Design of a Mobile Computer Aided Learning bus

Industrial Design Project III

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Guided by-
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Approval Sheet

Industrial Design Project III titled

Design of a Mobile Computer Aided Learning bus

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Is submitted in partial fulfillment of the requirement for the degree of

Master of Design In Industrial Design

Guide -

Chairperson -

External Examiner -

Internal examiner -

Contents

Acknowledgement

I am grateful to Prof. B.K. Chakravarthy, my project guide and Azim Premji Foundation family esp. Senthil, Rakesh, Dharmendra for their guidance and support throughout the course of this project and to all the faculty members for their valuable inputs and critical comments provided during the preliminary project presentations. I am also thankful to Neha Bhari, Rupesh Nath and Sarabjit Singh Kalsi for their invaluable help during initial phase of the project.I would also like to thank all other individuals including lab staff and friends who helped me at various phases of my project. Without their support, this project would have been incomplete.

1. Abstract

The project deals with the providing an innovative solution for the mobile computer aided learning bus. The objective is to make the learning experience a bit comfortable and enjoyable.

Observation was made to understand the entire process of e-learning process by these children as well as their interaction process with the bus. Different methods for user study and analysis were used like video documentation and questionnaire regarding the issues like ingress, egress, orientation of the workstation, ergonomic factors etc.

Due consideration was provided for devising the solution according to the manufacturing constraints.

2. Introduction

Of special concern are children from the large number of migratory families serving the booming construction industry in urban India.

A majority of these children do not go to school given the migratory nature of their families and the lack of suitable access to proximate quality schools. With the result that not only are they deprived of education in any form but are also in a way to forced to seek other kinds of engagement that may not be constructive to their development. It is a fact that many of these children often take to the streets and get involved, among other things, in theft, drug addiction, loitering, child labour, bootlegging etc.

There are several issues involved in the education of such children ranging from their possible multilingual composition, varied profile in terms of exposure to any kind of schooling, the temporariness of their habitation etc.

In the present scenario, every day the mobile bus unit caters to 36 children in one session at a site. It visits twice a week at each site for 1-2hrs duration.

Education is imparted by the use of APF's audio and visual e-learning material, which is preloaded in the system. During classes, each 15" TFT monitor is shared by three children.

And the learning assignments are performed with the help of mouse and keyboard along with individual headphones. "Interaction with the bus creates a sense of excitement and pride to these children as well as their guardians.

Azim Premji Foundation:

The Azim Premji Foundation is a not-for-profit organization operational since 2001 with a vision to "Significantly contribute to achieve quality universal education that facilitates a just, equitable and humane society".

Over 250 professionals and several volunteers are engaged in realizing this vision through the current engagement with over 16,000 schools and 45000 teachers in partnership with 17 Indian States.

To realize Azim Premji Foundation's vision related to equity in education, the Foundation has chosen to focus on some of the disadvantaged and underserved groups of children.

The major stakeholder in this project is the builder/developer of the site who is also the employer of the parents of the disadvantaged children.

3. Aim of study:

3.1 The target group in this project is the children of migrant labour, residing near the construction sites at Bangalore

3.2 Study was done to get acquainted with the present usage scenario and user aspirations based on the their living, activities, environment and daily routine.

3.3 The study is concerned for the children who may or may not attend the regular government run school.

4. Approach to the project

Levels of user -

- People — **Labour camp children**(primary user), these are the ones who spend most of the time using the bus.
  Driver (secondary), the preparation of the bus for use is done, along with the maintenance work
  Tutor(tertiary), he is mainly concerned with making children acquainted with the bus and looking for the proper functioning of the system

Usage - Weekly (once/ twice) for 1-2 hours

Problem area -

- **Workstation:** it is one of the most important component of the bus as children spent most of the time interacting with the monitors, keyboard, mouse, table and seat
- **Layout:** The layout includes wire harnessing as well as deciding on the placement of all the components including orientation of workstation, windows, placement of opening for exit/ entry
- **Light quality:** The light plays an important role as well lit but not harsh lighted interiors are required, with proper distribution of diffused light.
- **Visual appeal:** Since, the users are children, use of playful visual language is one of the requirement.

The afore shown areas were taken as to improve upon, after taking in account of how the users deal with the bus. These are not to be dealt as separate issues but interrelated with one another.

5. Design methodology

The following Design methodology was used for the project so that results are innovative and project brief can be met effectively -

- **Situation analysis-** understanding and evaluating need for a new concept.
- **Product proposal-** The product proposal is made for the lacunae area, new design for the CAL bus in this project .
- **Data collection and analysis-** The data collection stage included study of present scenario for user, usage and environment then the collected data has to be analyzed for proper inferences and probable design solutions.
- **Idea generation-** The idea sketches are generated for solving the problems as derived from analysis.
- **Concept development and exploratory modeling-** Then clustering and evaluating of the idea sketches ia made so as to sort out the best effective solution. After this stage concepts are made which have the more informative representation of the proposed product.

Design methodology contd.

- **Product detailing-** The final selected concept is further taken forward for detailing.
- **Evaluation and improvement-** The evaluation of product concept is made by mock up model analysis and user feedback. Thus, further refinement is made in the product.
- **Final Prototype development-** The final stage includes generation a prototype which provide a feel of the product.

6. User study and analysis

The data collection stage included studying the different vehicle's to understand the basic setting and correlation of different units which constitute together for interiors and to identify the problem area. Here, effort was made to examine all the associated dimensions also.

Understanding all the necessary information on user, use and his/ her environment

Identify the problem areas

Study of manufacturing process

6.1 User study

- **Sites Visited :**
  Whitefield
  MFAR const.
  Jai Bhubaneshwari const.
  Bellandur
- **Local School visit :** Govt. school, Sarjapur Rd., Bangalore
- **Vendor meeting :** S.M. Kannappa (Lalbagh, Bangalore)
- **Video documentation and contextual enquiry**
- **Documentation of present bus** – Dimensioning, Layout, Fixtures, Components (electric/ non-electric) including driver's cabin
- **Interaction between** – bus to user, user to user
- **Anthropometric dimensioning** of children

6.2 Manufacturing site visit

Steps of manufacturing :

- Chassis
- Frame are decided (depending upon the no. of seats/ arrangement of seats)
- Frame is developed (square pipes)
- Phosphate painted
- Flooring (fixing screws and bolts)
- Fixing sheet metal panels on the exteriors, either aluminum (7guage for upper part) and steel for lower part (15 gauge)
- Plywood (5mm) sheet inside
- Fixing interior (sheets of metal or ABS)
- Roof interior (extra ABS pre molded sheet)
- Painting of exteriors
- Full furnished seats are fixed

6.3 Problem Identification: for Children

6.3 Problem Identification: for Children

Problem	Probable solution
Leg hanging from the chair	Reduction in chair height
Hands have to be kept at the higher level	The keyboard support has to be lowered
Children have to lean forward to monitor	Reduction in the distance between monitor and child
Headphones have to taken out with a bit of difficulty	Replacing the strings for headphone resting
Mouse cannot be held easily	Use of smaller mouse
Wires get entangled during use	Placing the wires other than from side lower
Have to come out of the seat to help the other children	Changing the seating pattern
There is a bit difficulty in climbing Ist step	Provision for an extra step
Curtain has to moved for viewing outside	Providing proper channel for interaction between outside and inside

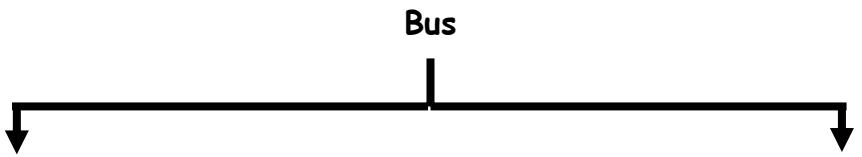
6.4 Problem Identification: for Helper

Problem	Probable solution
Cleaning is difficult due to switches position	Switches has to be placed out of reach of children
Furniture has to be placed and removed daily	Reduction in the movable furniture and other objects
Monitors are to be fixed before and after use	
Internal Temperature becomes more	Maintaining the internal temperature in the range of 27-30 deg./ reduction in humidity.
Wire has to taken from driver back	
Keyboard and mouse placement after use	Fixed resting place for keyboard and mouse

6.5 Problem Identification: for Tutor

Problem	Probable solution
Loose connection between headphone jack and CPU Internal Temperature becomes more CPU maintenance is difficult due to orientation and placement Non uniformity of light	Providing the fixed wirings within the bus body Temperature maintenance Making the reach to CPU simpler Providing sufficient sources for proper diffused light

6.6 Composition of project



Interiors

- Work station
- Lightings
- Floor
- Stairs
- Air vents
- Speakers
- Place for Projector
- Wire harness
- CPU place
- Hand rail
- Color

Exteriors

- Graphics
- Window glass
- Head lights

7. Project Brief

From the data collected and analyzed the project has been evolved.

7. Project Brief

User	Bus	Activity
The age group has been decied at 7-11 yrs The seat height to made at 137mm The height of the table at The wirings ahs to be cased and boxed The step size is made Horizontal- 178mm Vertical- 172mm Provision for additional movable step for reduction in height of first step. Use of smaller keyboard and mouse according to the children's grip Enhancing the playful elements	Reduction in the number of elements in contact with the floor for easy cleaning Reducing the no. of fixed components to reduce the effects of vibrations during bus movement Two doors for entry and exit Capacity increment (48-56) Internal Temperature range (27 – 30) Providing space around CPU for easy maintenance	Orientation of seats to improve group interaction Headphone placement has to be rigid Provision for proper and sufficient distribution of light (natural/ artificial)

8. Ideation

Idea generation involved the development of innovative solutions to the problem analyzed after data collection.

They were further focused as layout, workstation, interior and exterior of the bus body.

8.1 Layout

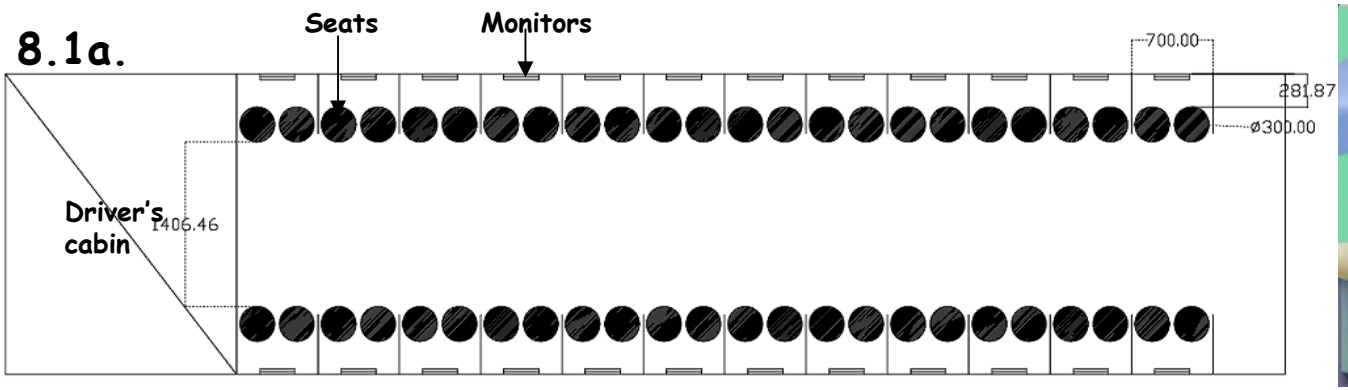
Finalizing the layout was the first requirement so that the other components could be build upon that -

Considerations for making the layout were -

- Playfulness
- Relation to the children's activities
- Easing the movement of people between the workstations
- Modularity i.e. repetition of similar components for ease of manufacturing
- Wiring harness
- Safety
- Maintenance reduction

8.1 Layouts

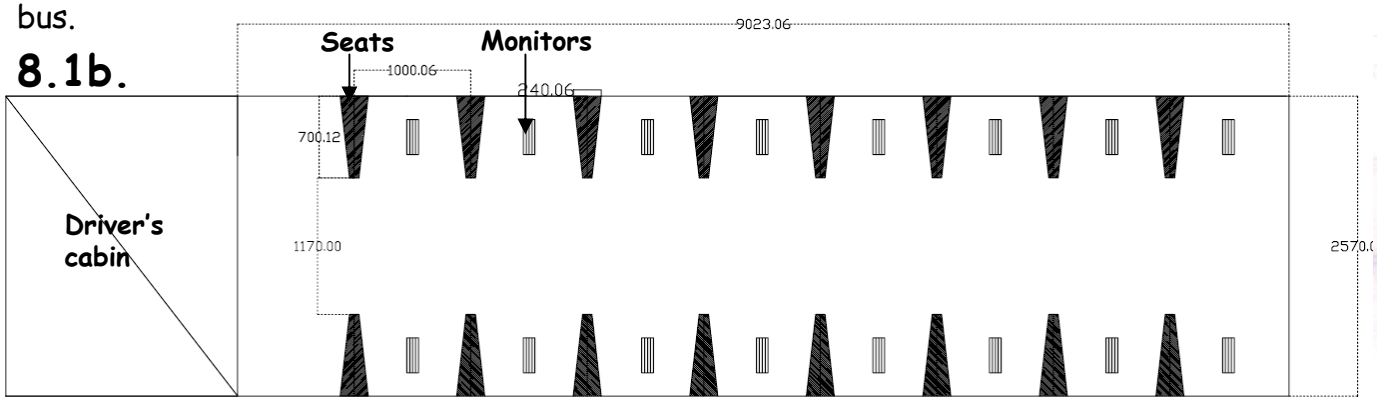
8.1a.

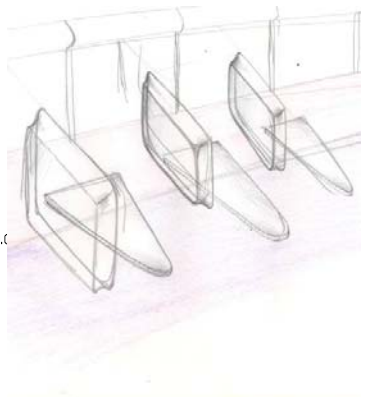


In this layout, the monitors are arranged in linear fashion, along the wall of the bus body

Characteristic feature of this is the presence of space at the centre area of the bus.

8.1b.

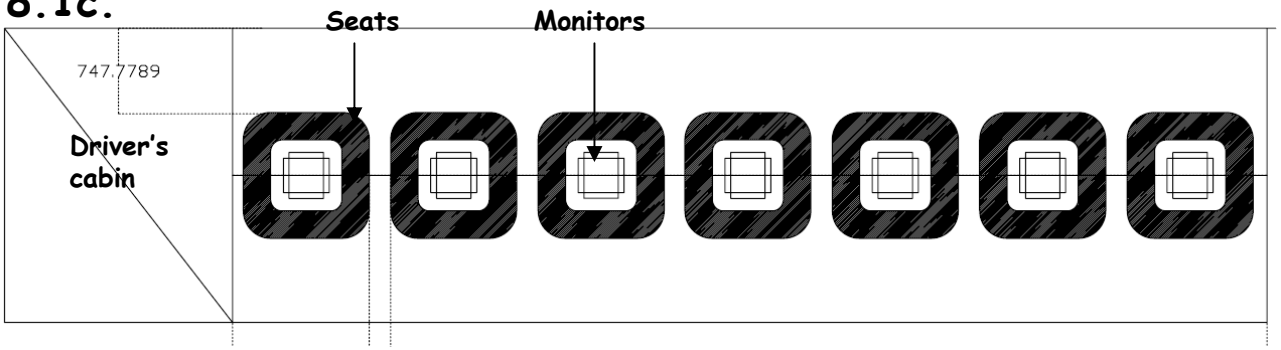


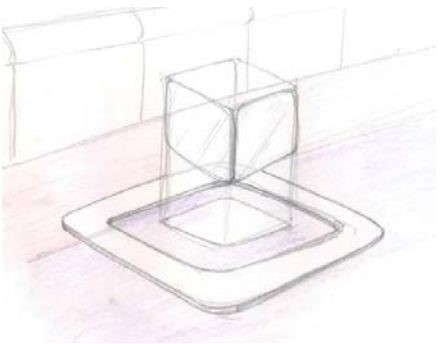


In this layout, the monitors are perpendicular to the wall of the bus body with two monitors placed back to back. Characteristic feature in it is the common seat for two rows of children.

