Summer Internship @ Larsen & Toubro, Powai

Design of MMI and GUI for a Weapon Launch Platform

Ameya Naik
07613001
PD-2007
Industrial Design Centre
Indian Institute of Technology Bombay

As this project is related to Defence System and the Defence Ministry of India, not all data could be published in form of the report. The data published in this report is sole property of **Larsen & Toubro Pvt. Ltd. Powai, Mumbai** and cannot be republished or utilized in any manner without the permission of Larsen & Toubro Pvt. Ltd. Powai, Mumbai.

Index

Certificate

Acknowledgements

About Larsen & Toubro

Project Brief

Approach Strategy

About the Weapon Launch Platform

Control Panel

Operator Console (OC)

External Body (Form)

Conclusion

LARSEN & TOUBRO LIMITED

HEAVY ENGINEERING DIVISION

(An ISO-9001, ISO-14001 & OHSAS-18001 Regd. Division)

Powai Campus, Saki Vihar Road, P. O. Box 8901, Mumbai-400 072, INDIA • Tel . : 6705 0505 • Fax : 91-22-6705 1319

E-Mail :

Ref. : HED-HR&PERS./VT/07-08/608193 June 27, 2008

CERTIFICATE OF TRAINING

(TO WHOMSOEVER IT MAY CONCERN)

Name	:	Mr. Ameya Naik
College/Institution	:	Indian Institute of Technology (Powai)
Branch	:	Industrial Design (Product Design)
Category	:	Summer Training
Date of Joining	:	05/05/2008
Date of Leaving	:	05/06/2008
Place of Training	:	Heavy Engineering Division (HED)
Department	:	Technology Development Centre – Special Projects
Project	:	Designing of Man Machine Interface and Graphical User Interface for a Launch System

for **LARSEN & TOUBRO LIMITED**

27/06/08

(Somraj S. Roy)
Deputy General Manager – HR

Regd. Off. : L & T House, Ballard Estate, P. O. Box 278, Mumbai - 400 001. • Tel. : 6752 5656 • Fax : 91-22-6752 5858
Website : www.lnthed.com

LARSEN & TOUBRO LIMITED

HEAVY ENGINEERING DIVISION

(An ISO-9001, ISO-14001 & OHSAS-18001 Regd. Division)

Powai Campus, Saki Vihar Road, P. O. Box 8901, Mumbai-400 072, INDIA • Tel . : 6705 0505 • Fax : 91-22-6705 1611 / 4160

E-Mail :

Ref. :

Date : 04-07-2008

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Ameya Naik** has successfully completed the assigned project for his Summer Internship at the Technology Development Centre, Heavy Engineering Division, Larsen & Toubro Powai.

His conduct during the period of Internship has been good. Showing keenness in the project assigned he has also displayed capacity to learn and grasp new concepts very quickly.

A. T. Ramchandani

A.T. Ramchandani
(Joint General Manager)
Technology & Product Development centre
HED

Details of L&Tiets with whom I Interacted

Mr. A. T. Ramchandani:
Head of Dept. - Technology and Product Development Centre
☎ + 91 22 6705 2776
arun.ramchandani@hed.ltindia.com

Mr. Mukesh Bopalkar:
Dept. - Technology and Product Development Centre
☎ + 91 22 6705 1066
mukesh.bopalkar@hed.ltindia.com

Mr. Harshan Budke:
Dept. – Defence Electronics
☎ + 91 22 6705 3883

Mr. Aditya Kumar:
Dept. – Defence Electronics
☎ + 91 22 6705 1767

Ms. Mamta Parekh:
Dept. – Defence Electronics
☎ + 91 22 6705 1802

Acknowledgements

I would like to take this opportunity to express thanks and profound gratitude to all those who were involved and helped me during this training period.

I offer my profound gratitude to ***Mr. A. T. Ramchandani*** of Technology & Product Development Centre of Larsen & Toubro Pvt. Ltd. Powai, Mumbai who offered us to work on this esteemed project in his department.

I would also like to thank ***Mr. Mukesh Bopalkar*** for guiding us through the entire project and introducing us to the practical environment of Industrial Design.

My sincere thanks to ***Mr. Harshan Budke, Ms. Mamta*** and ***Mr. Aditya*** from the Defence Electronics Department of Larsen & Toubro Pvt. Ltd. Powai, Mumbai.

I would also like to thank the *Staff of IDC* for providing me this wonderful opportunity.

About Larsen & Toubro

L&T was founded in Bombay (Mumbai) in 1938 by two Danish engineers, Henning Holck-Larsen and Soren Kristian Toubro. Both of them were strongly committed to developing India's engineering capabilities to meet the demands of industry.

Beginning with the import of machinery from Europe, L&T rapidly took on engineering and construction assignments of increasing sophistication. Today, the company sets global engineering benchmarks in terms of scale and complexity.

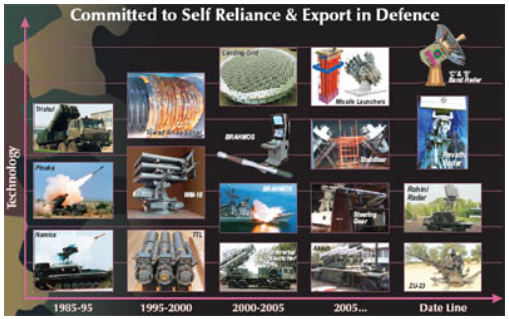
Larsen & Toubro (L&T), headquartered in Mumbai (Maharashtra) is a technology-driven engineering and construction organisation and one of the largest companies in India's private sector. It has further interests in manufacturing, services and Information Technology. The evolution of L&T into the country's largest engineering and construction organization is among the most remarkable success stories in Indian industry.

Larsen & Toubro Limited (L&T) is a technology, engineering, construction and manufacturing company. It is one of the largest and most respected companies in India's private sector. Seven decades of a strong, customer-focused approach and the continuous quest for world-class quality have enabled it to attain and sustain leadership in all its major lines of business. L&T has an international presence, with a global spread of offices. A thrust on international business has seen overseas earnings grow significantly. It continues to grow its overseas manufacturing footprint, with facilities in

China and the Gulf region. The company's businesses are supported by a wide marketing and distribution network, and have established a reputation for strong customer support. L&T believes that progress must be achieved in harmony with the environment. A commitment to community welfare and environmental protection are an integral part of the corporate vision.

A strong, customer-focused approach and the constant quest for top-class quality have enabled the company to attain and sustain leadership in its major lines of business. It has established an international presence, with a global spread of offices. A thrust on international business across the last few years has seen overseas earnings growing to 18 per cent of total revenue. With factories and offices located around the country, further supplemented by a comprehensive marketing and distribution network, L&T enjoys an image and equity in virtually every district of India. Its signature of excellence is evident on several projects:

- The world's largest Continuous Catalyst Reactor
- World's largest Tubular Reactor for a petrochemical plant
- The world's largest Fluid Catalytic Cracking Regenerator
- The world's longest Product Splitter
- The world's longest LPG pipeline
- Asia's highest Viaduct
- The first to offer electrical distribution products & systems engineered for tropical environments
- India's first indigenous Hydrocracker Reactor
- India's first open sea jetty
- India's biggest Offshore Oil Platform
- India's longest Coal Conveyor
- India's widest range of Low Tension Electrical Switchgear



- World’s longest gas pipeline
- World’s longest coal conveyor
- Building an international class football stadium in 260 days
- World's largest coal gasifier made in India and exported to China

Operating Divisions:

- Engineering & Construction Projects (E&C)
- Heavy Engineering (HED)
- Engineering Construction & Contracts (ECC)
- Electrical & Electronics (EBG)
- Machinery & Industrial Products (MIPD)
- Information Technology & Engineering Services

Heavy Engineering (HED):

L&T's Heavy Engineering Division has established a reputation in global markets for quality products. The Division manufactures & supplies custom designed & engineered critical equipment & systems to the needs of core-sector industries and the defence sector. It is the preferred supplier of equipment for a select range of products, globally.

