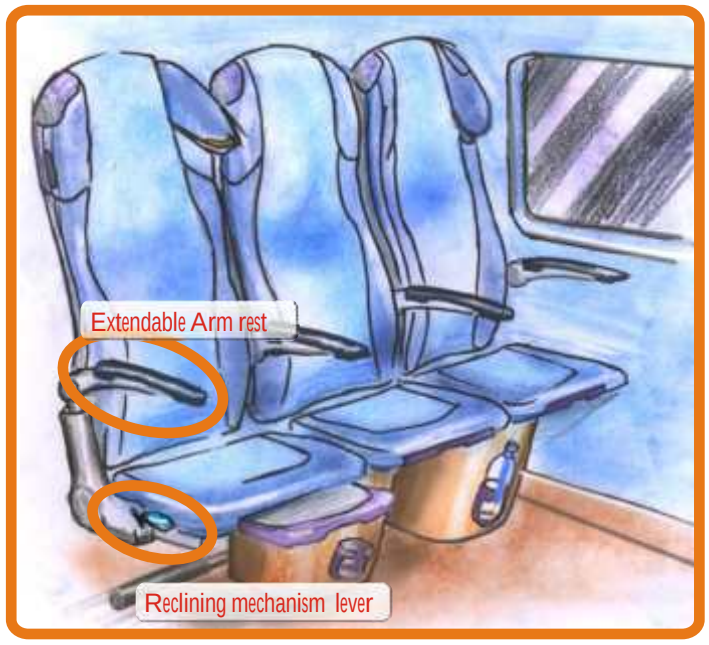
Side view of the final concept

9.5 FINAL DESIGN CONCEPT

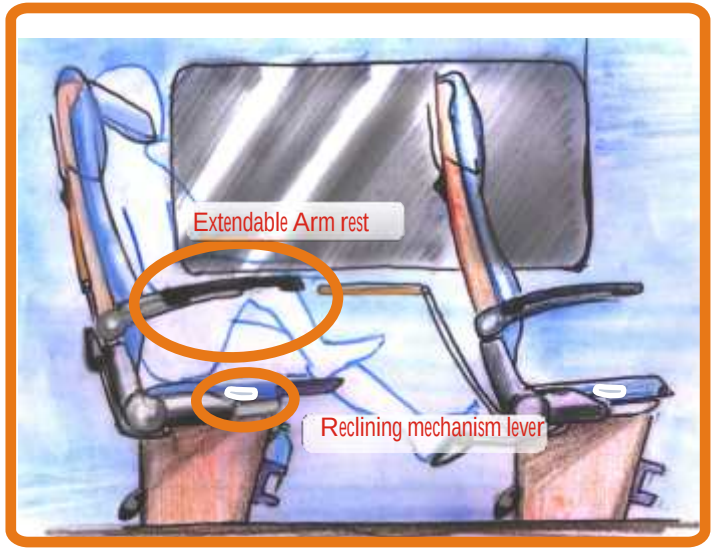
2. FOOTREST BELOW THE SEAT

The movable foot rest below the seat can be used by the user to sit with their legs folded or can be used when they want their legs close to their body. This footrest can be pushed back when not in use.

It is would be made of a suitable polypropylene by injection moulding process. A part of the footrest where the feet rest will be covered with foam.