8.1 Layouts

8.1c.

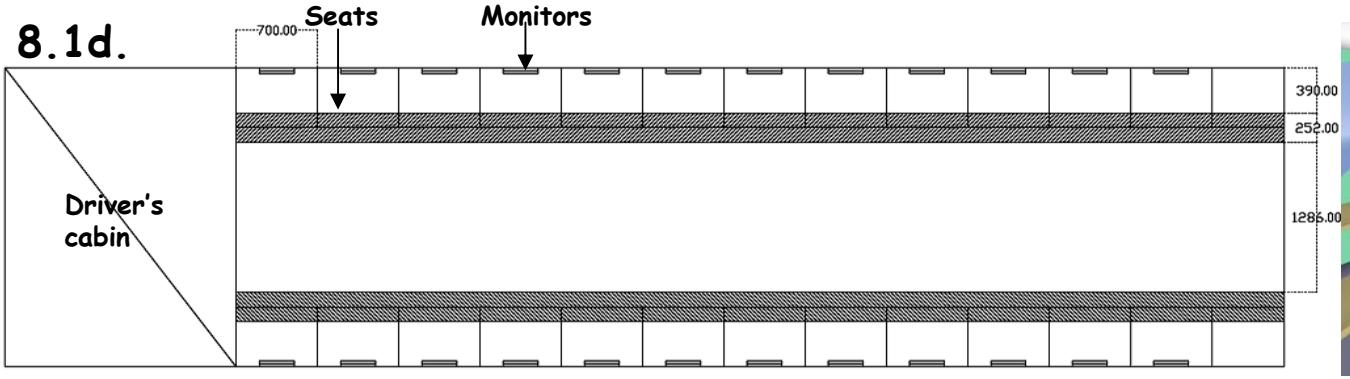


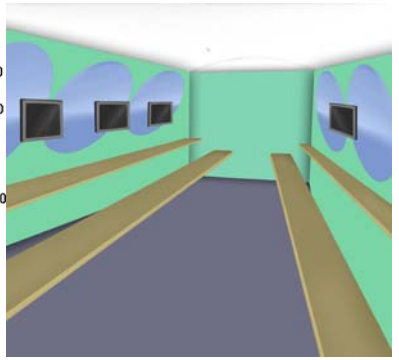


In this layout, the monitors are in a square pattern, at the centre line of the bus

Characteristic feature of this is the presence of free space along the wall of the bus body.

8.1d.

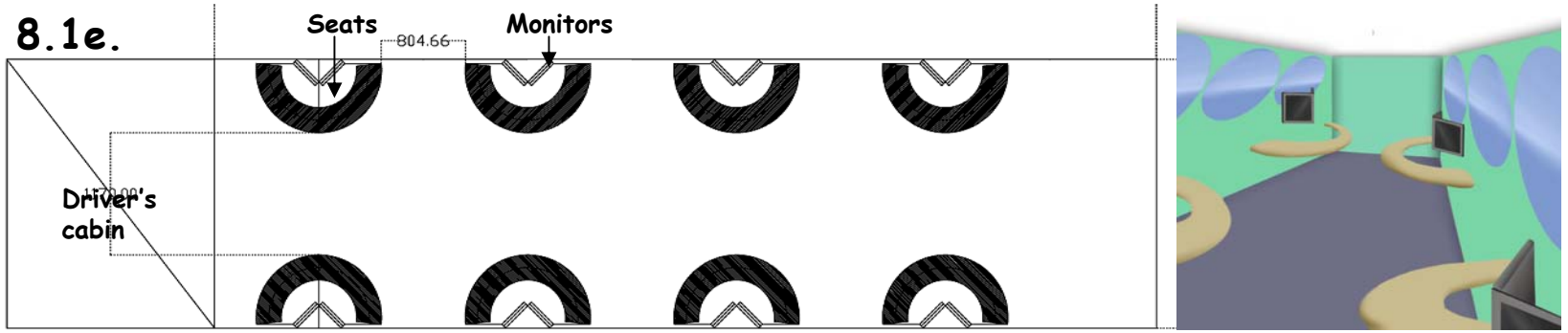




In this layout, the monitors are parallel to the wall of the bus body.

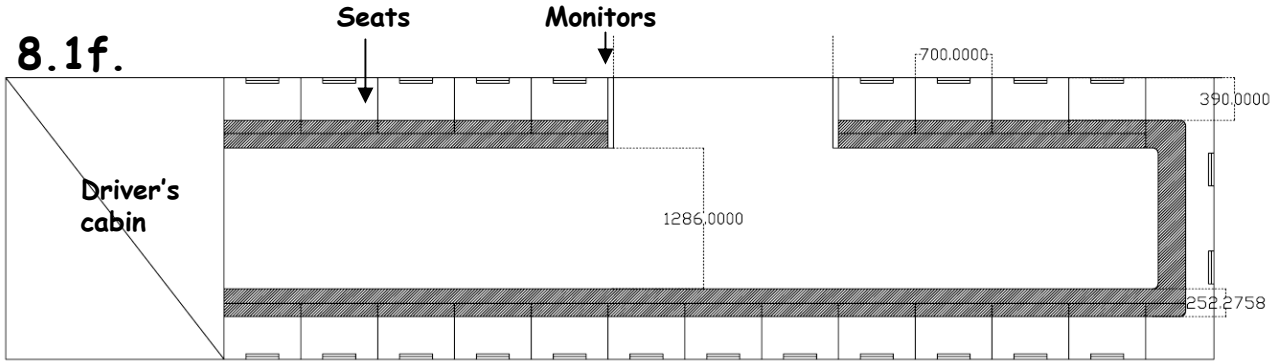
Characteristic feature in it is the common continuous seat for children.

8.1 Layouts



In this layout, the monitors are in a triangular pattern, at the wall of the bus body.

Characteristic feature of this is the presence circular pattern of seats.

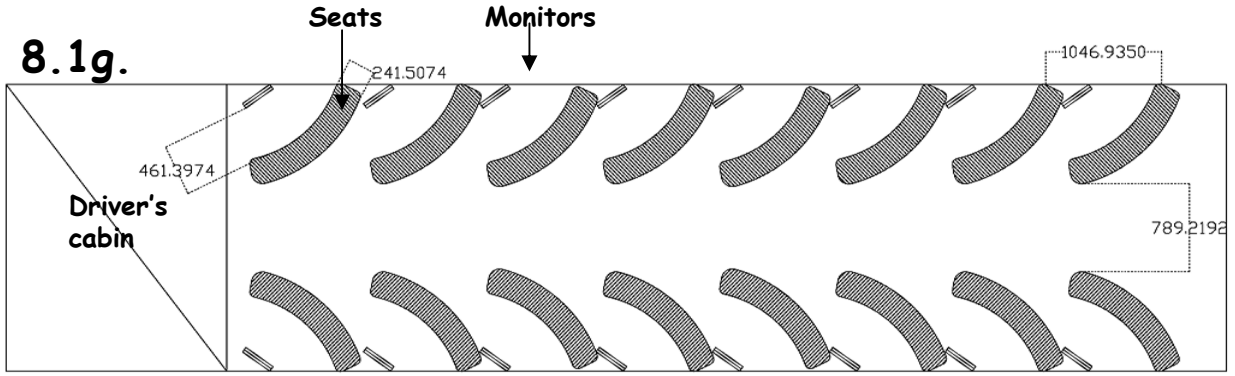


In this layout, the monitors are parallel to the wall of the bus body.

Characteristic feature in it is the common continuous seat for children with entrance at the bus centre.

8.1 Layouts

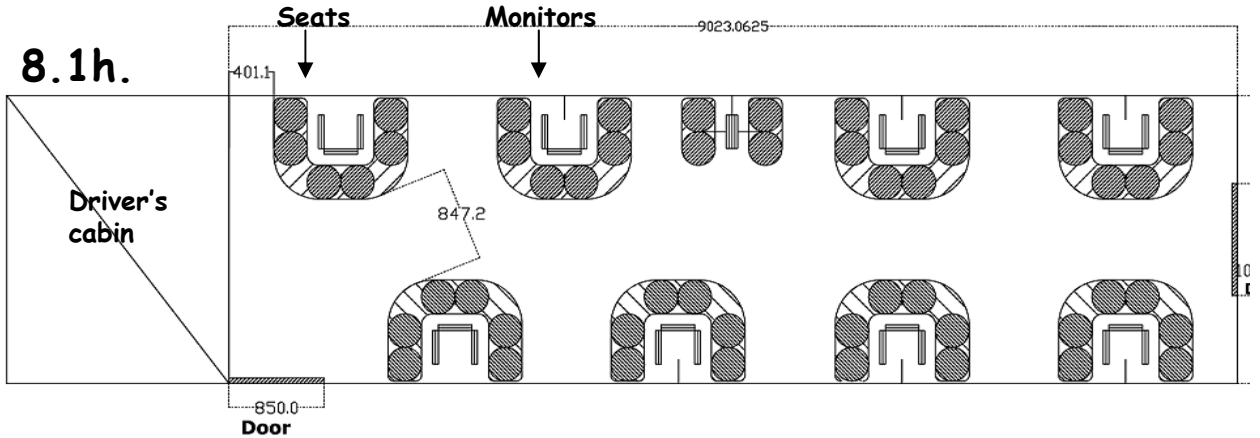
8.1g.



In this layout, the monitors are tilted at an angle, to the wall of the bus body.

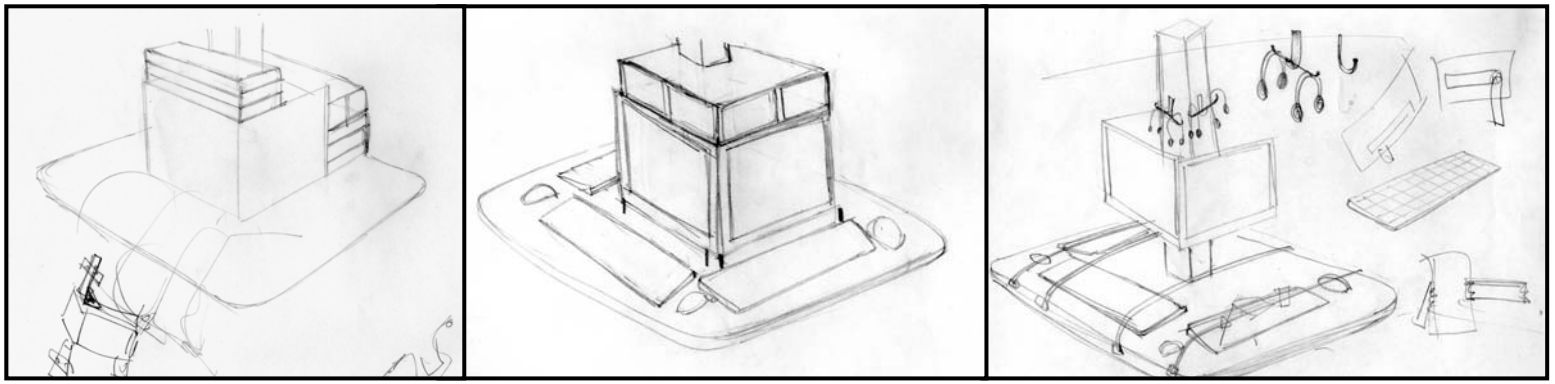
Characteristic feature of this is the presence arc like pattern of seat around the monitor.

8.1h.

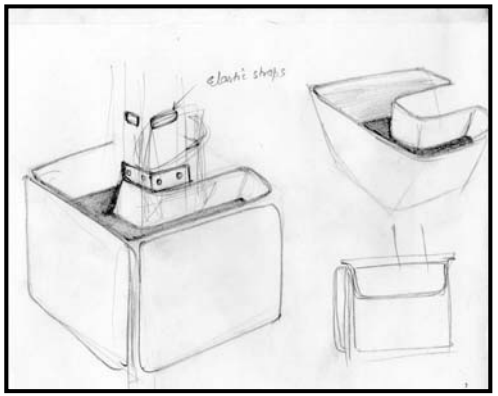


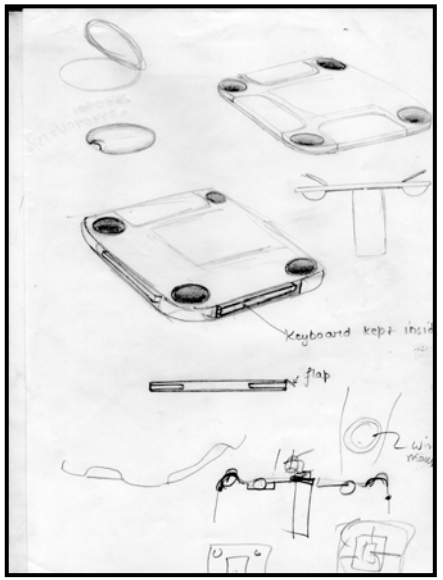
In this layout, the monitors are placed parallel to the wall of the bus body, in D-type pattern. Characteristic feature in it is the half-square seating around the monitor consoles

8.2 Workstation

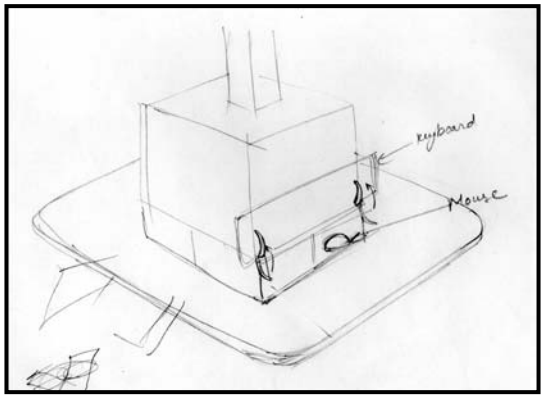


Different possibilities were explored for storage of mouse and keyboard

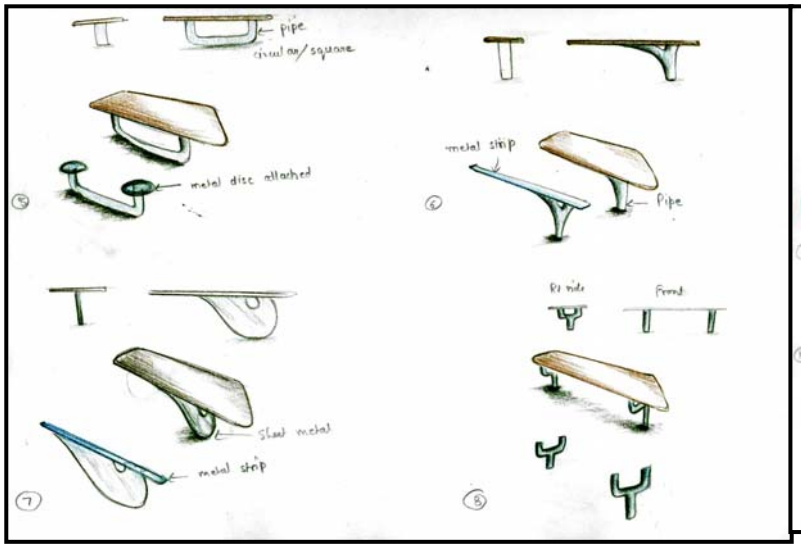


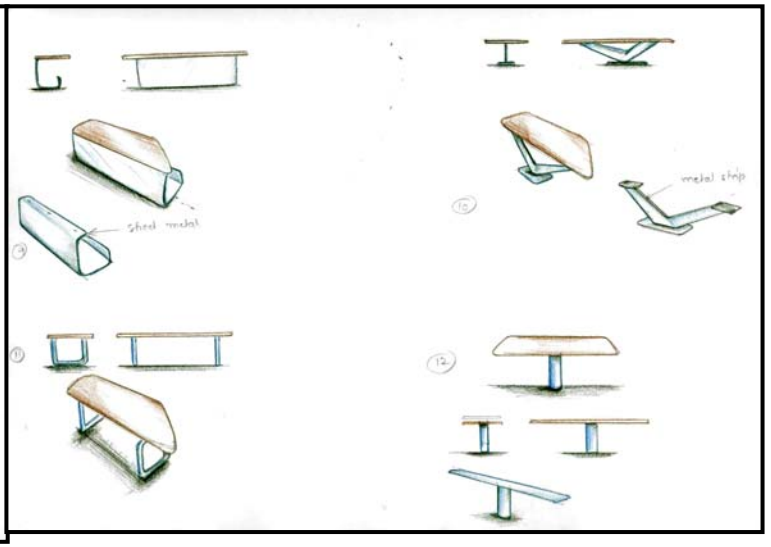


Exploration was also done to know the most effective place so as to reduce unnecessary clustering