L&T has state-of-the art manufacturing facilities, which are capable of meeting the challenges of technology, quality conformance and delivery, while ensuring cost competitiveness.

The manufacturing plants are among the top fabrication facilities in the world with processes streamlined to achieve high efficiency and benchmarked to the latest technologies.

Defence: L&T has licenses for manufacture and supply of a wide range of defence products, after the Government of India's decision to open up Defence production to the private sector. The licenses issued to L&T cover design, development and construction / manufacture of warships, submarines, weapon platforms & launchers, field & air defence guns, anti tank weapon systems, missiles, rockets, torpedoes, land / naval mines including associated systems and subsystems, RADAR, SONAR, sensors, armored and combat vehicles, airborne assemblies, systems and equipment for aircraft, helicopters and UAV, etc.

Current Product Range: Naval Marine Systems, Naval Combat Systems, Army & Air Force Products, Defence (Army, Navy & Air Force) Strategic Electronics, Complete Naval Units, Radars, Advanced Composite Products for various Defence applications

My department: Technology & Product Development Centre (Special Projects) – This department carries out design and development activities for projects in the Defence, Nuclear Power, and Aerospace sectors. All kind of design (2D, 3D and analysis of the design) is accomplished at this centre that is well equipped with a range of software and prototyping facilities. The department works closely with the Defence Electronics Department in the development of multi-disciplinary defence systems.

Aesthetics, Ergonomics and Usability study and recommendations of a weapon launch system.

The project is complex in nature with a blend of technologies from the Electrical, Electronics, Computer and Mechanical Engineering disciplines. Our expectations from the study are:-

1. Product User Interaction Design
    a. Studying of existing procedure of
        i. Normal Operation
        ii. Emergency Operation
        iii. Training Model
        iv. Debugging mode
        v. Manual Operations
    b. Study of
        i. Existing Console
        ii. Existing screens
    c. Understand & comprehend complete requirements for the new interaction
    d. Concepts for the console layout / switches / hardware / graphics
    e. Concepts for the screens
    f. Finalization of concepts for the Console and Screens
    g. 3D / Physical Mockup for the console and screens

2. Aesthetics & Ergonomics Study:
    a. Carry out a benchmark and competitive study of the earlier

prototypes, competitive products, and similar products available in the world market with respect to Aesthetics.

b. Prepare "List of Recommendations" for aesthetics covering
   i. Form improvements
   ii. Qualitative suggestions
   iii. Layout improvements
   iv. Any other suggestions

c. Ergonomics & Usability study and recommendations covering
   i. The operations
      - Regular operations
      - Maintenance Operations
   ii. Maintenance evaluations

d. Adding user friendly features to the user - penthouses, camouflage mechanism, etc, flexible utility spaces.

Approach Strategy

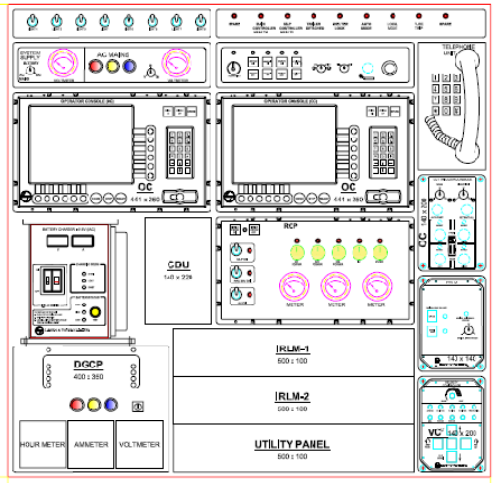
The project involved developing an ergonomic and aesthetic Man-Machine-Interface (MMI) and Graphical User Interface (GUI) for a weapon launch platform. After analyzing the entire launcher system various areas that required design intervention were identified. These were again categorized and worked upon in certain order considering time requirements.

Major areas identified were:

1. Man-Machine Interface :
    - Layout of control panel of the launcher
    - Modularity of control panel
    - Selection of various control elements
2. Graphical User Interface :
    - Operator Console colour scheme
    - Study of logic of operation of the launcher
3. Aesthetics :
    - Overall form of the launcher
    - Form of various consoles

About the Weapon Launch Platform

The weapon launch system is a ground based mobile launch platform used to transport and fire weapons. The lower part of the platform is fixed to the automotive chassis and houses the control electronics. The upper part of the platform is equipped with drives for motion and is used to launch the weapon.



Existing Layout as designed by L&T

About the control panel:

The lower part of the weapon launch system houses the control panel. The control panel has various modules fixed vertically and is accessible from outside of the launch system.

Two layouts of control panel were available:

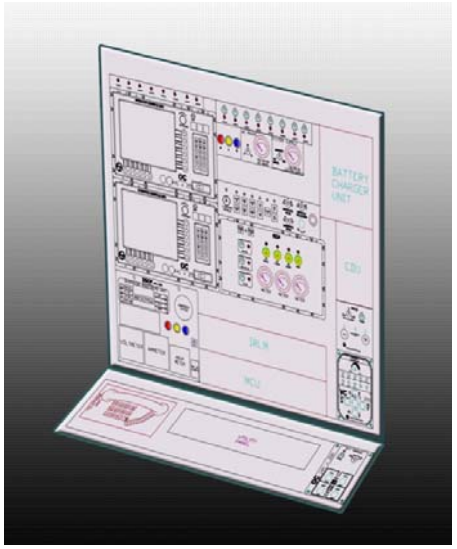
- Layout suggested by the user (customer).
- Existing layout designed by L&T.

Study of Existing Control Panel:

A complete study of the layout including ergonomic placement of various modules and the switches revealed lacunae in the existing layouts suggested by the user (customer) as well as the designers (L&T).

Some of these were as follows:

- Switches placed above the LCD screen.
- Redundancy in navigation keys on LCD panel.
- Duplication of switches.
- Switches not in order of operation.
- Redundancy in various switches



- Existence of mechanical levers as well as electrical switches creating duplication in signals to various mechanisms.
- Unable to read the LCD screen when the Launch system is raised.
- Huge and heavy electronic modules mounted on the panel.
- Confusion in indicator switches.
- Improper placement of the telephone unit.