Front Perspective view of the final Concept



Side view of the final concept

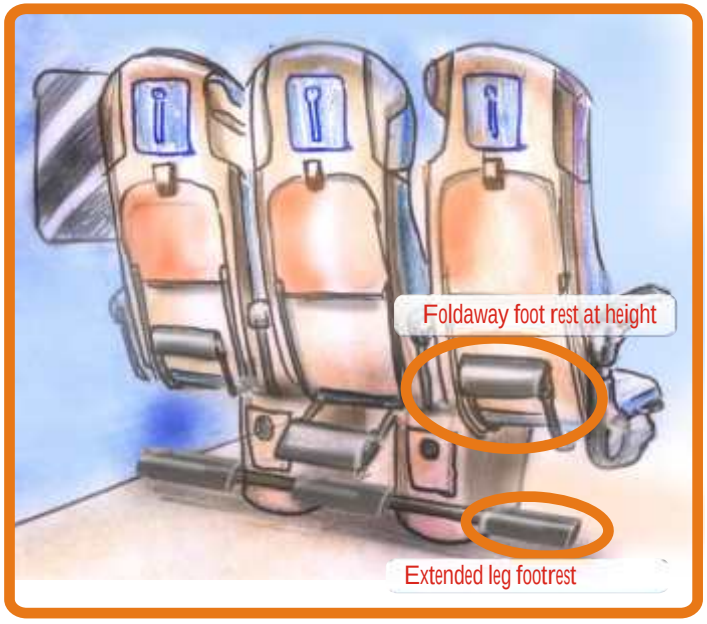
9.5 FINAL DESIGN CONCEPT

3. EXTENDABLE ARM REST

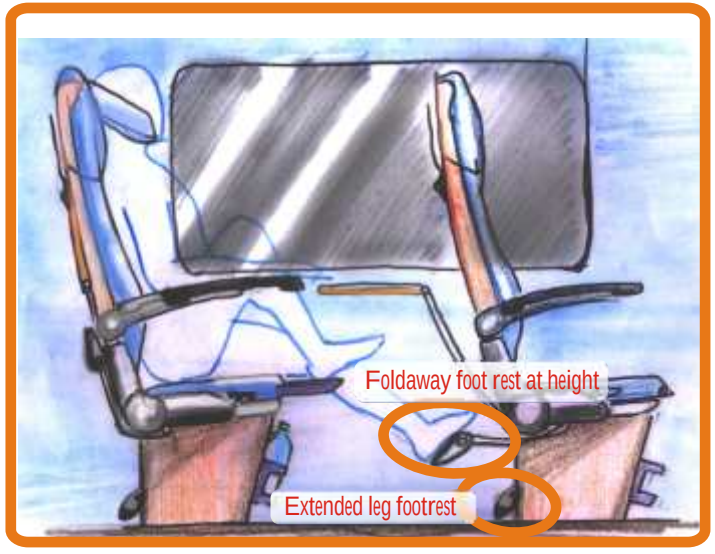
The Arm rest in this concept can slide out and thus act as a support to the thigh region of the leg when the user is sitting in folded legs posture. This arm rest made of PU foam coated with flexible surface. This foam will be backed by suitable structural plastic.

4. RECLINING MECHANISM LEVER

The backrest reclining mechanism is used from the current one available in market. The lever to operate this mechanism is changed for easy access and operation. The surface area of the lever handle is increased to reduce the pressure on palm while being operated.



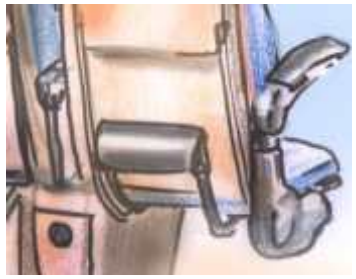
Rear Perspective view of the final Concept

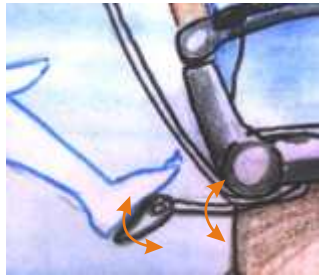


Side view of the final concept

9.5 FINAL DESIGN CONCEPT

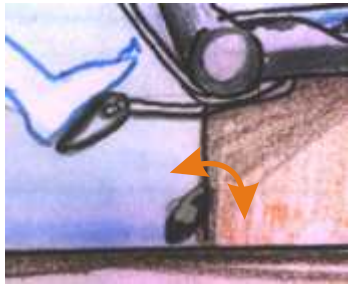
5. FOLDAWAY FOOT REST AT HEIGHT



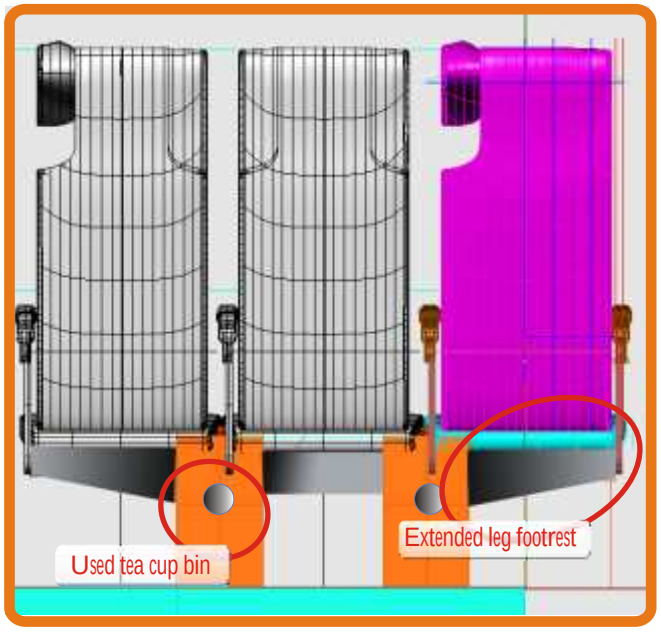


This concept has a foldaway footrest which can be brought into use by the feet itself. It is loaded with a soft spring so that when the user removes his leg it moves back to its foldaway position. This footrest would give two positions.