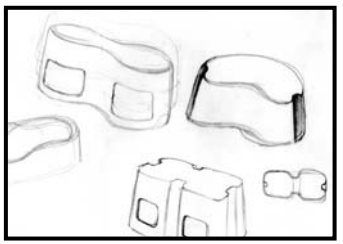
8.3 Seats





The features considered for the seats were

Storage after use, flexibility of usage, low weight, easy maintenance, durability, playful form

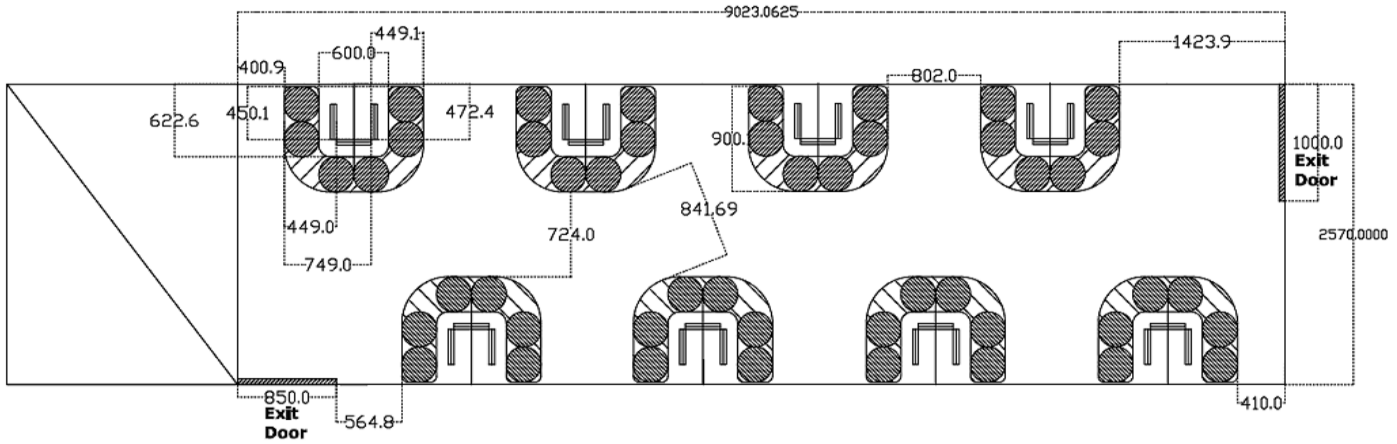


8. Variations

Variations were made in the selected layouts for further explorations in the arrangement of children and workstation

Layout and workstation

a



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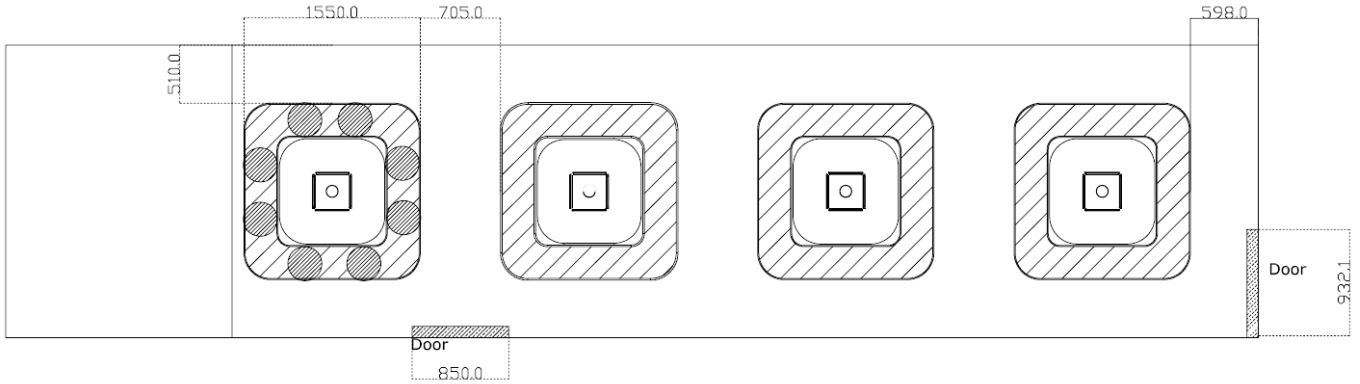

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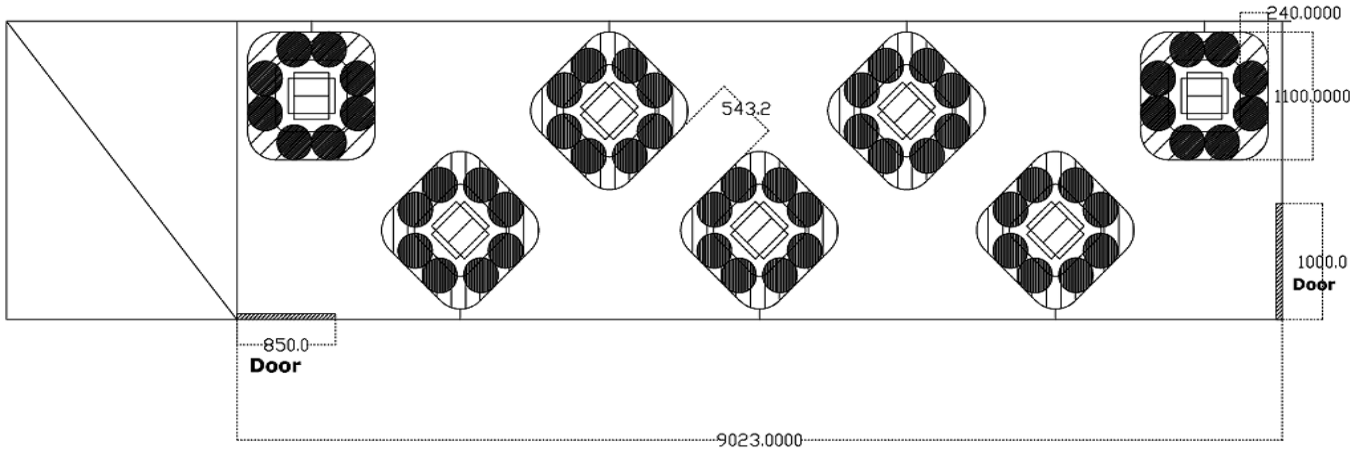
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543.2
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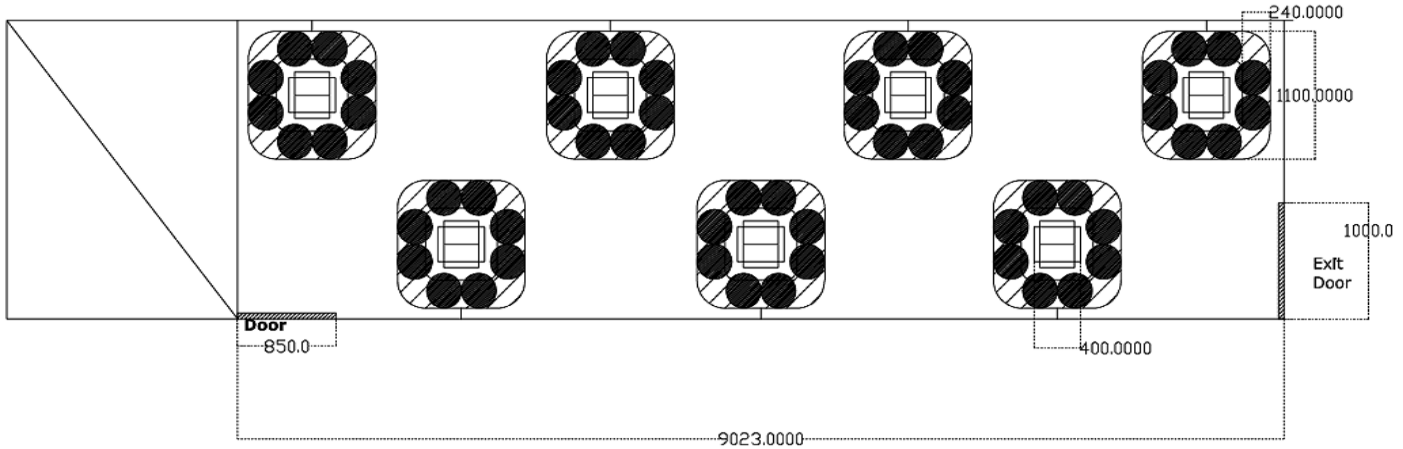
d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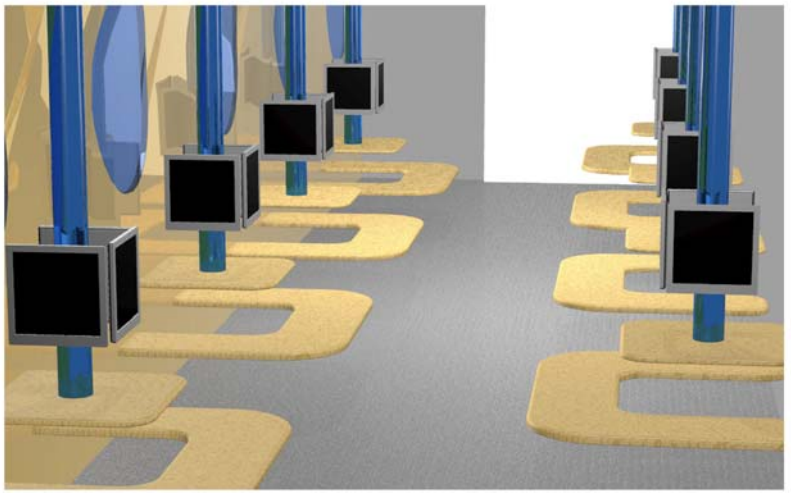
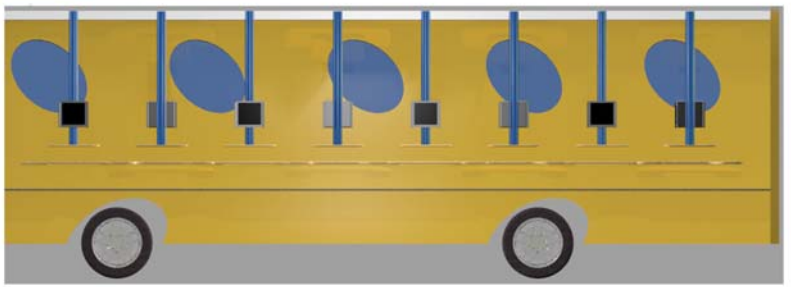
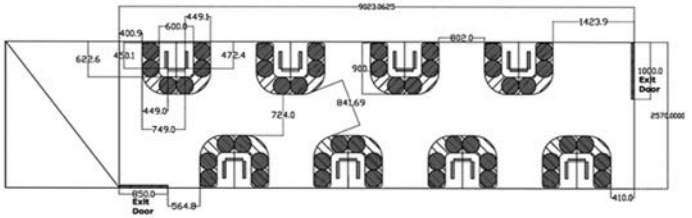
9. Conceptualization

Selected layout configurations

Configuration a

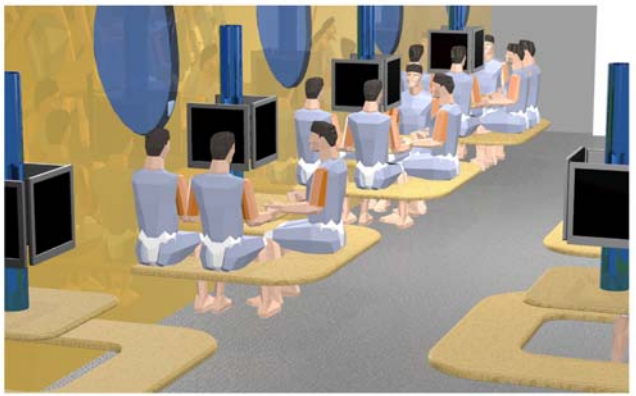




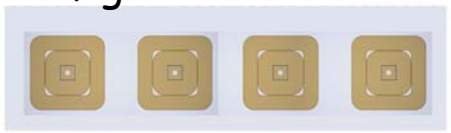


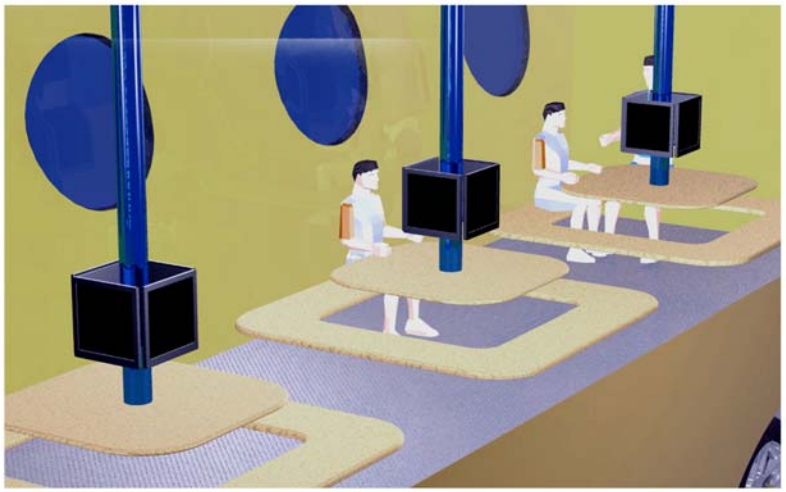
Number of students (max.) = 48

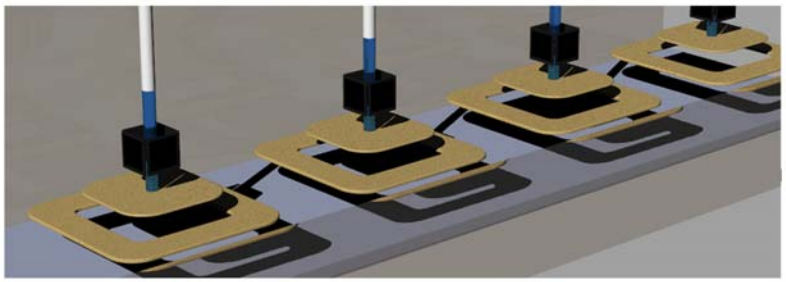
This is the D-arrangement of workstation where each monitor is shared by two children, thus each unit/ module supports six children.