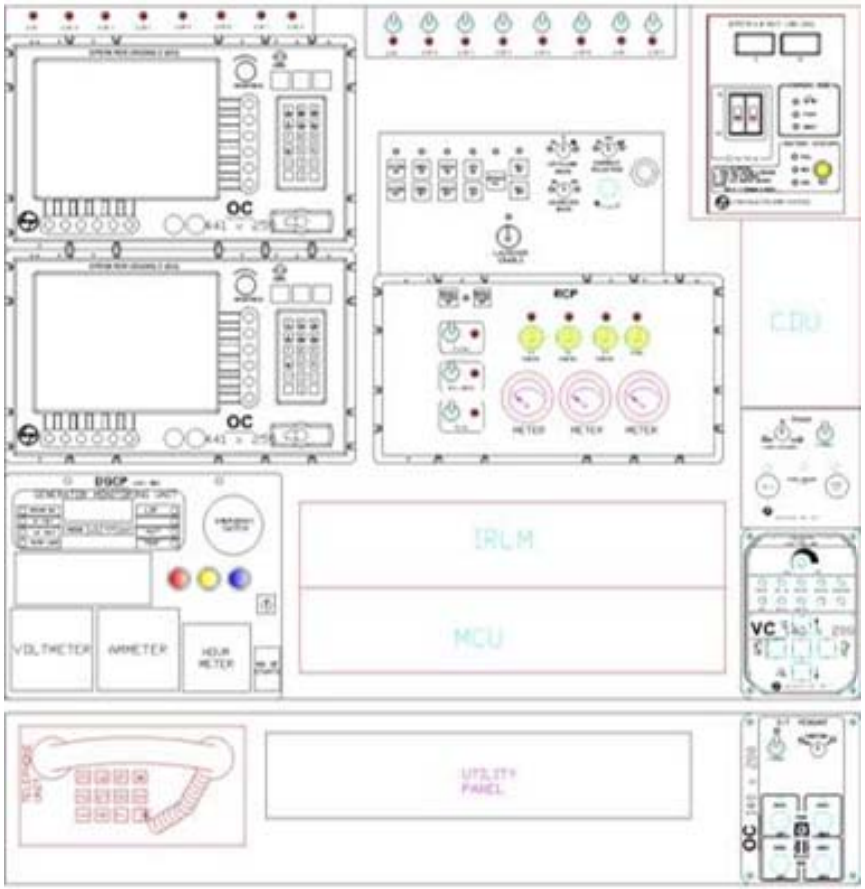
Ideation:

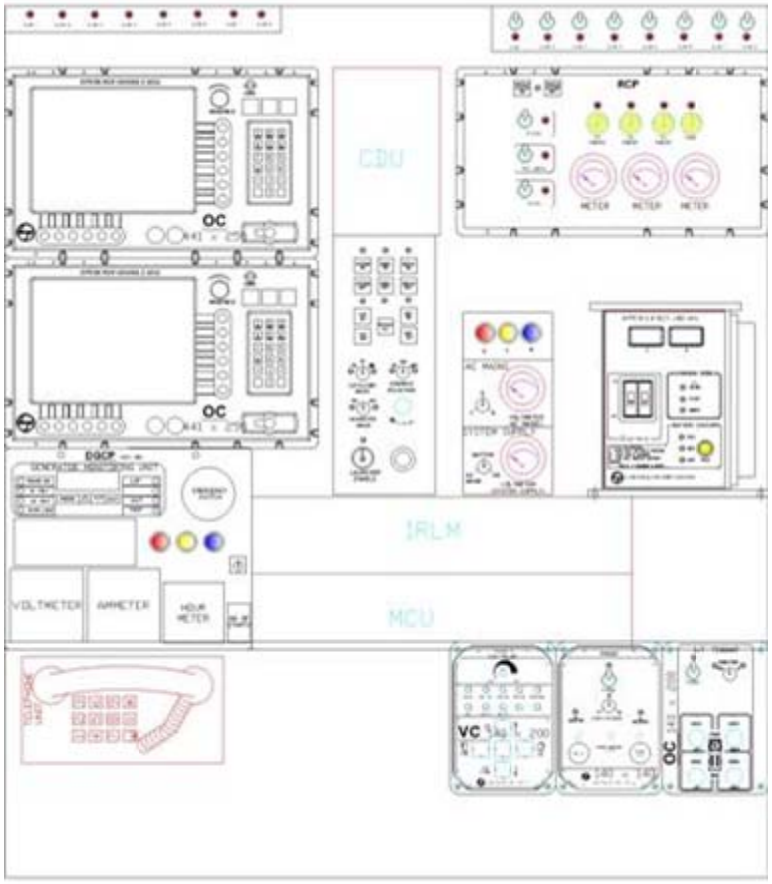
The external dimension of the control panel being limited, hardly any layout using the existing modules and considering ergonomic and operational constraints was possible. Hence the shape of the panel had to be changed all together.

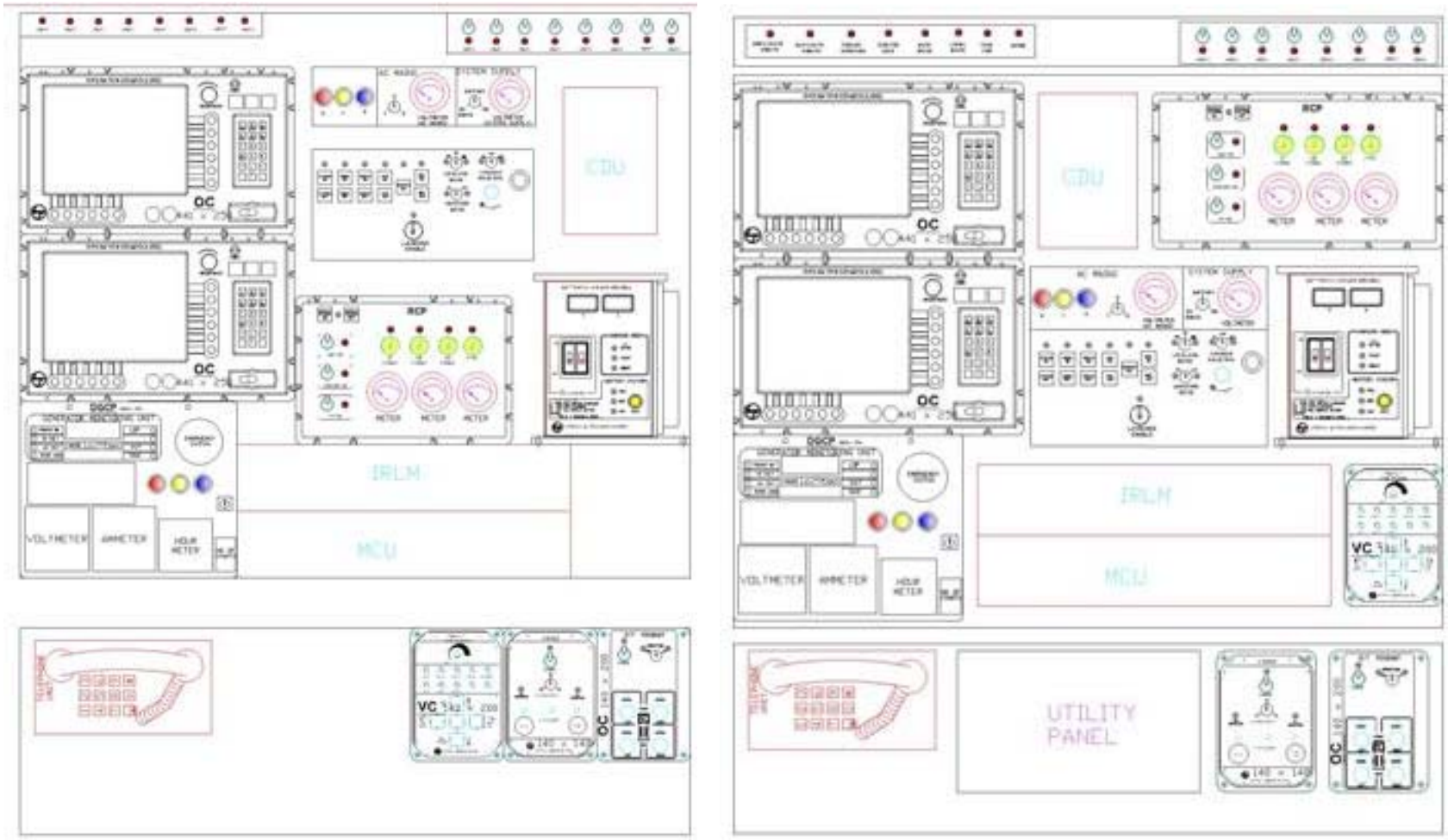
Hence two staged and three staged panel was considered as shown on the R.H.S.