6. EXTENDED LEG FOOTREST



This footrest would be used when the user is in alert sitting position. The footrest can be swivelled about its hinge so that the user can move his feet and have some kind of exercise for the feet. This exercise would improve the blood circulation and reduce numbness caused in long distance traveling.

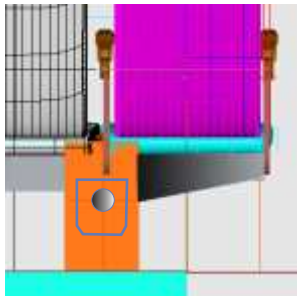


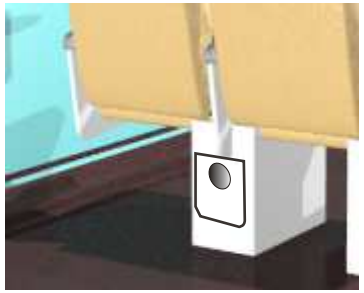
Rear view of the final Concept

Side view of the final concept

9.5 FINAL DESIGN CONCEPT

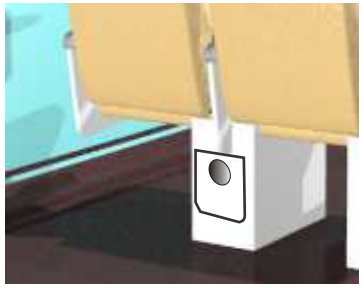
7. CANTILEVERED SEAT





The side seats are cantilevered to the base structure. This provides space for smaller languages.

8. BOTTLE HOLDER AND USED CUPS BIN



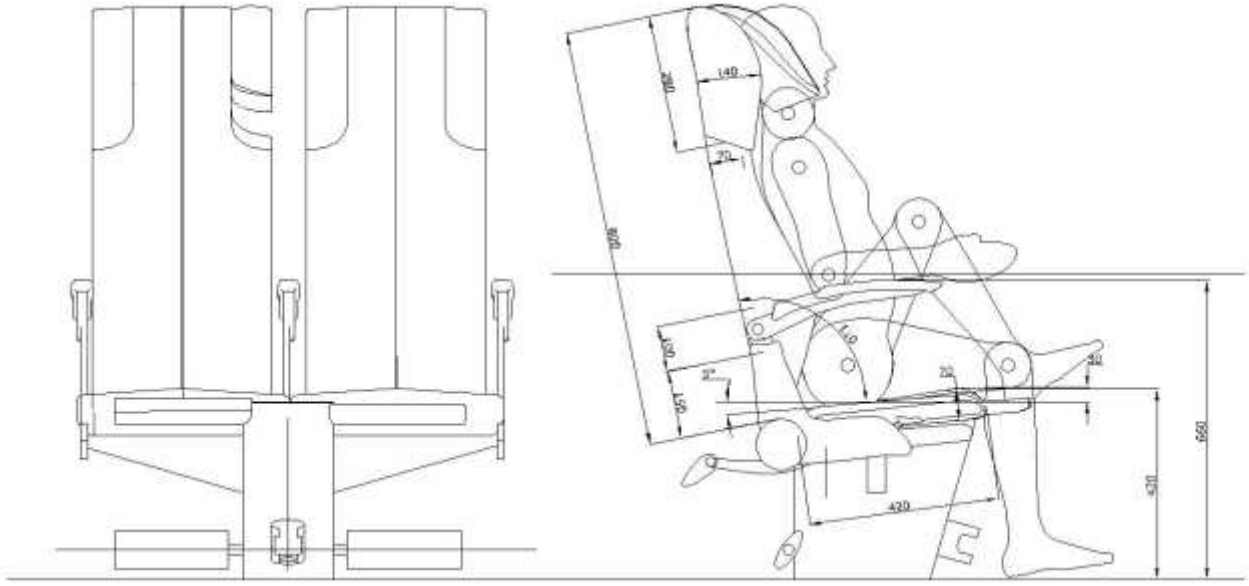
The main base structure carries a bottle holder in front. The main base structure will be covered with plastic panel which would carry the bottle holder.