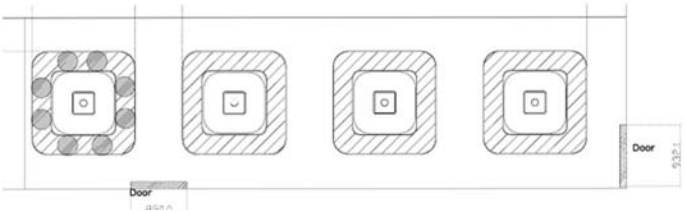


Configuration b





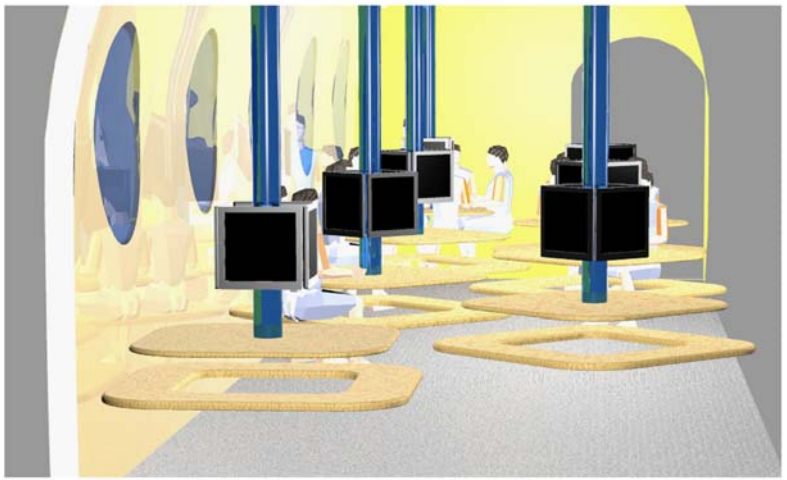


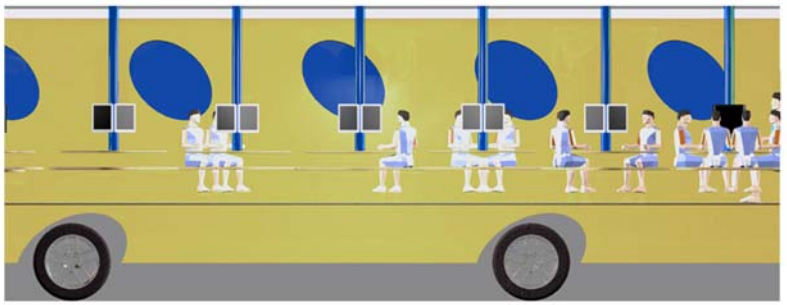


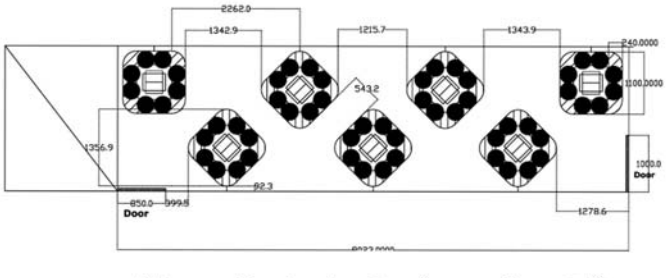
Number of students (max.) = 32

This is the linear, square-arrangement of workstation where each monitor is shared by two children, thus each unit/ module supports eight children.

Configuration c



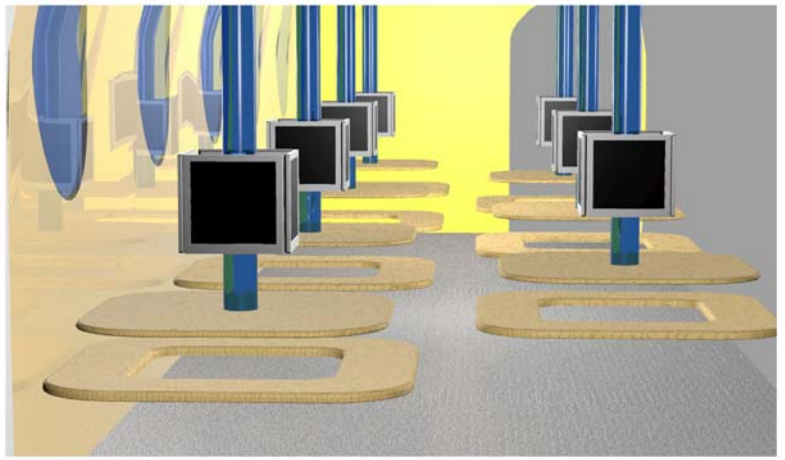


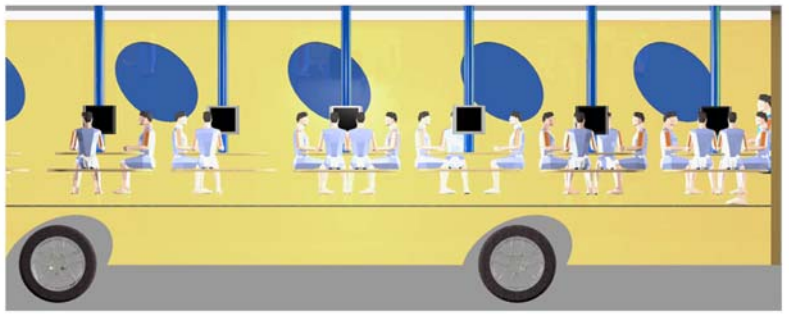


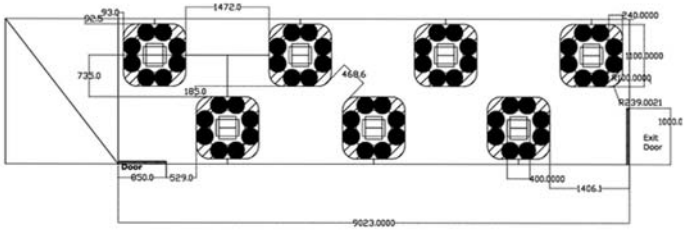
Number of students (max.) = 56

This is brick kind of orientation of square-arrangement of workstation where each monitor is shared by two children, thus each unit/ module supports eight children.

Configuration d





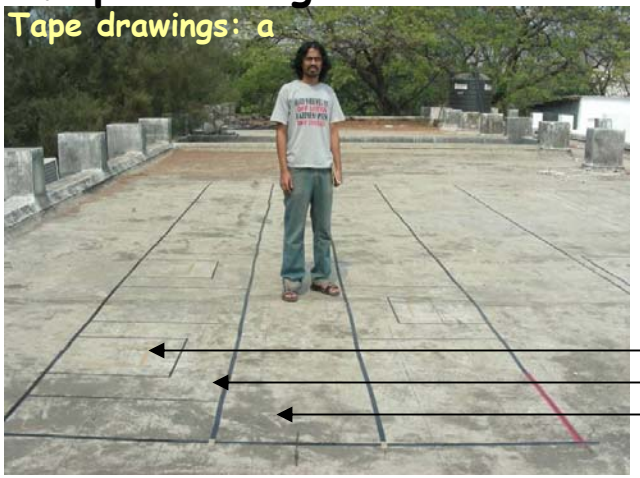


Number of students (max.) = 56

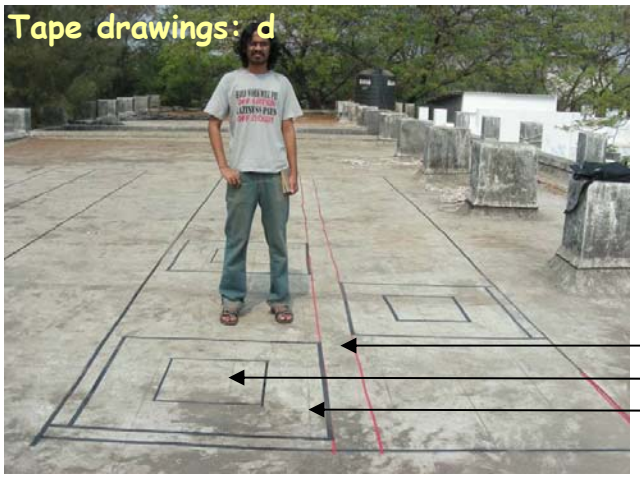
This is again dual row, square-arrangement of workstation where each monitor is shared by two children, thus each unit/ module supports eight children.

Full scale simulation

1.Tape drawings



These drawing were made to visualize the full scale area being used in the layout , as well as to know the relation of objects with the users.



Concept selection

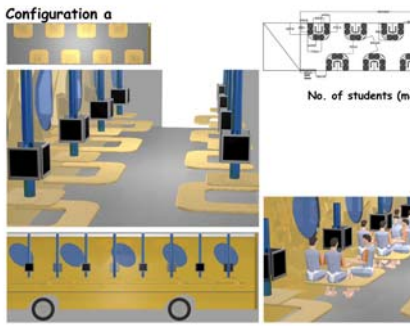
Concepts were marked out on a scale of **1 – 9** with,

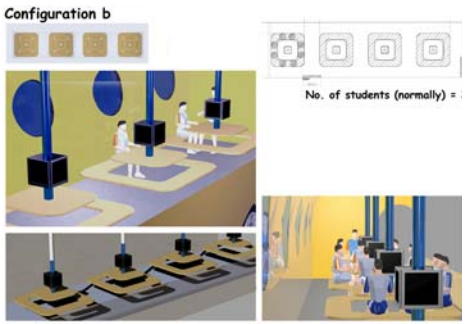
0 - representing least effective solution

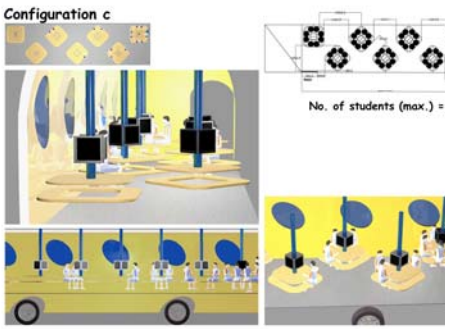
9 - representing best solution

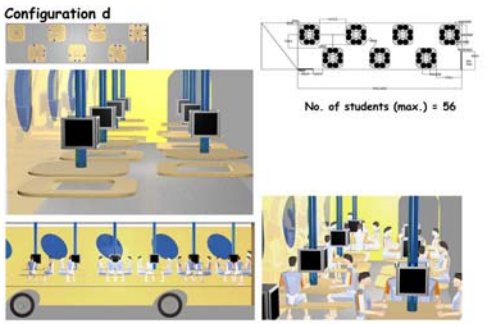
Hence, the highest scorer layout "a" ; was selected for further improvement.

Layout	Ease of movement	Sitting interaction	Open spaces	Uniformity	Simplicity of object placement	Playfulness	Modification possibilities (space context)	No. of seating	Leg space	Total
a	9	9	9	7	7	7	9	7	6	**70**
b	7	5	3	9	9	2	2	5	9	**53**
c	5	6	6	4	2	8	5	9	2	**47**
d	3	3	7	3	6	9	7	9	2	**49**

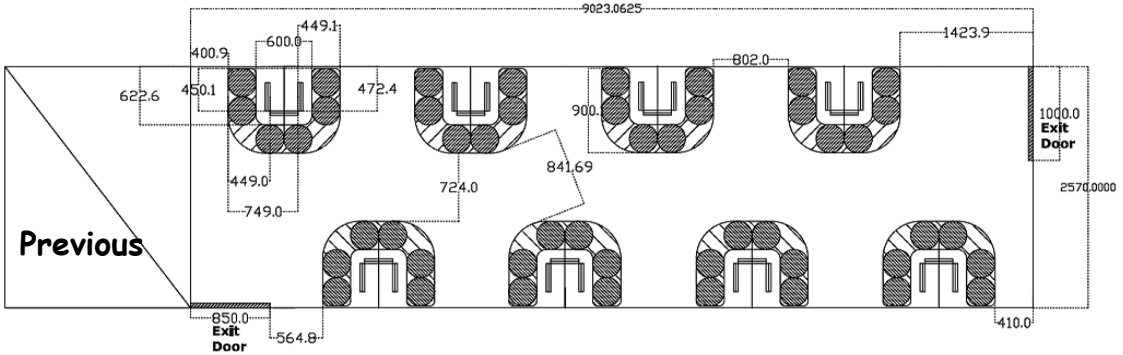


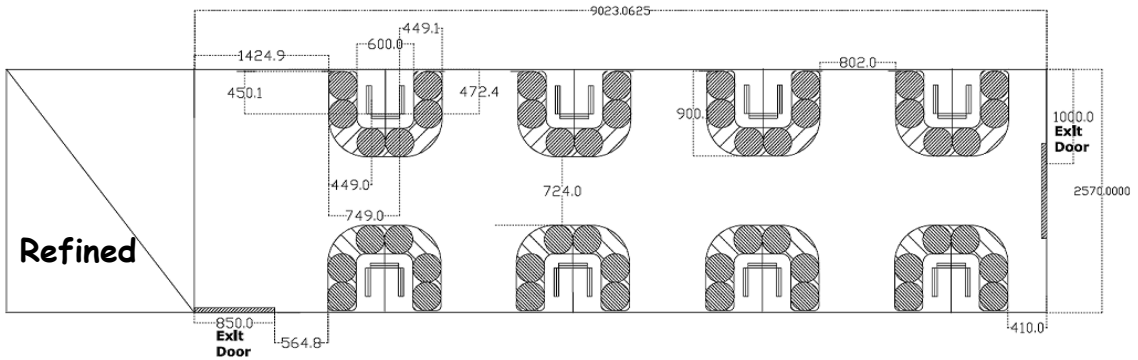






Further refinement

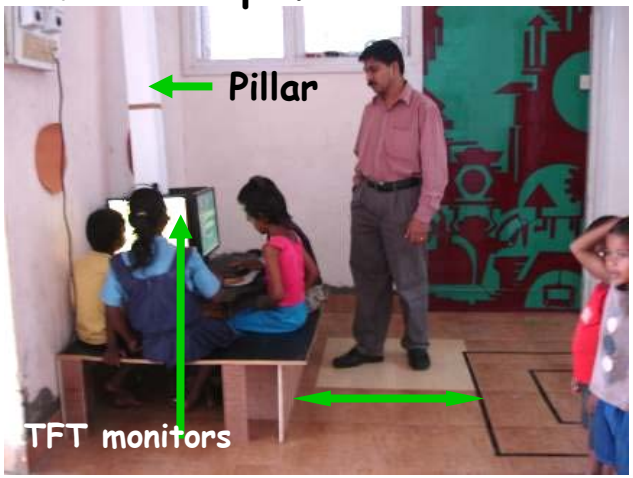




- The demarcation of area available for movement Placement of doors for entry/ exit as well as emergency
- Availability of space for CPU's
- Dimensioning according to the anthropometric data available
- Final positioning of workstation consoles/ units in the layout

Testing for usage

2. Mock up model

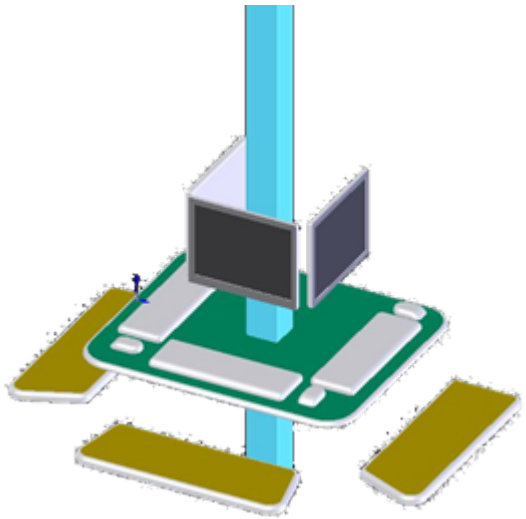


Partial layout of the bus

Mock up model was made to assess the implementation feasibility of proposed concept, as well as to conduct the simulation of the actual usage scenario.

Feedback analysis

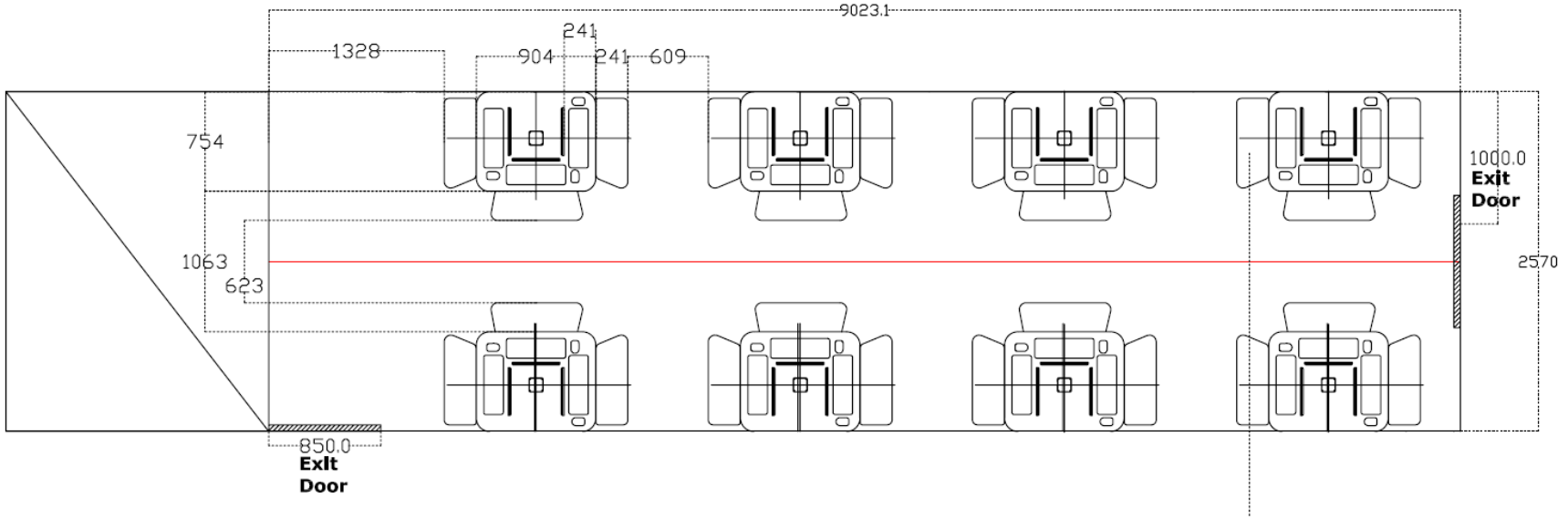
- Enough leg room.
- Seating space optimized.
- Height of monitors adjusted according to the children's height
- Distance between monitor and child modified.
- Space for the placement of mouse is enhanced by increasing the table length.
- Margin provided for keyboard of the side monitors.
- As well as smaller keyboard option explored
- Mode of entrance into the console cleared by splitting of the single bench seat.