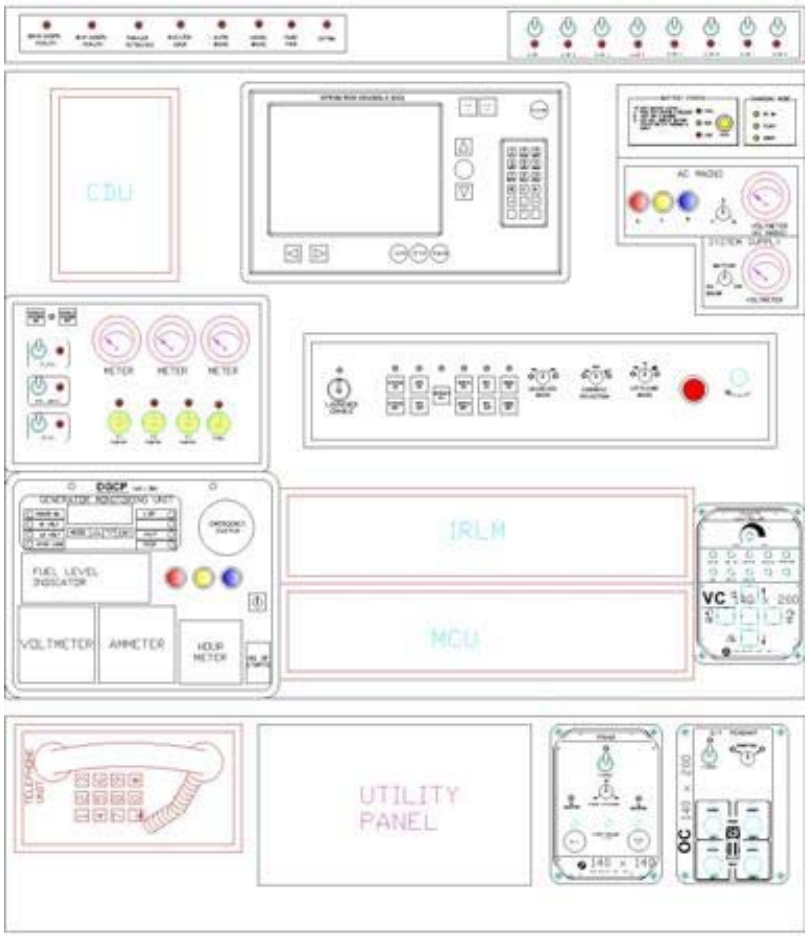
For purpose of generating various layouts, Tangram method was used wherein each module was cut from paper and played with in the constrained area.

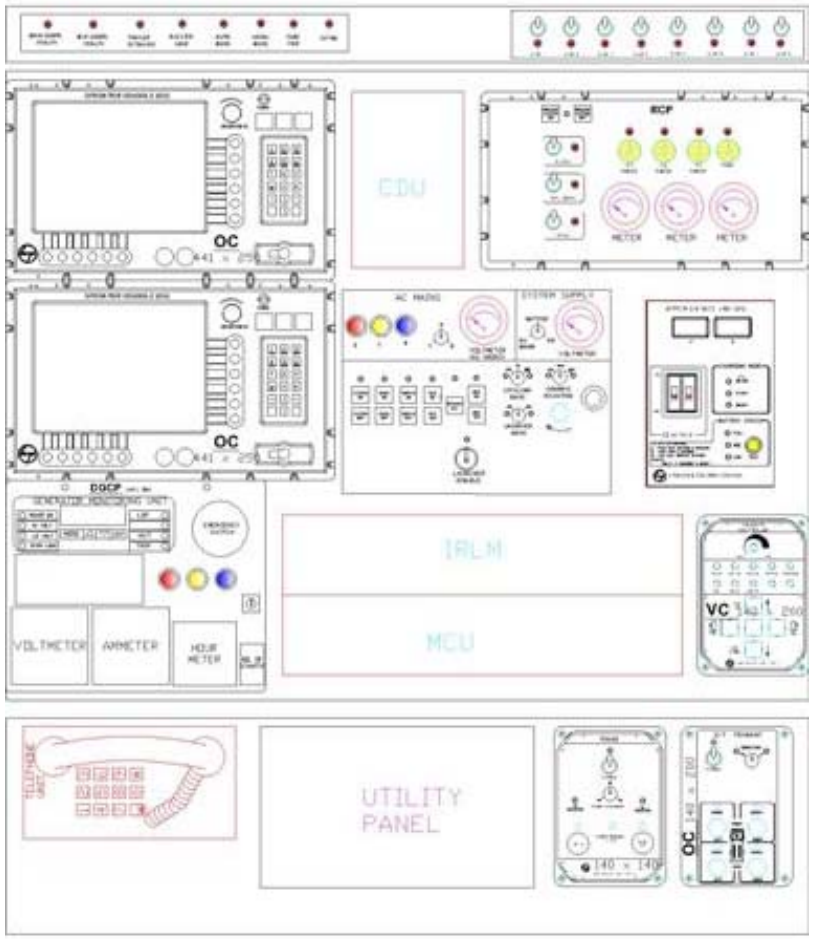
As a result following layouts were generated:


OC
OC
RCP
METER
METER
METER
CDU
DGCP
IRLM
MCU
VOLTMETER
AMMETER
HOUR METER
VC
UTILITY PANEL
OC


OC
OC
CDU
RCP
METER
METER
METER
DGCP
IRLM
MCU
VOLTMETER
AMMETER
HOUR METER
VC
OC


CDU
IRLM
MCU
UTILITY
PANEL

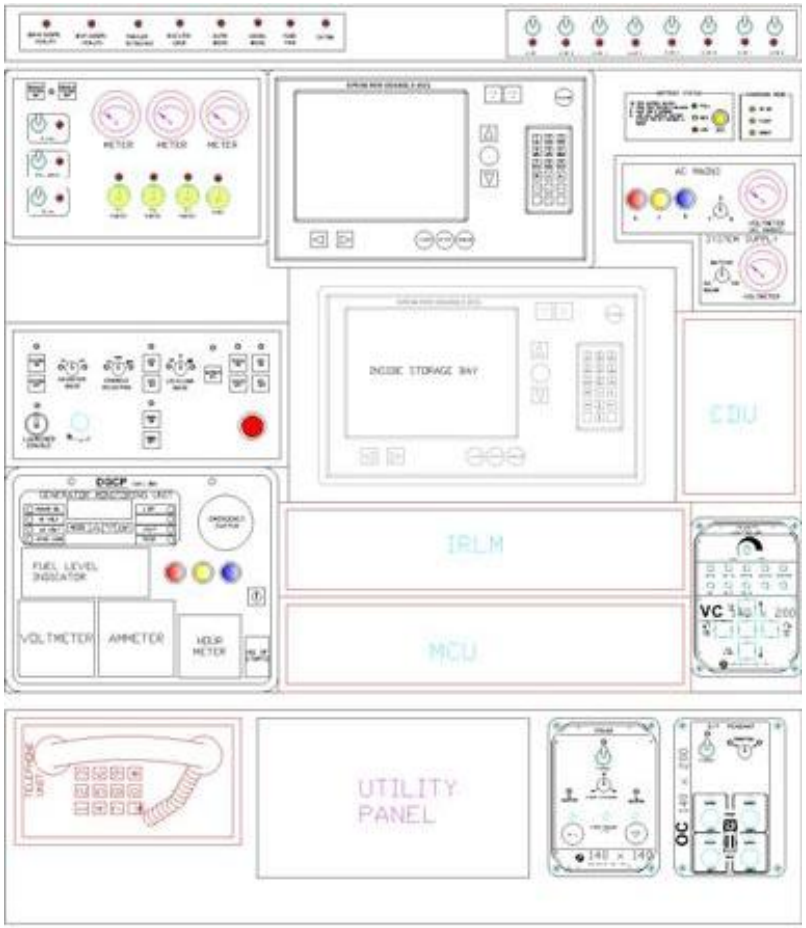

CDU
AC PANEL
METER
METER
METER
DGCP
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
IRLM
MCU
VC
UTILITY PANEL
OC

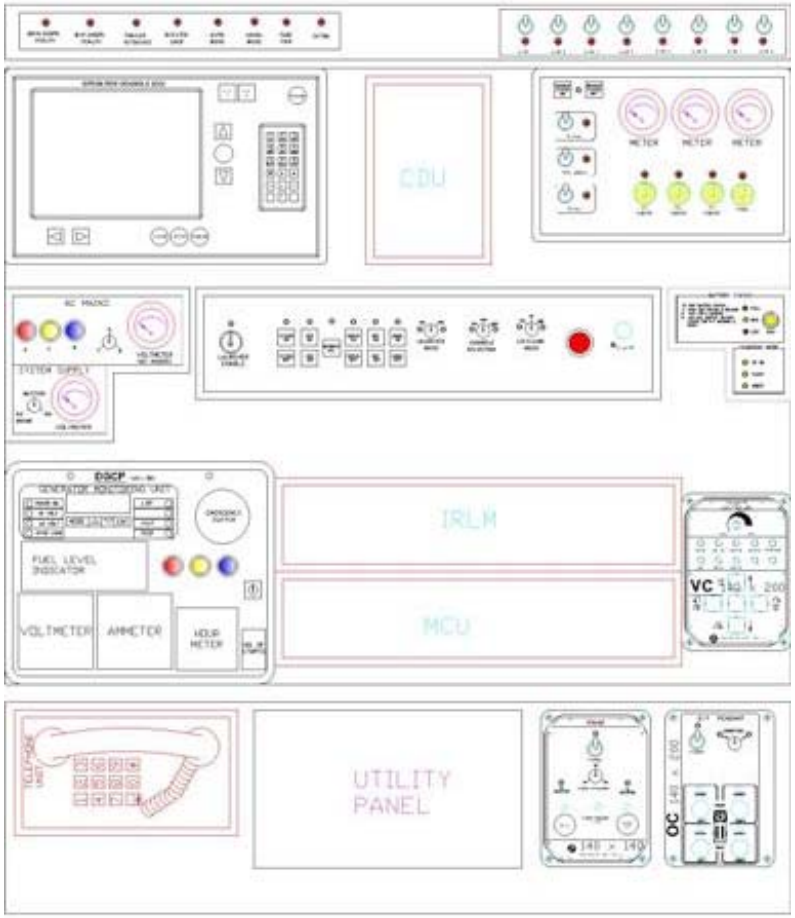

CDU
ECP
METER
METER
METER
OC
OC
AC PANEL
DGCP
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
IRLM
MCU
VC
UTILITY PANEL
OC

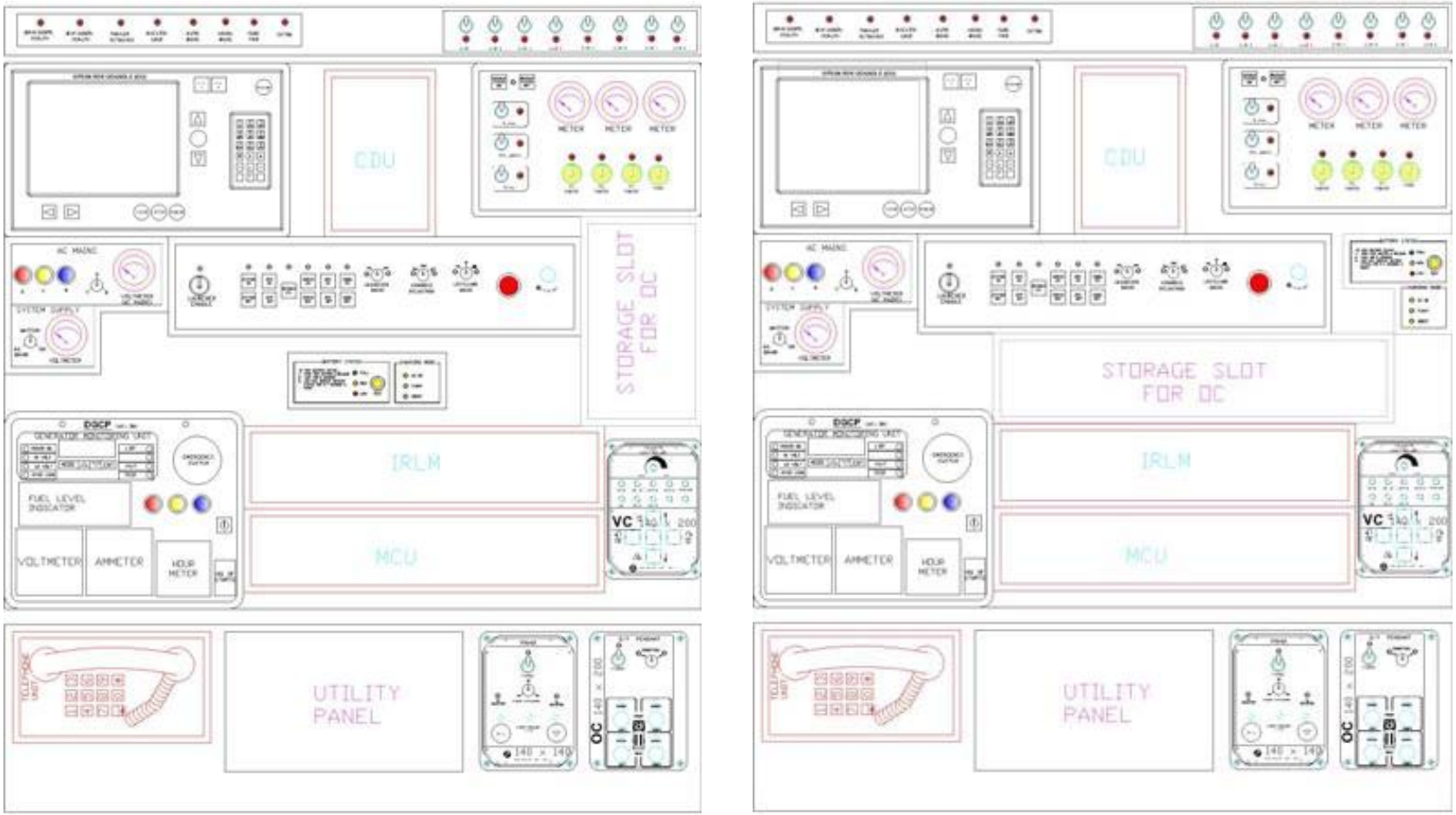
After initial ideation a full scale model of the three stage control panel was made. Also each module was made out of themocole sheets and the same tangram method was used but on actual scale.