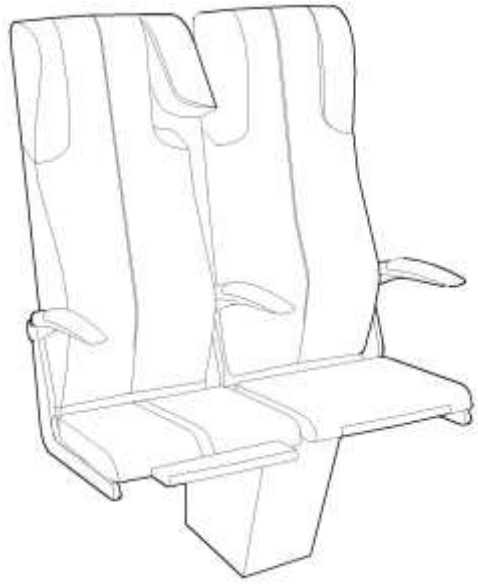
Similarly at the rear used cup bin would be provided. This bin will be of the same material as the panels.

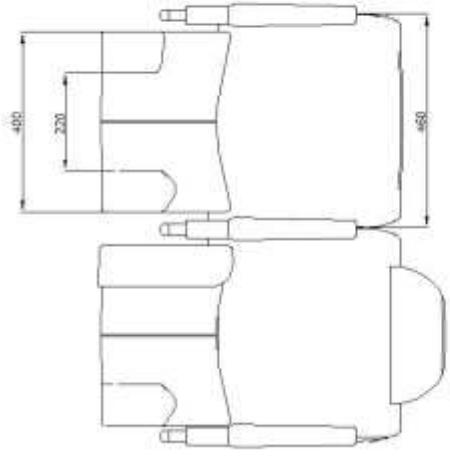
9.6 CAD MODELING

After the dimensional study a CAD Model of the Design concept was made. This model was refined at various stages to include the features that would satisfy the requirements that were listed in the product brief.

9.7 OVERALL DIMENSIONS







All dimensions are in mm.
Drawings not to scale.

10. FINAL PRODUCT

Final Product

Side head support with integrated task lighting

The salient features incorporated in the final concept which meets the requirements as stated in the product brief are explained below.

1. SIDE SUPPORT WITH INTEGRATED TASK LIGHTING

Side head support is the main feature of this seat.

The side head support is pivoted at the top. This can be swivelled and kept at the desired height for resting the head when sleeping or even when relaxing. This swivelling of the head support takes care of the variation in user heights. In the rig study users with varying buttock to top head height were tested and the dimensions decided.

A LED task light could be provided in this head support, so the user can use it for lighting his space by rotating the unit. Each seat has two side head supports so that the user can use either one depending on their habit of sleep.

2. FOOTREST BELOW THE SEAT

The movable foot rest below the seat can be used by the user to sit with their legs folded or can be used when they want their legs close to their body. This footrest can be pushed back when not in use.

3. FOLDAWAY FOOT REST AT HEIGHT

The seat has a foldaway footrest which can be brought into use by the feet itself. It is loaded with a soft spring so that when the user removes his leg it moves back to its foldaway position.

4. EXTENDED LEG FOOTREST

This footrest would be used when the user is in alert sitting position. The footrest can be swivelled about its hinge so that the user can move his feet and have some kind of exercise for the feet. This exercise would improve the blood circulation and reduce numbness caused in long distance traveling.

5. EXTENDABLE ARM REST

The Arm rest in this concept can slide out and thus act as a support to the thigh region of the leg when the user is sitting in folded legs posture.

6. BOTTLE HOLDER AND USED CUPS BIN

The main base structure carries a bottle holder in front.

Similarly at the rear used cup bin would be provided. This bin will be of the same material as the panels.

7. CANTILEVERED SEAT

The side seats are cantilevered to the base structure. This provides space for smaller languages.

REFERENCES

BOOKS

1. Fitting the task to the man
   By: Etienne Grandjean, 4th edition

2. Indian Anthropometric Dimensions for Ergonomic Design Practice
   By: Chakrabarti Debkumar

PUBLISHED PAPERS

1. Designing fo comfort for long distance bus travel.
   By: K. Munshi, Professor,IDC, IIT-Bombay.

REPORTS

1. Mobility Vehicle for Handicapped
   By: N. S. Sunil Kumar, Project report, IDC, IIT-Bombay.
2. Design of a passenger cum cargo microbus.
   By: George Thomas, Project report, IDC, IIT-Bombay.
3. Design of passenger compartment of suburban train in Mumbai.
   By: George Thomas, Project report, IDC, IIT-Bombay.

WEB SITES

1. www.indianrail.gov.in
2. www.seat61.com
3. Www.acma.co.nz

Drawings

1. Bogie 2nd class AC Chair car, Janshatabdhi express (ICF)