Refined concept by feedback analysis

After taking in account of the issues noted from the user testing on mock up model, the changes were introduced and the model changed accordingly.

Refined 2-D drawing

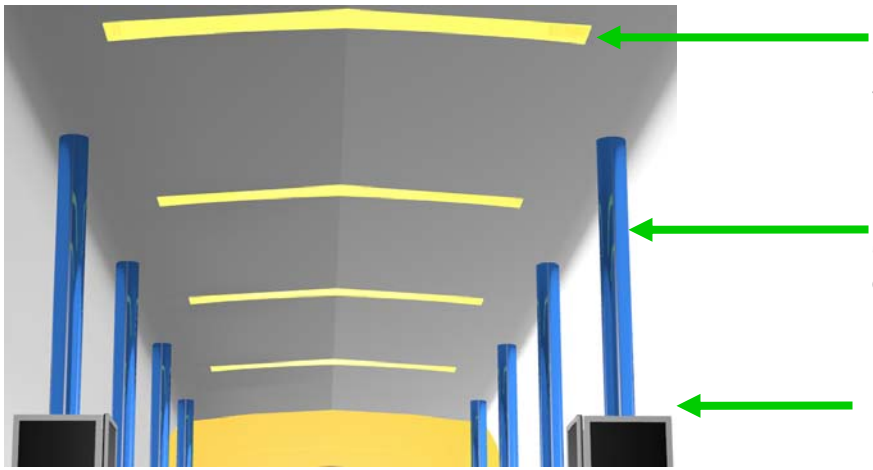


3D Layout

According to the inputs from mock up model feedback analysis, the layout and seating were changed accordingly.

The seats were made into three separate parts instead of single continuous D-shape, for ease of ingress and egress. Table dimensions were increased to provide adequate space for mouse and keyboard.

Lighting requirements



Translucent polycarbonate for providing natural diffused light

LED lights on the pillar

Windows

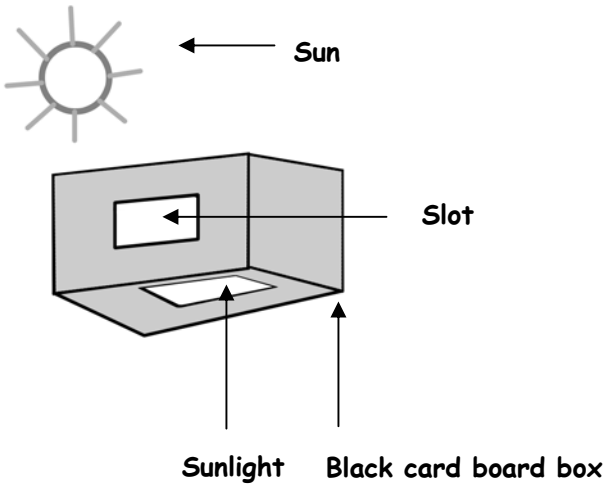
Polycarbonate dome -

Characteristics of the light source

- Uniform diffusion
- Maintenance of sufficient intensity
- Reduction in glare

Selection of Dome type roof outlet was done in accordance with the theme of playful form and in accordance with windows also

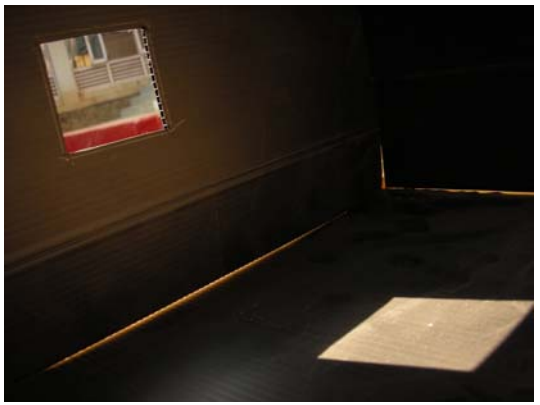
Testing for light quality (for dome material)



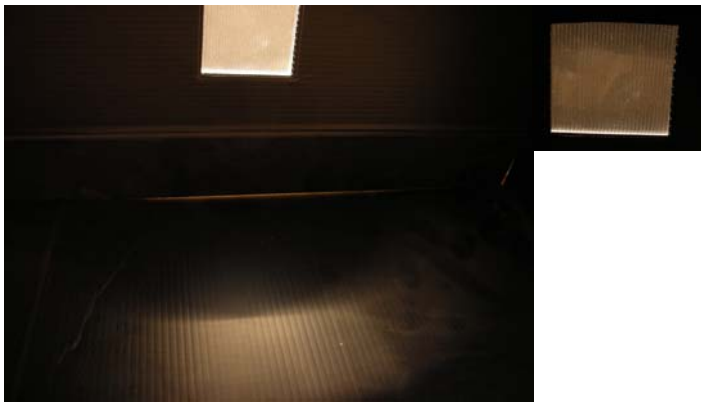
A black cardboard box was made, which was left open on one side for observation.

While a slot was cut to provide opening for sunlight. This slot was covered with different with acrylic sheets so as to assess the correct type of acrylic to be used for dome material.

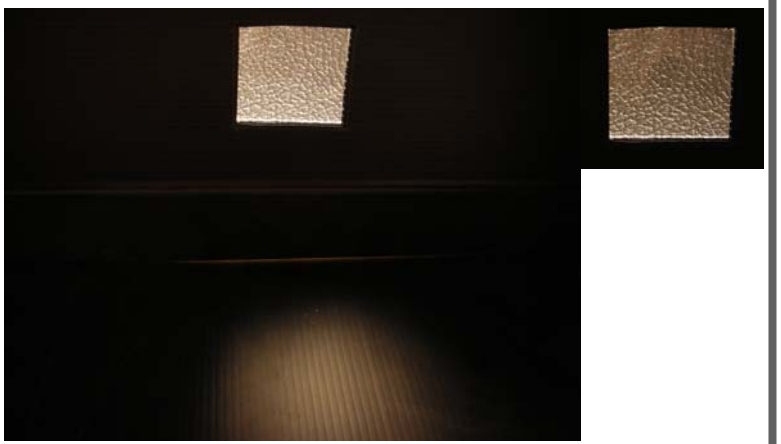
Testing for light quality



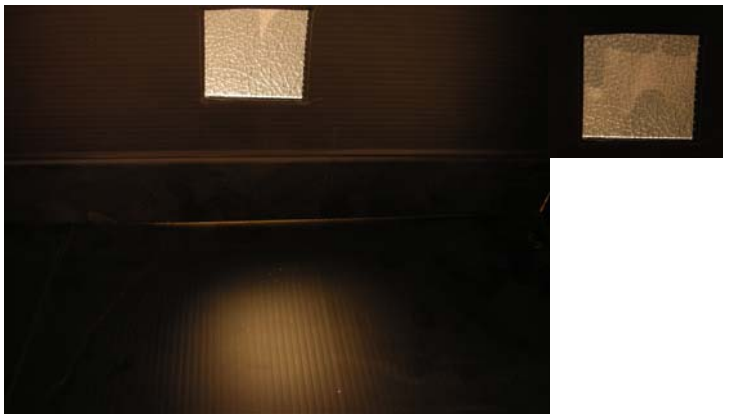
Plain light



Plain linear textured acrylic

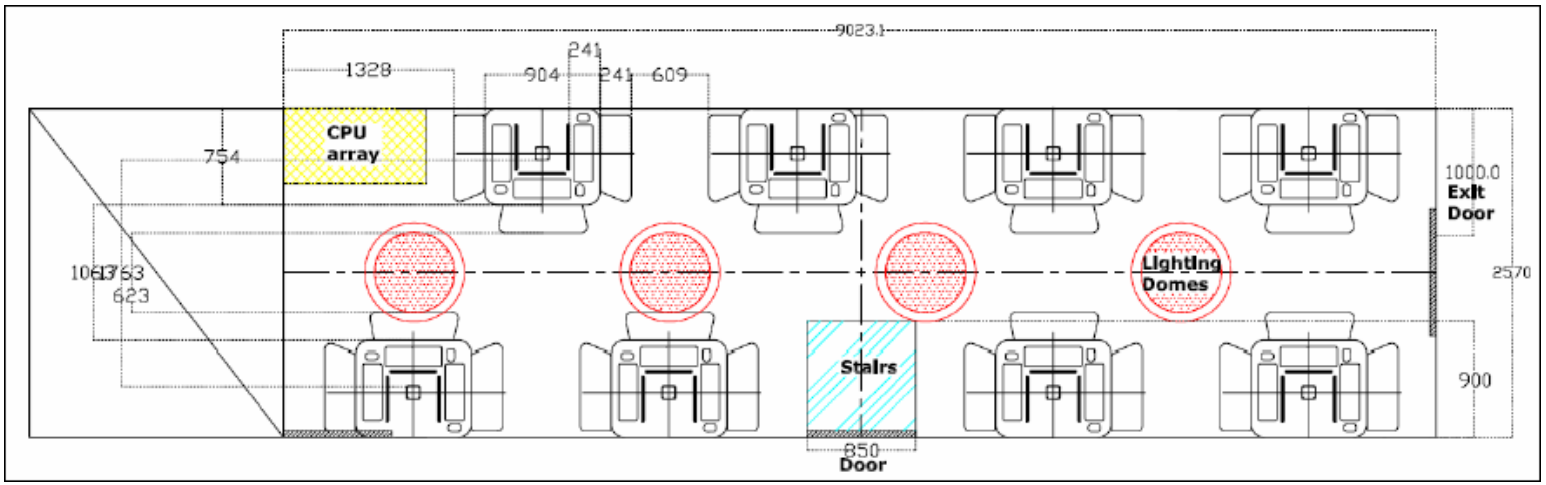


Plain textured acrylic



Tinted acrylic

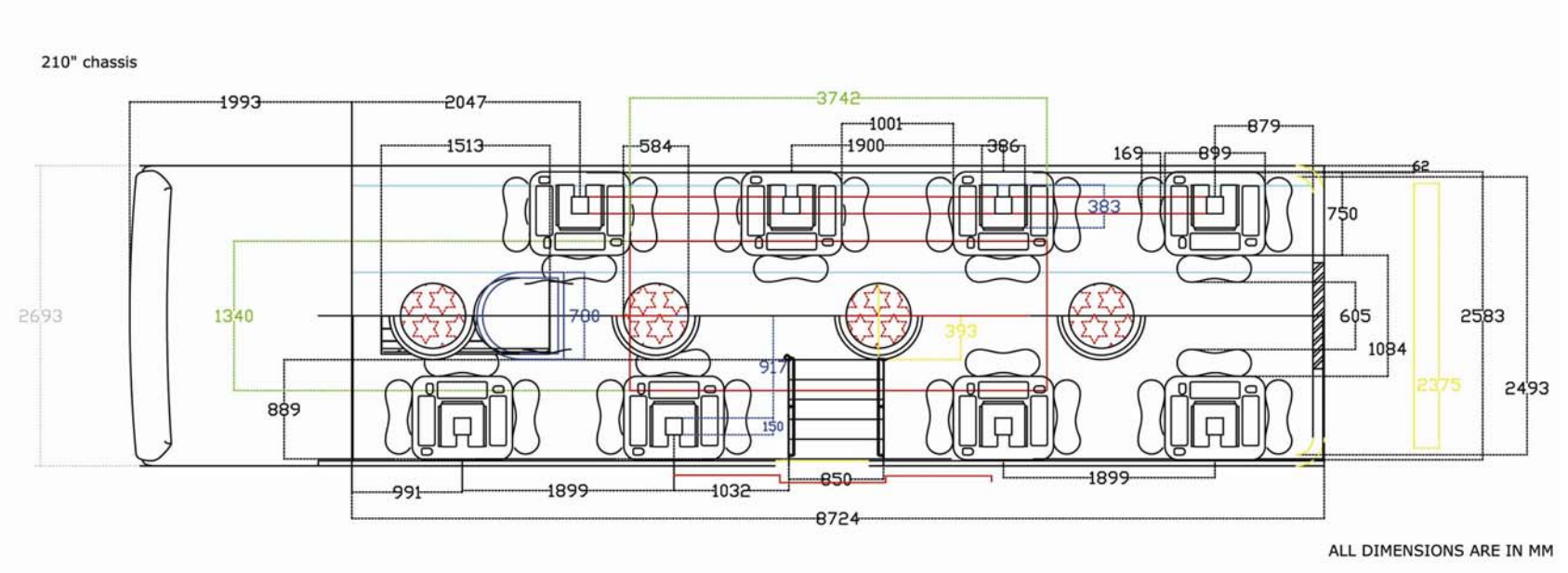
selected layout: showing the placement of polycarbonate dome



2-D Layout

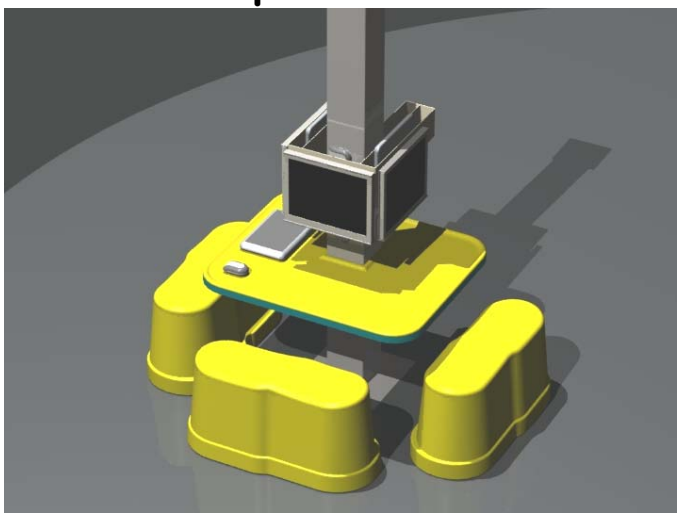
10. Final product detailing

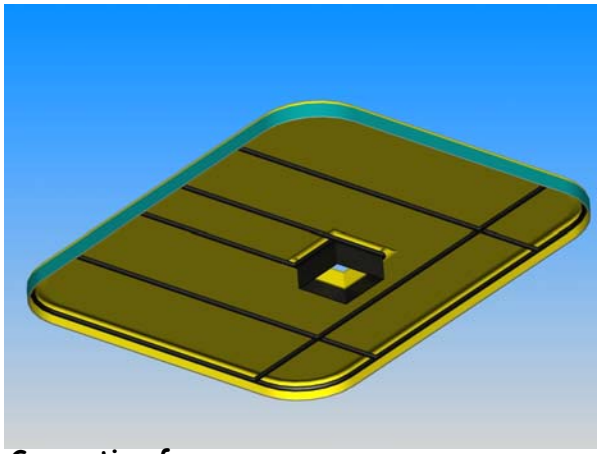
Refined Layout concept



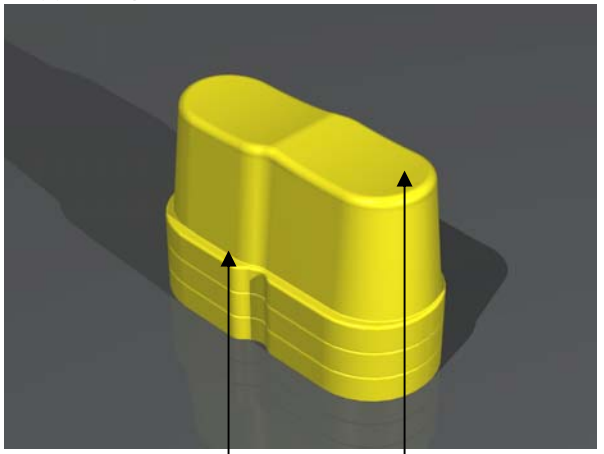
10.1 Workstation

Concept 1





Supporting frame



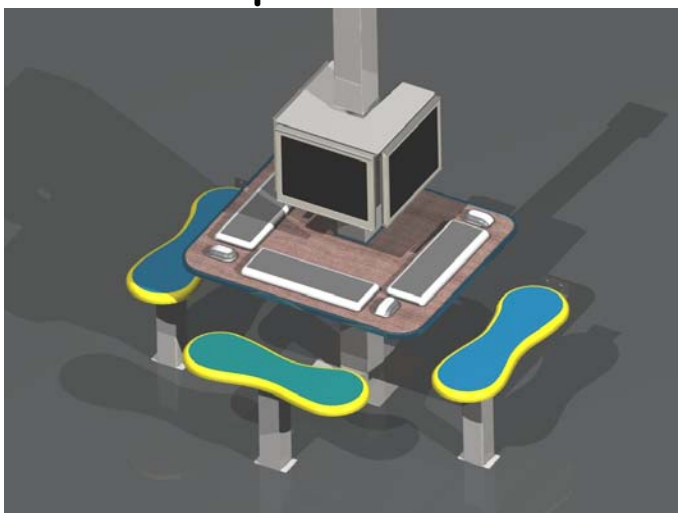
Molded seats (thermoformed):