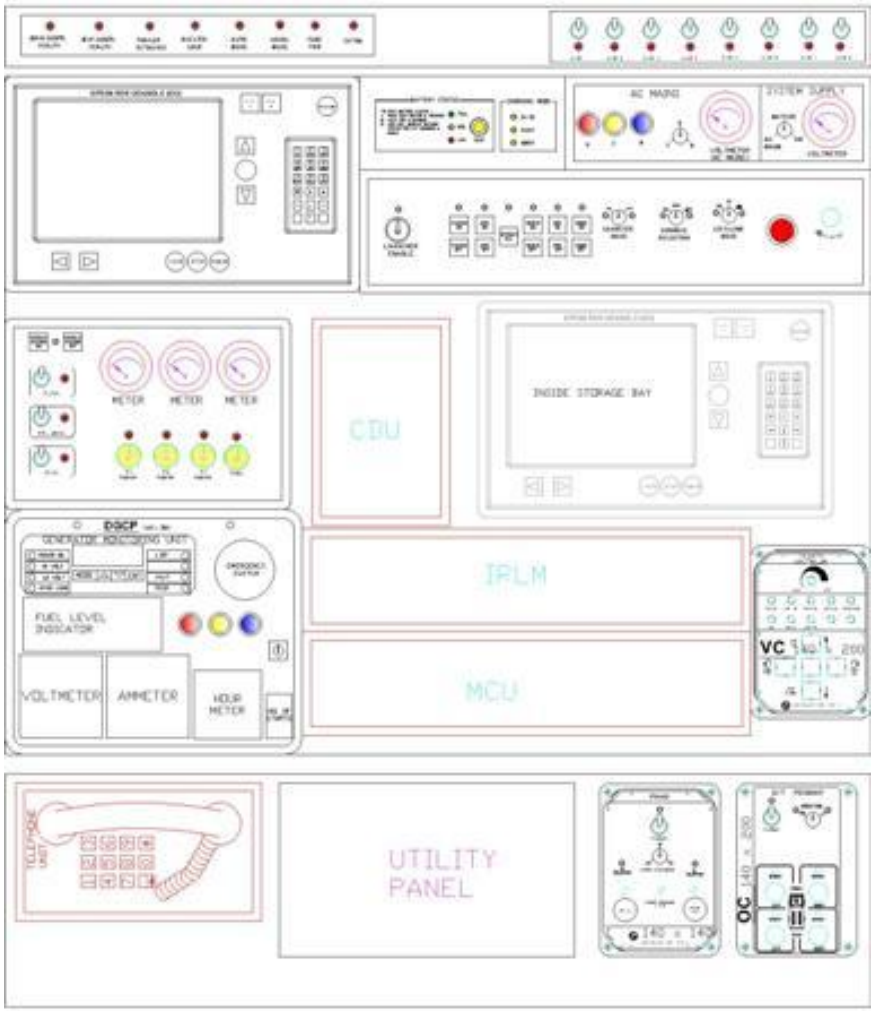
The actual scale of the model gave a better idea of space between the modules and the actual size of various elements making it easy to visualize problems faced while operating the control panel.

Following layouts were generated as a result:


INSIDE STORAGE BAY
CDU
DGCP
IRLM
MCU
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
VC
UTILITY PANEL
OC


CDU
DGCP
IRLM
MCU
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
VC
UTILITY PANEL
OC


CDU
METER
METER
METER
AC MAINS
STORAGE SLOT FOR DC
IRLM
MCU
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
UTILITY PANEL
TELEPHONE UNIT
DC

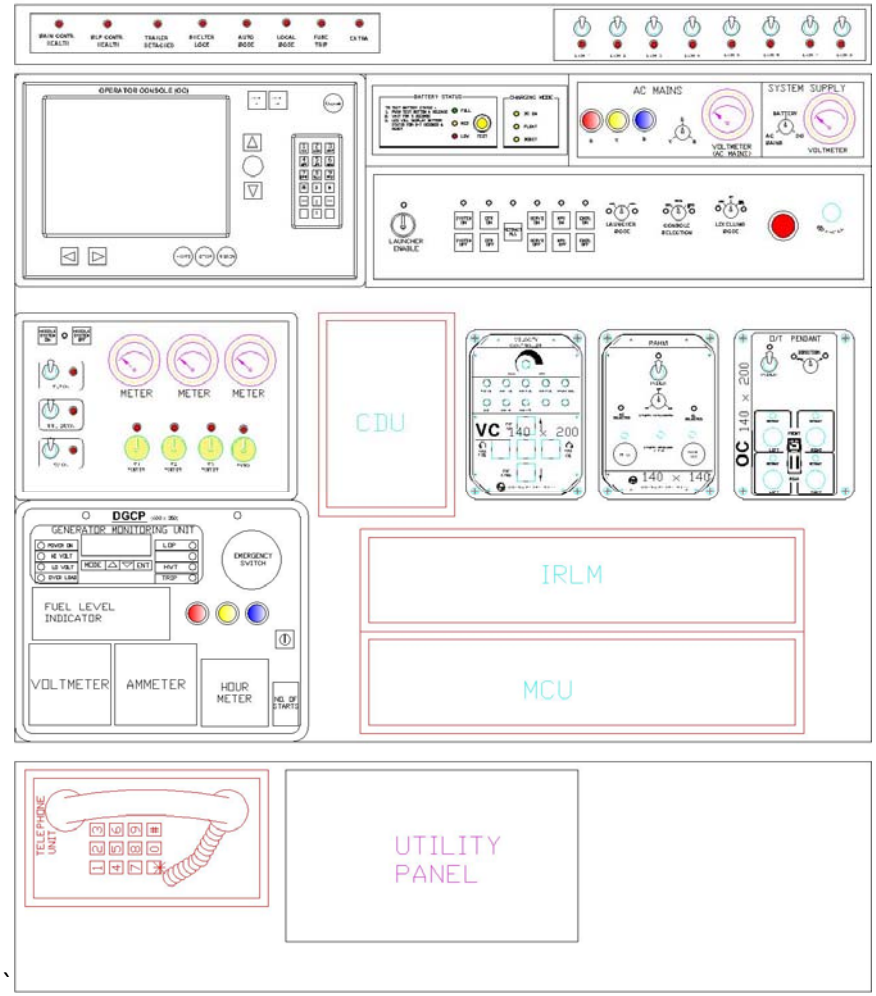

AC MAINS
SYSTEM SUPPLY
METER
METER
METER
CDU
INSIDE STORAGE BAY
DGCP
FUEL LEVEL INDICATOR
VOLTMETER
AMMETER
HOUR METER
IRLM
MCU
VC
UTILITY PANEL
OC

Concept Generation:

Following concepts were chosen as the final three concepts each having certain functional advantage.