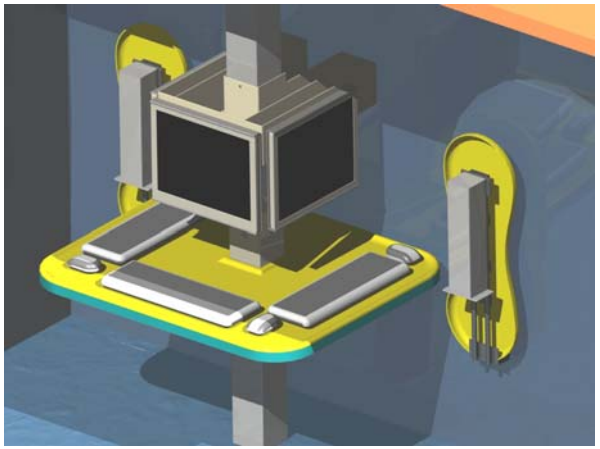
- Stackable
- Flexibility of use
- Colour options
- Ease of maintenance
- Lightweight

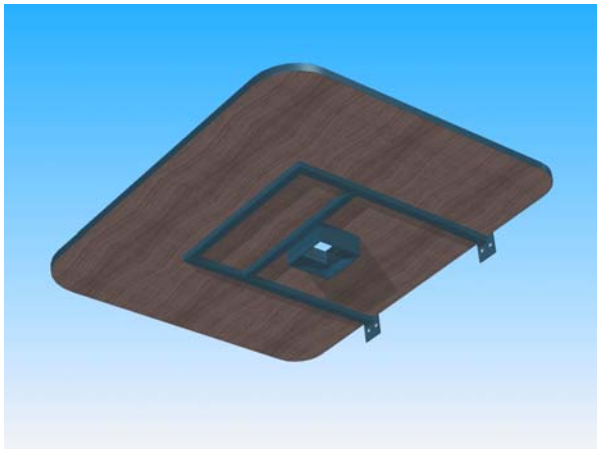
Molded table :

- Light weight
- Any form possible
- Colour options
- Ease of maintenance
- Contouring possible

Concept 2







Supporting frame

Wooden/ Plastic molded top on steel frame base

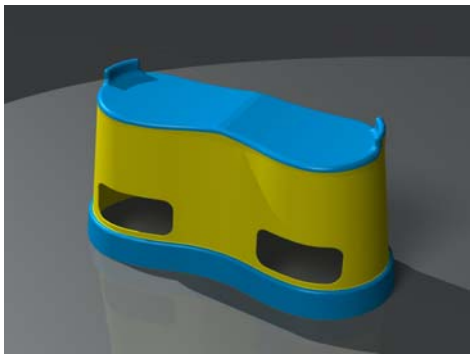
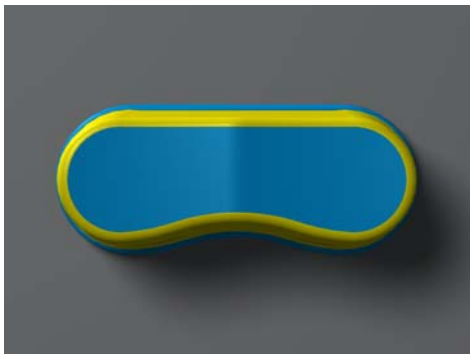
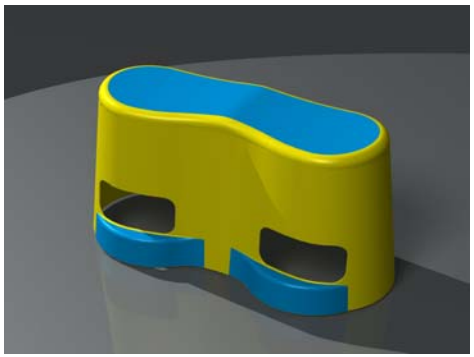
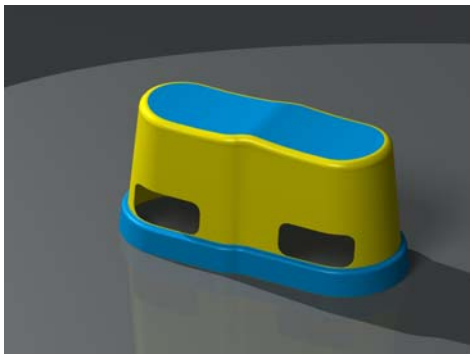
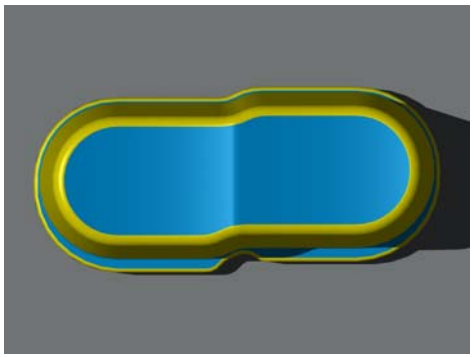
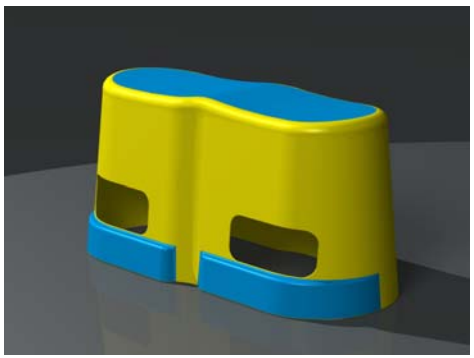
Fixed seats:

- Foldable
- Limited flexibility in terms of placing
- Requirement of metal frame for support
- Maintenance requirement

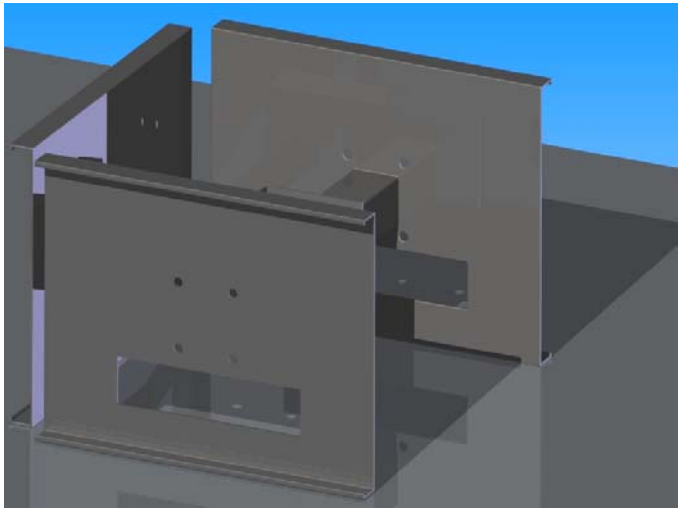
Wooden table:

- Heavy
- Limitations in case of fillets
- Requirement of metal pipe frame
- Maintenance requirement

Seat form options

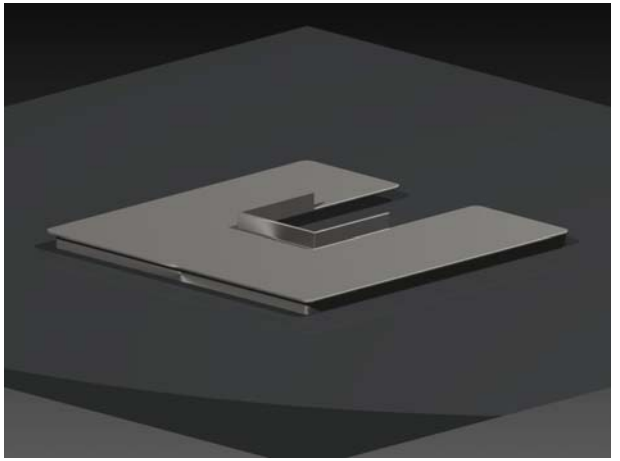







10.2 Monitor assembly

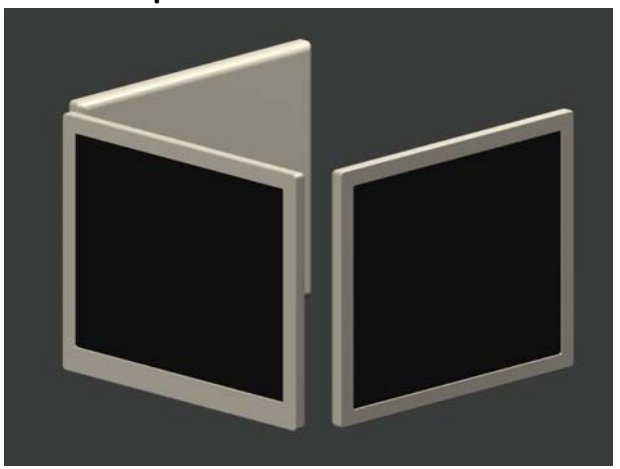


Sheet metal holding frame

Manufactured of MS sheets and fixed on to the pillar by the use of bolts.



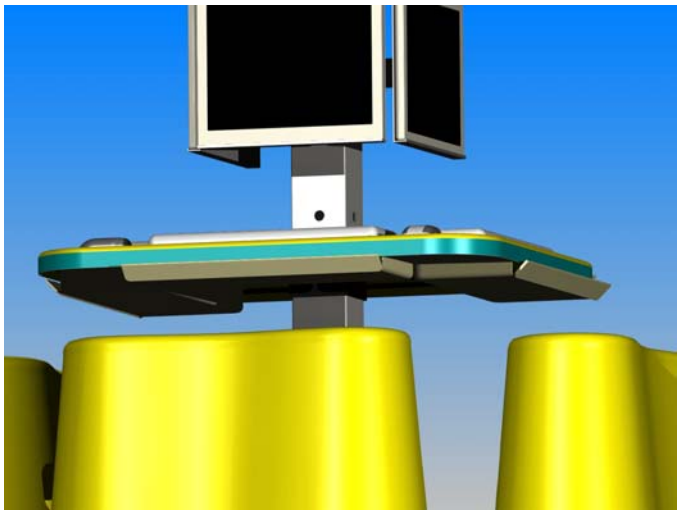
Plastic top cover



Monitor placed in D-pattern

10.3 Key board and mouse storage

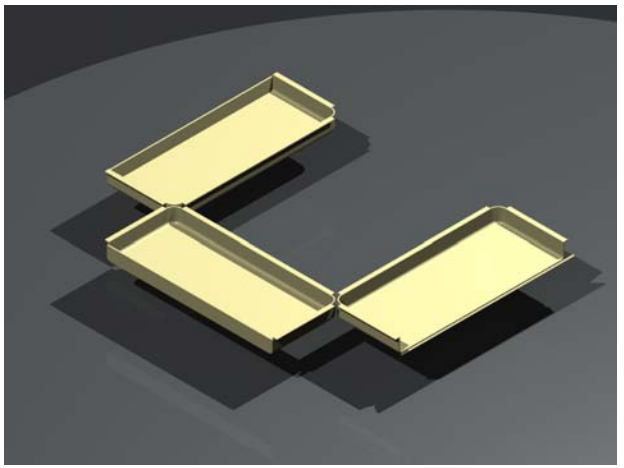
Concept 1



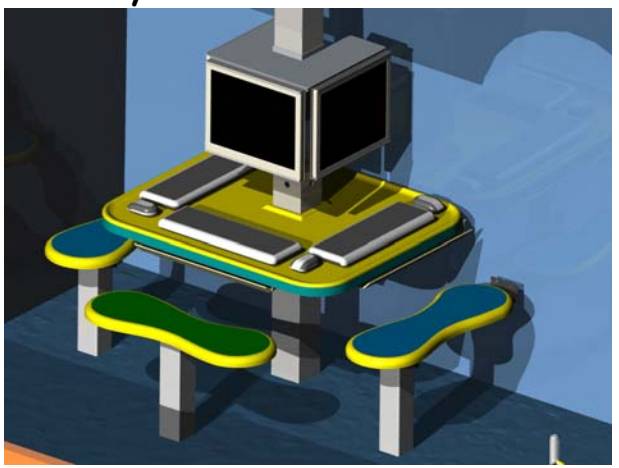
Fixed under the table

Features:

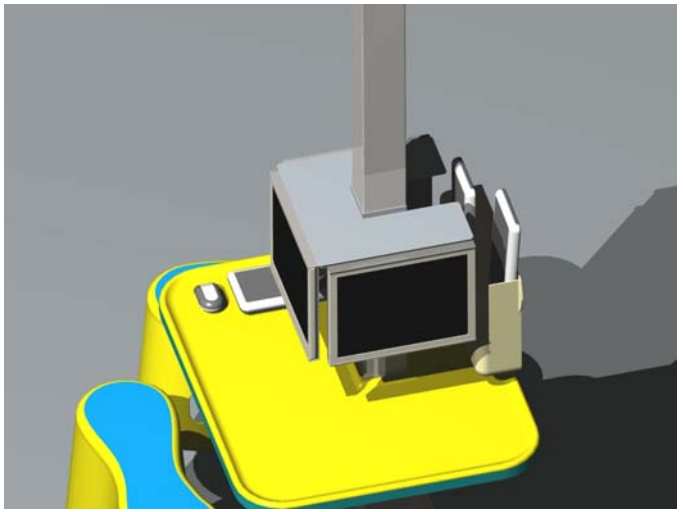
- Not visible from the above
- Integrated with the table
- Lightweight (ABS plastic)
- Sleek
- Can cause some hindrance to legs
- Opening and closing has to done with care
- Wires may cause clutter
- Chance of keyboard/ mouse falling down if not flap not closed



FRP keyboard/ mouse holder



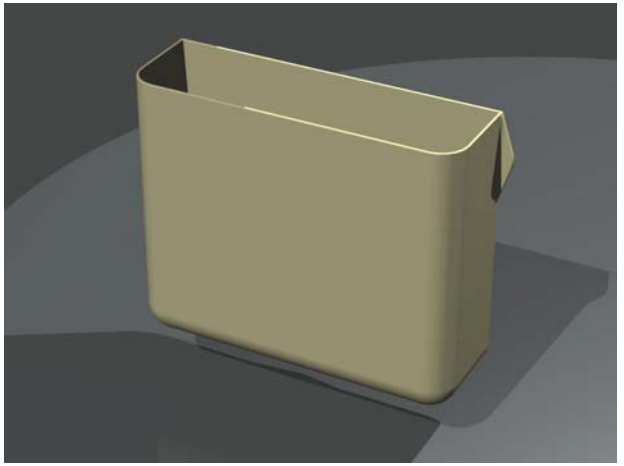
Concept 2



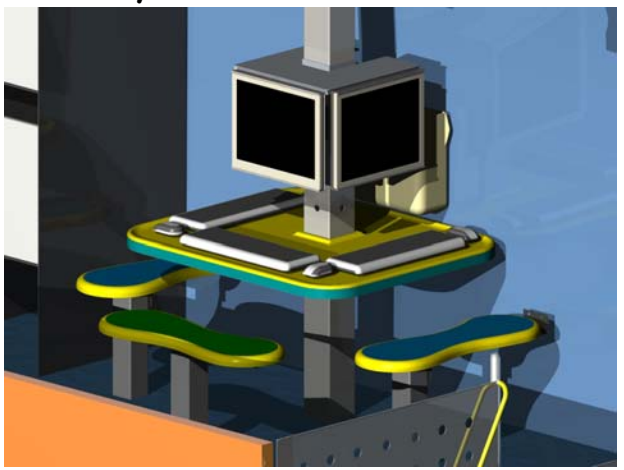
Fixed behind the monitors

Features:

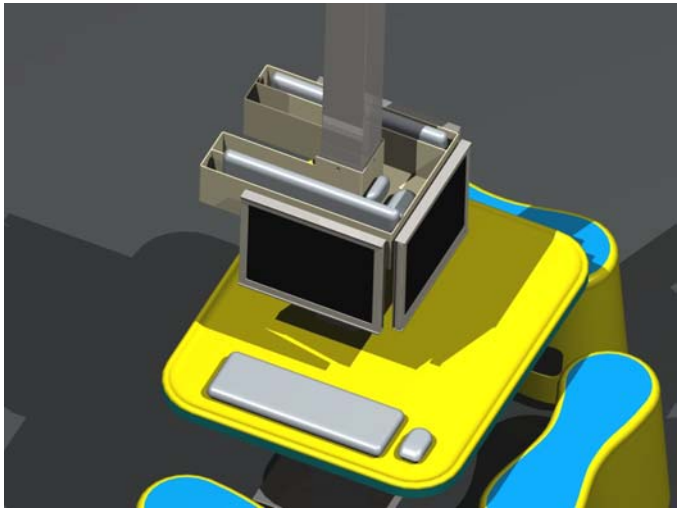
- Visible from the side
- Integrated with the bus side body
- Lightweight (ABS plastic)
- Utilization of free space
- Can be left open
- Wires cause clutter
- Keyboard/ mouse could be fixed by use of cushion material
- Obstruction for placing the objects



FRP keyboard/ mouse holder



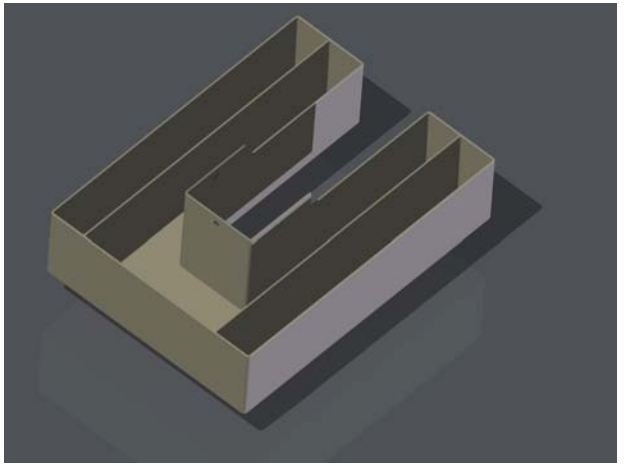
Selected Concept



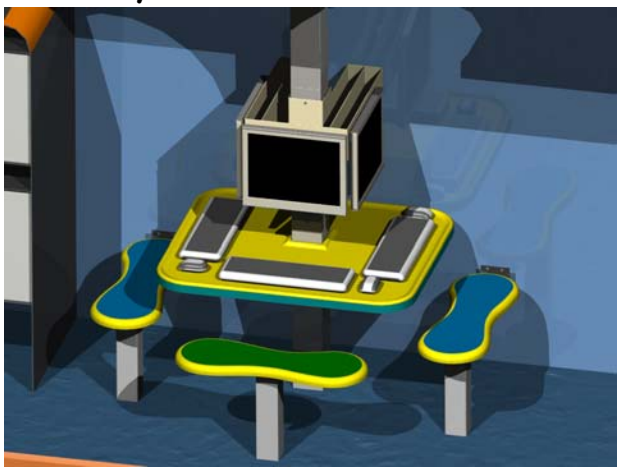
Fixed behind the monitors

Features:

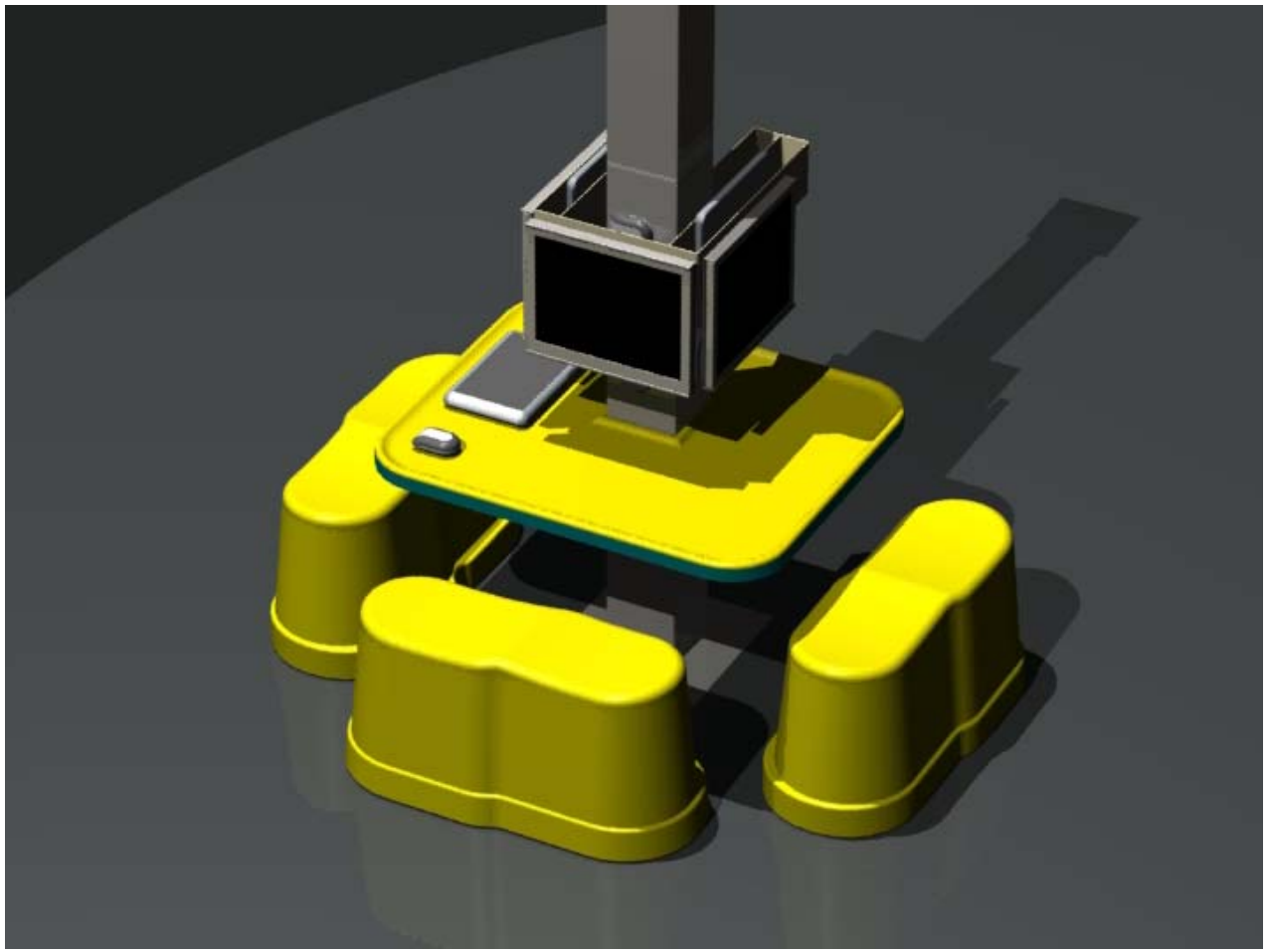
- Quite visible from the above
- Integrated with the monitor console
- Lightweight (ABS plastic)
- Utilization of free space
- Can be left open
- Wires may cause clutter
- Keyboard/ mouse could be fixed by use of cushion material



FRP keyboard/ mouse holder



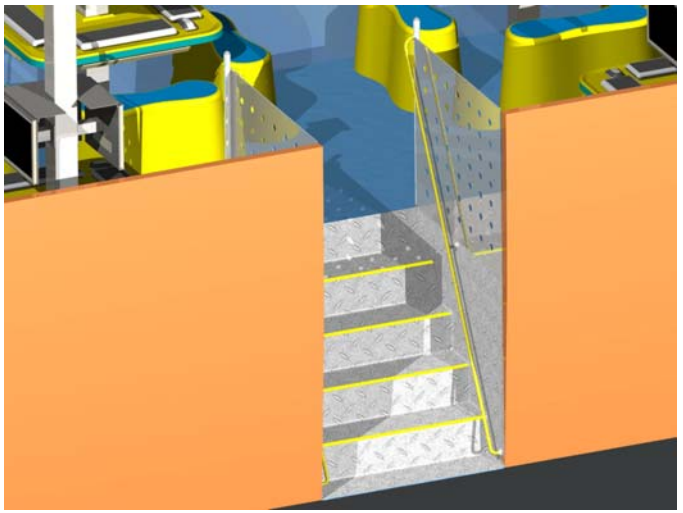
Final workstation

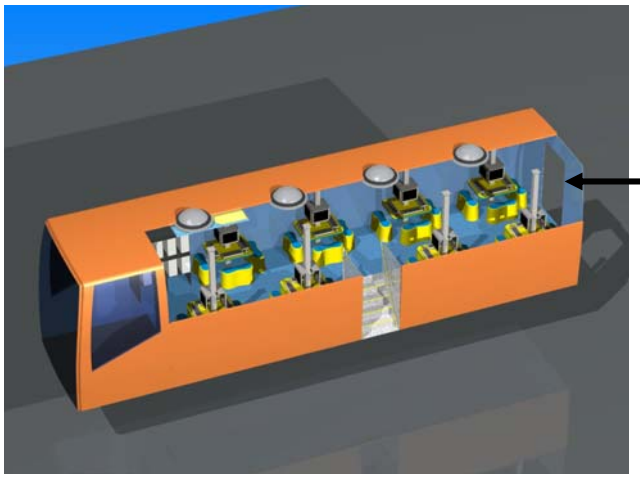


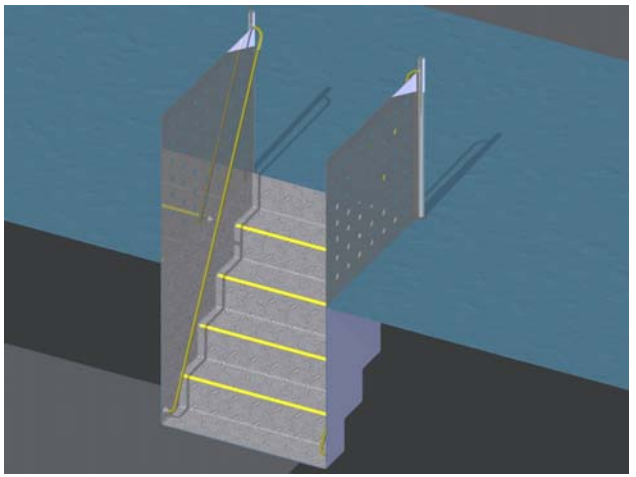
Considerations for the workstation

- Keyboard is under fingers when upper arms are relaxed at sides and elbows are bent to about 90 degrees.
  Wrists are straight
  Upper arms are relaxed at the sides of the body.
- The mouse should be located next to the keyboard so that it is easy to reach.
- The wrists should be straight when keying or using the mouse
- The monitor should be directly in front of the student so that no neck twisting is required to view the screen. The top of the screen should be below eye level.
- The student should not have to bend his/her neck backwards to view the screen. Watch that the chin doesn't poke out when using the computer. This posture is hard on the neck tissues and may happen because the monitor is too far away or because the student is concentrating on whatever he/she is viewing.

10.4 Position for Entry/ Exit



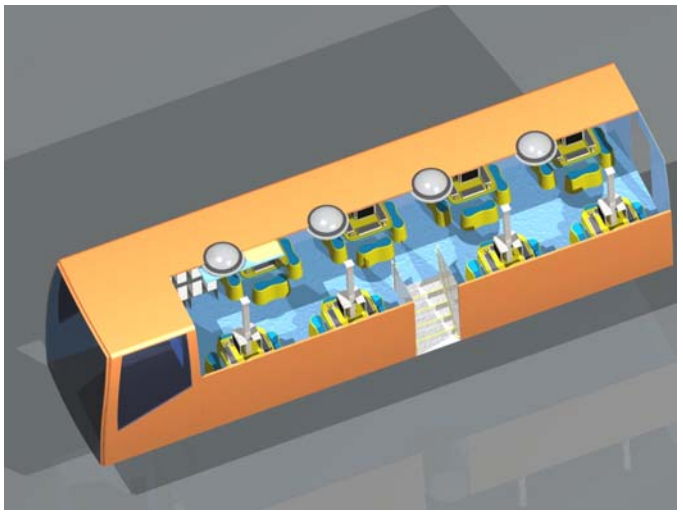




- Hand rail is PVC coated,
- Bright yellow colored for indication of change of plane
- Side grills erected to prevent accidental falling as well as for support

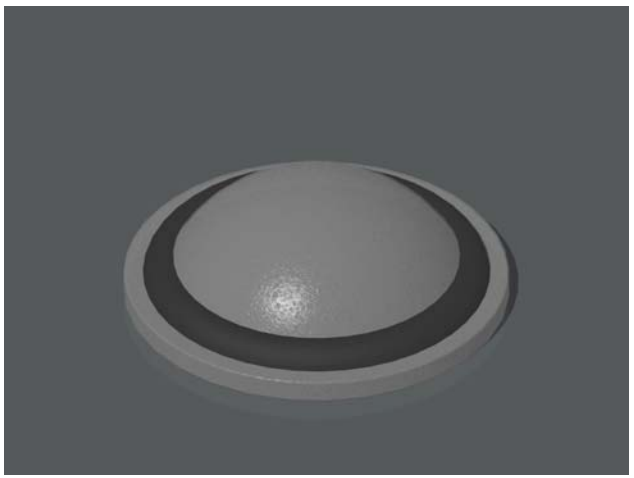
Options for front entrance and middle entrance were explored , but the criterion of ease of movement, as well as enhancing the playful element were used to decide on the current position.

10.5 Natural opening through the roof



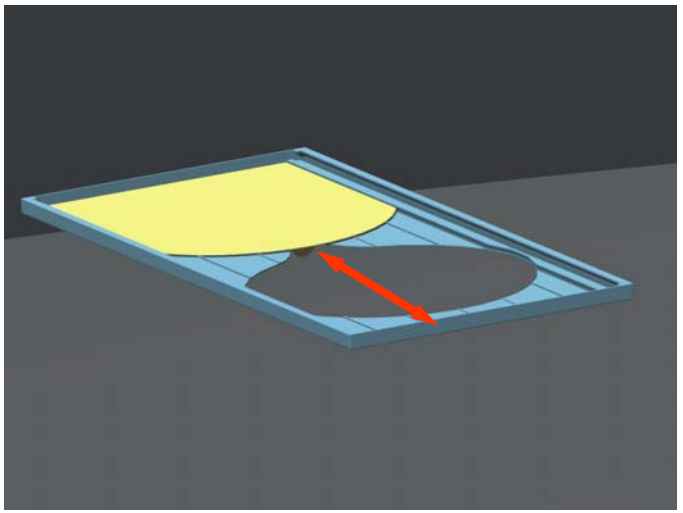
Translucent polycarbonate dome

The dome were placed for provision of uniform diffused light as well as providing an element of surprise, especially during monsoon season.



Lined with rubber gasket

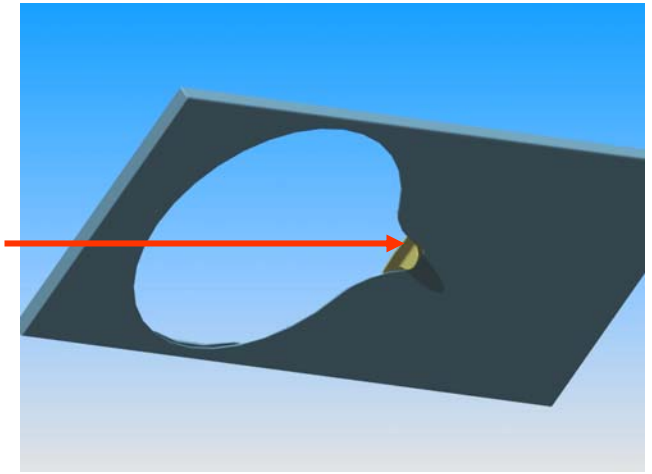
Panel to control light through dome

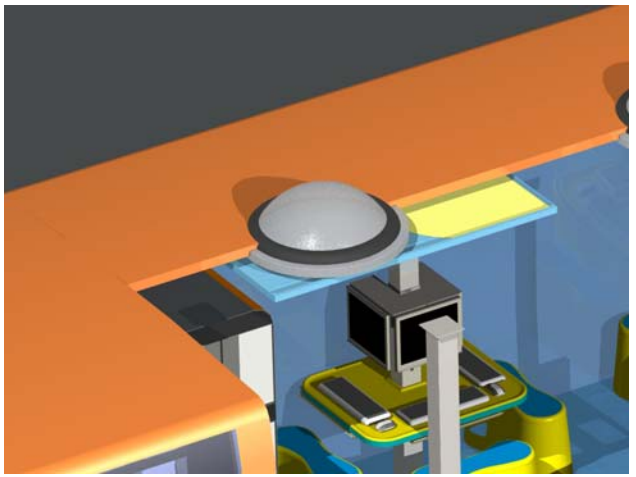


ABS panel with slider

Slider has to pulled out for reducing the light in case of non-requirement i.e. at the time of presentation

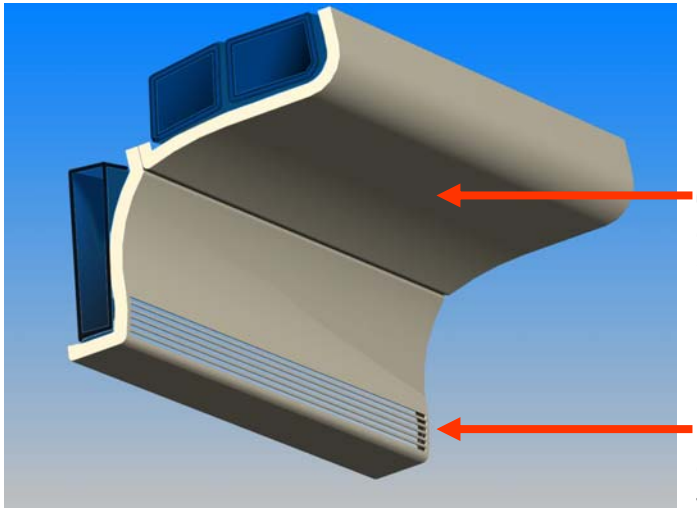
Slider

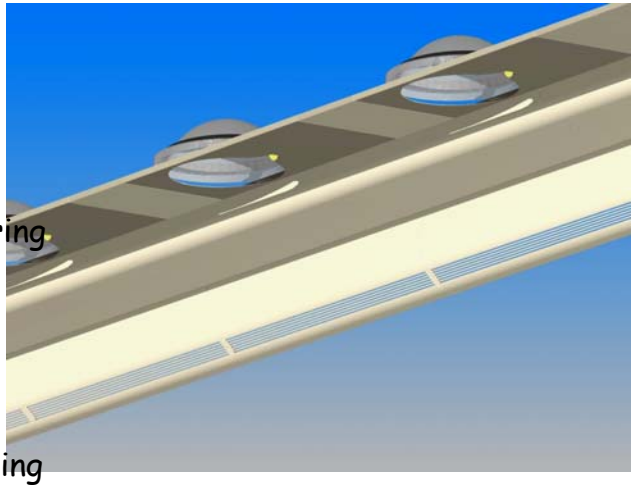




10.6 Wiring and Air conditioning panels

Concept 1

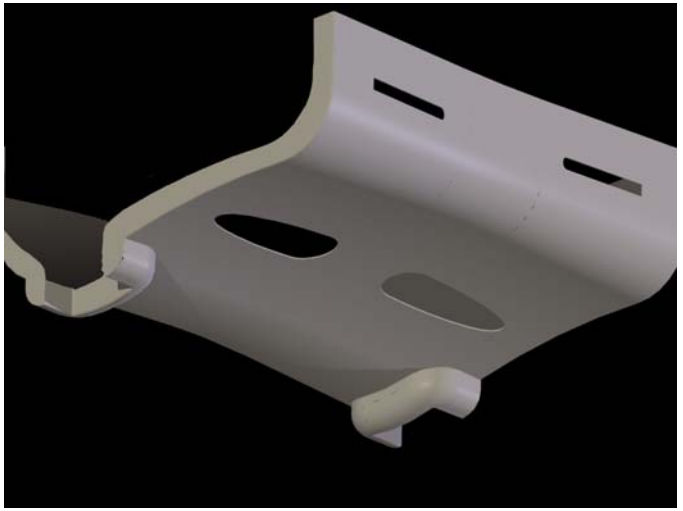




ABS panels

The panels have to be mounted on the side wall and roof so as to cover the duct network and insulated wiring channels

Selected Concept



ABS panels for covering the a/c duct and wiring pipes

The panels have to be mounted on the roof and will cover the a/c duct as well as the wire carrying pipes, interconnected to workstation poles.

This concept was selected due to its playful form and modularity. It also provides smart space for placing the artificial light sources; as the junction of two panels is used for pillar and lights alternately.

10.7 Exterior graphics

Theme of paw of a lion was taken for the windows

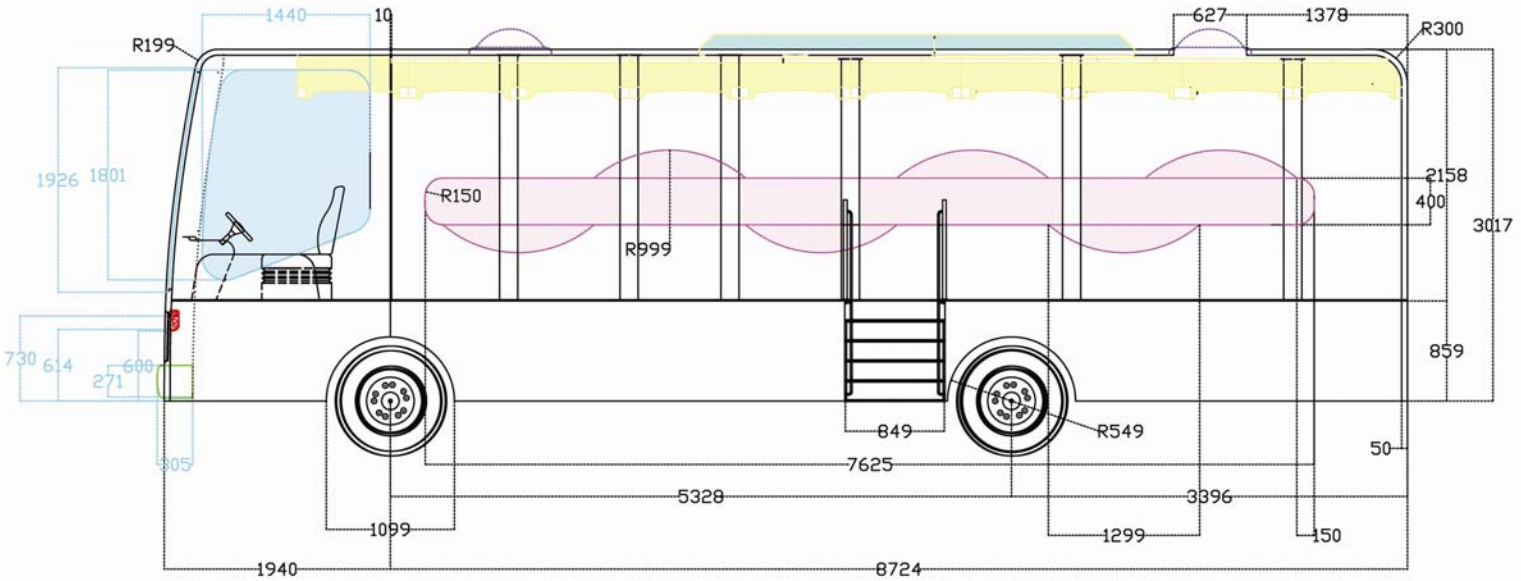
Theme taken was of windows of the home

Theme was of jungle with snake crawling on a stick

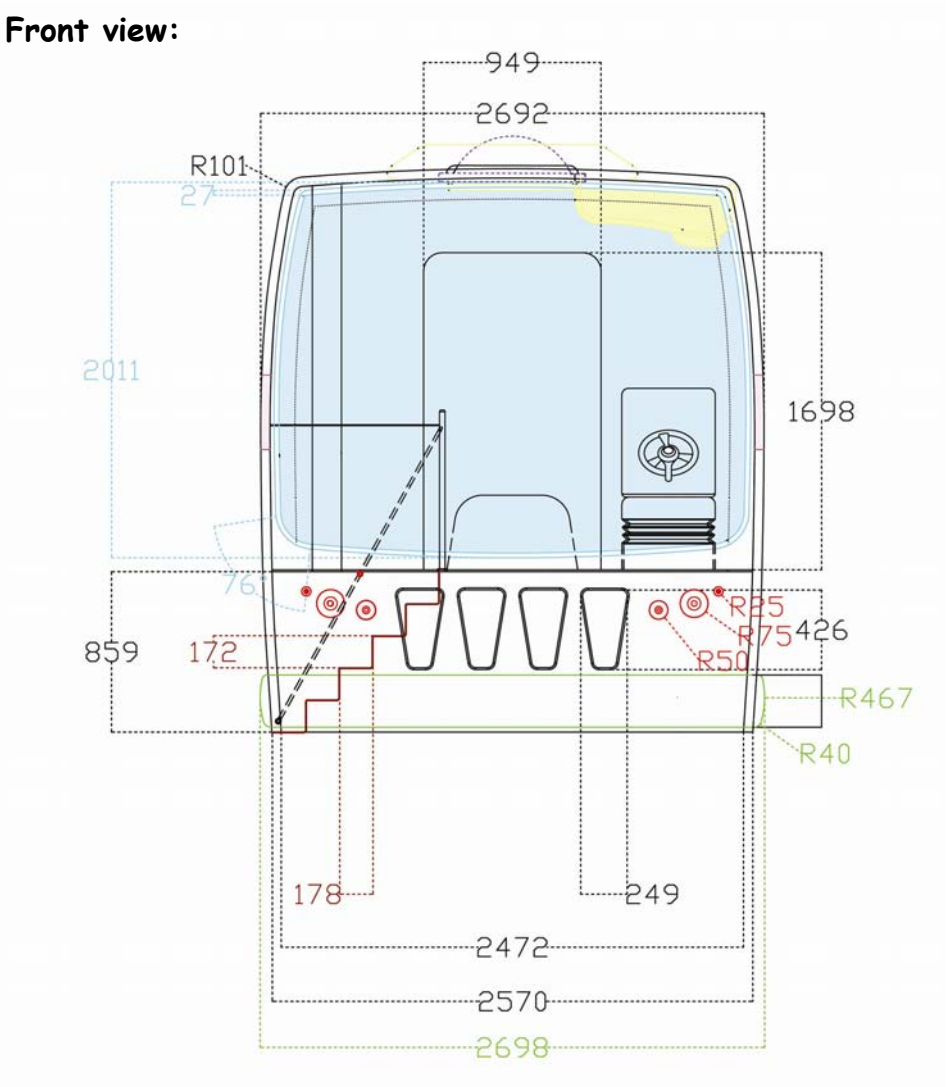
Theme taken was of water droplets splashed

11 Drawing Details

11.1 Side view:

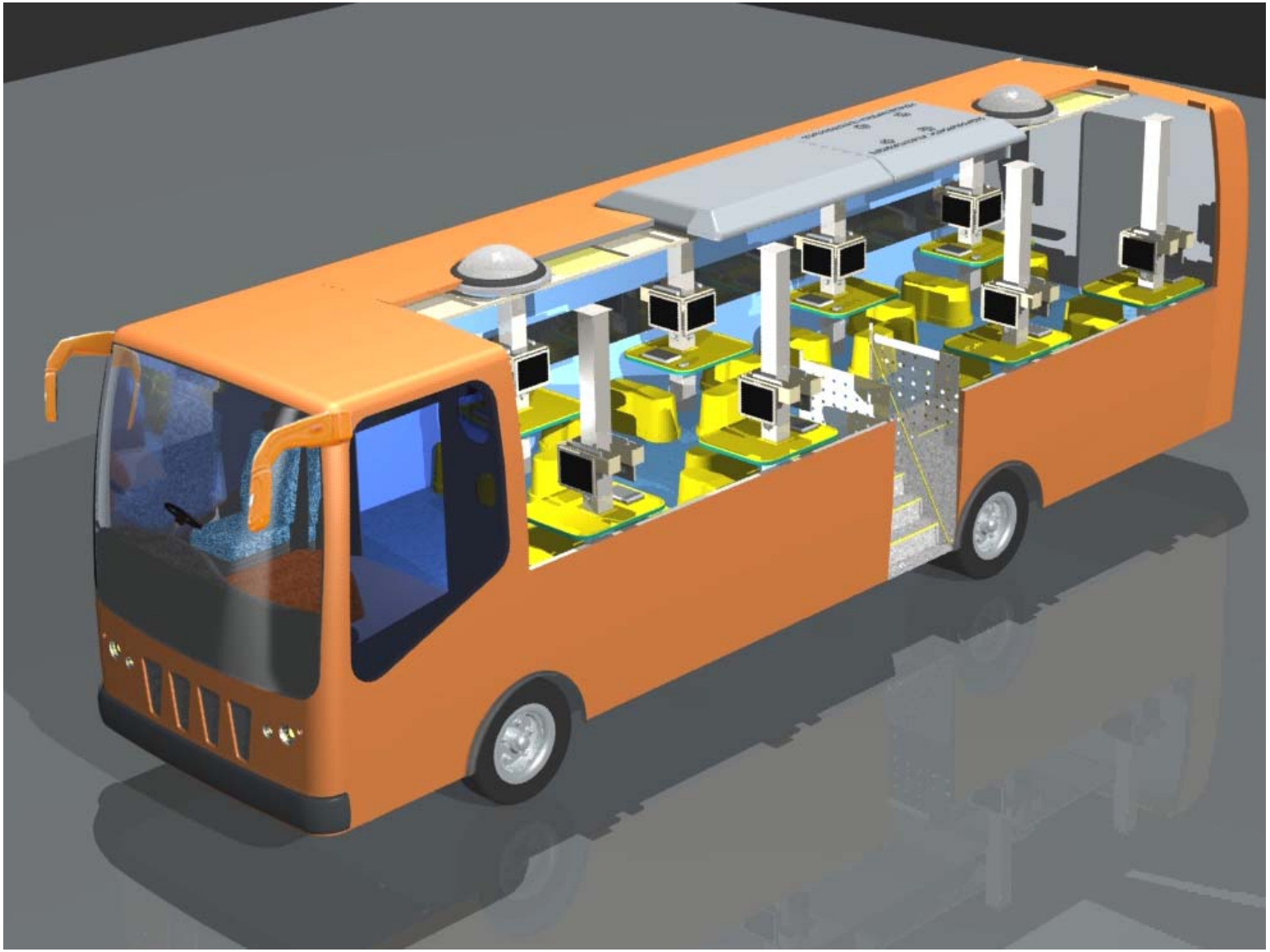


11.2 Front view:



12. Final Design renderings

Sectional view



Exterior & graphics

Exterior & graphics

Model photography

Perspective view

Side view

Model in exhibition

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