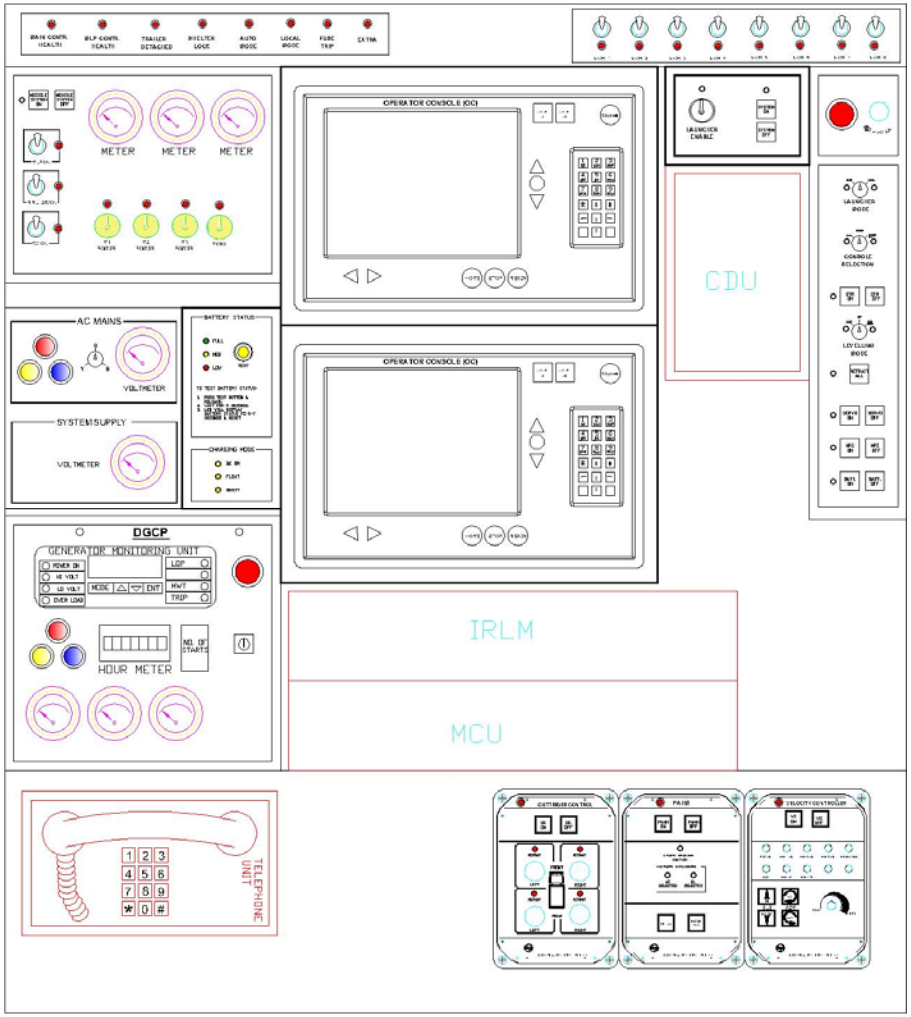
Concept #1:

Here the second Operator Console (LCD screen) was completely hidden from the user to avoid any confusion. The other display being stored elsewhere in the system. Large Space was available on the horizontal panel for keeping the manual resting palm during prolonged usage.



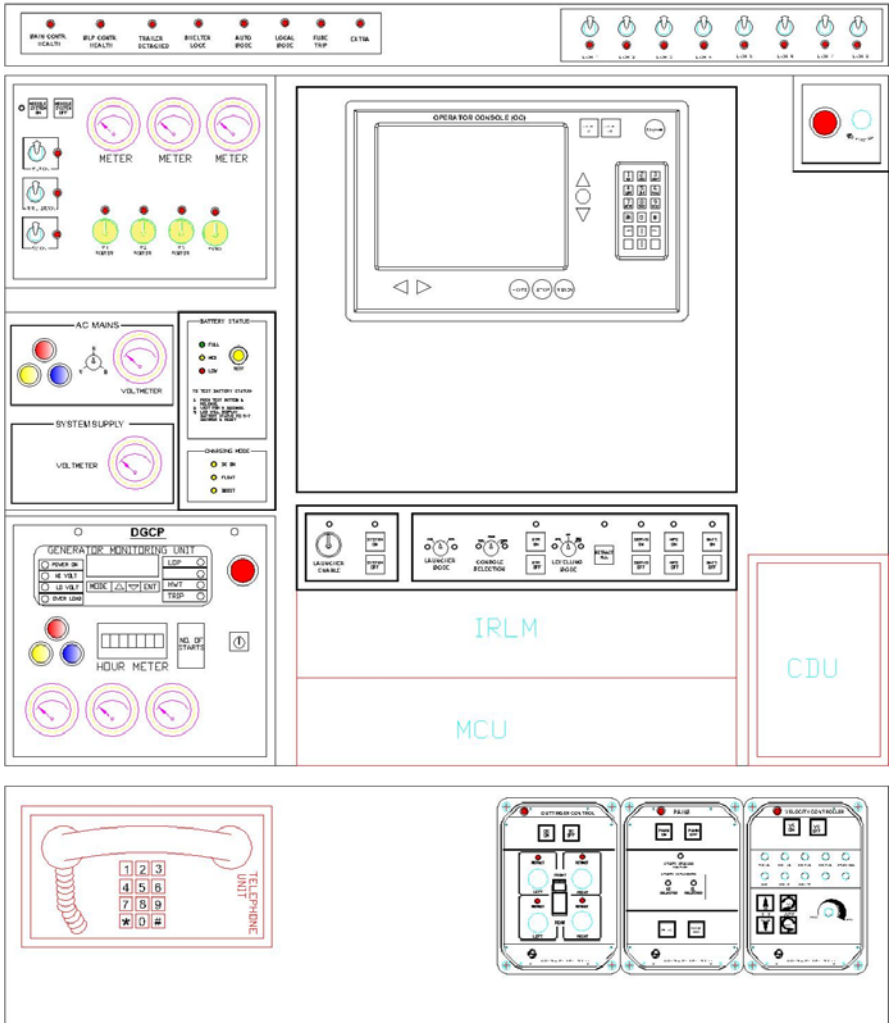
Concept #2:

Here only one display was visible at a time other being covered by an open able lid. Here both the displays were connected all the time. Also the dual display arrangement one above the other made of good usage when the system had to be raised keeping the 2nd screen still in vision.

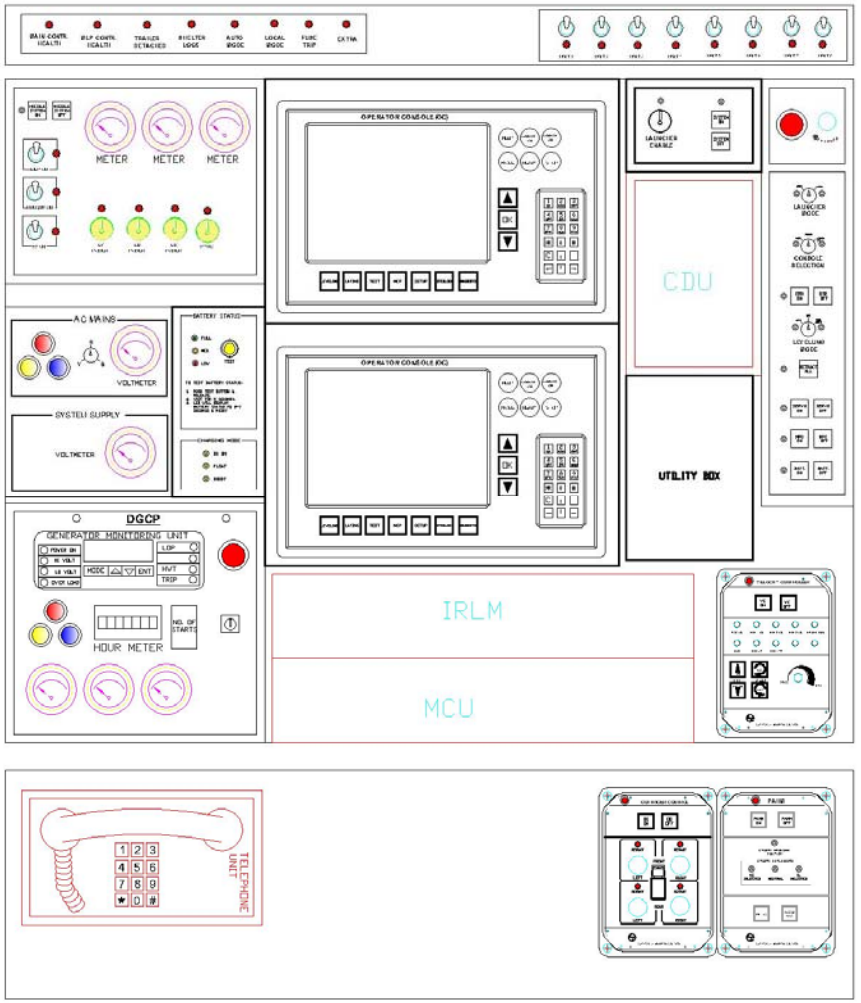


Concept# 3:

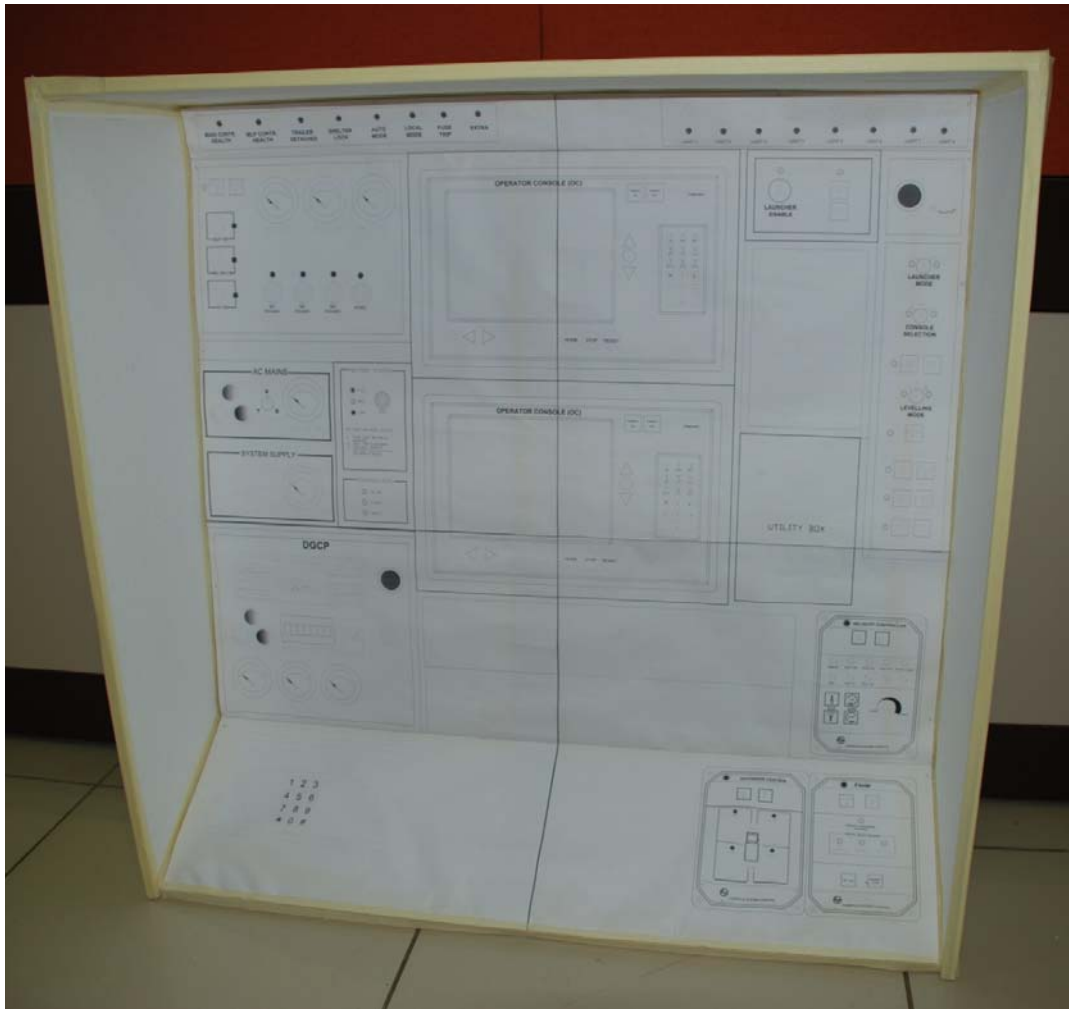
Here only one display could be seen at a time. Though the other display was hard wired all the time it would slide out only when the 1st display would slide in. see the figure below.



Final Concept:



This system being of military purpose it was necessary to avoid any moving electronic components as they had to be fixed and protected from vibrations. From the above three concepts, the concept #2 having no moving electronic components and with all the modules at required position was selected and fine tuned.



Final Layout was plotted and pasted on the model.

Operator Console (OC)

About OC:

Almost all the functions that could be done manually using various modules on the control panel are available on the OC using a GUI. Actually OC is the module that was to be used for routine checks and diagnostics. It basically had a TFT display, buttons to navigate through the GUI and a alphanumeric keypad with navigation key.

Study of existing OC:

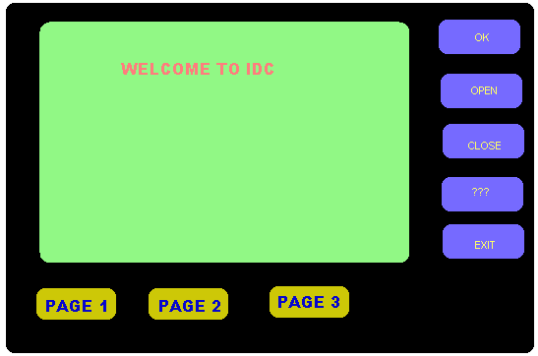
Working with the actual size OC while designing layout of control panel, following were the few problems identified with the design.

- The OC was pretty big and had too many confusing keys.
- The screen was barely visible in sunlight.
- GUI was not flexible enough to be upgraded.
- Navigating through the GUI was difficult.

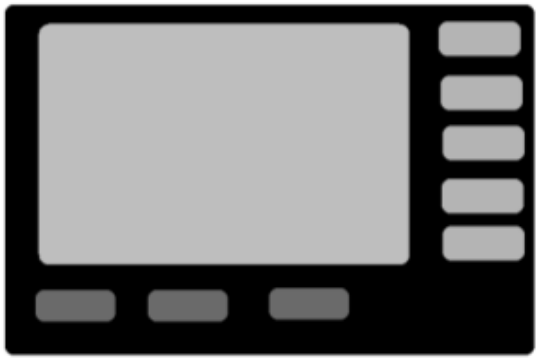
Colour Scheme for GUI:

Experiments were conducted to check the effect of harsh light on the TFT display. Even the though contrast colours were used it was difficult to differentiate. After doing several experiments it was realized that in harsh sunlight colours were hardly visible, what was visible was their grayscale value. The results can be seen from the following visuals.

Using only contrast colour scheme:



Normal viewing



In harsh Sunlight

Using Contrast colour scheme with differing grayscale value:

Normal viewing

In harsh Sunlight

OC Layout and GUI:

After several iterations following was selected as the operating console layout and the GUI.

Also it was decided to have super bright sunlight visible TFT screen.

A GUI screenshot showing window requiring access authorization.

Final Control Panel:

Final control panel layout on full scale coloured model.

External Body (Form)

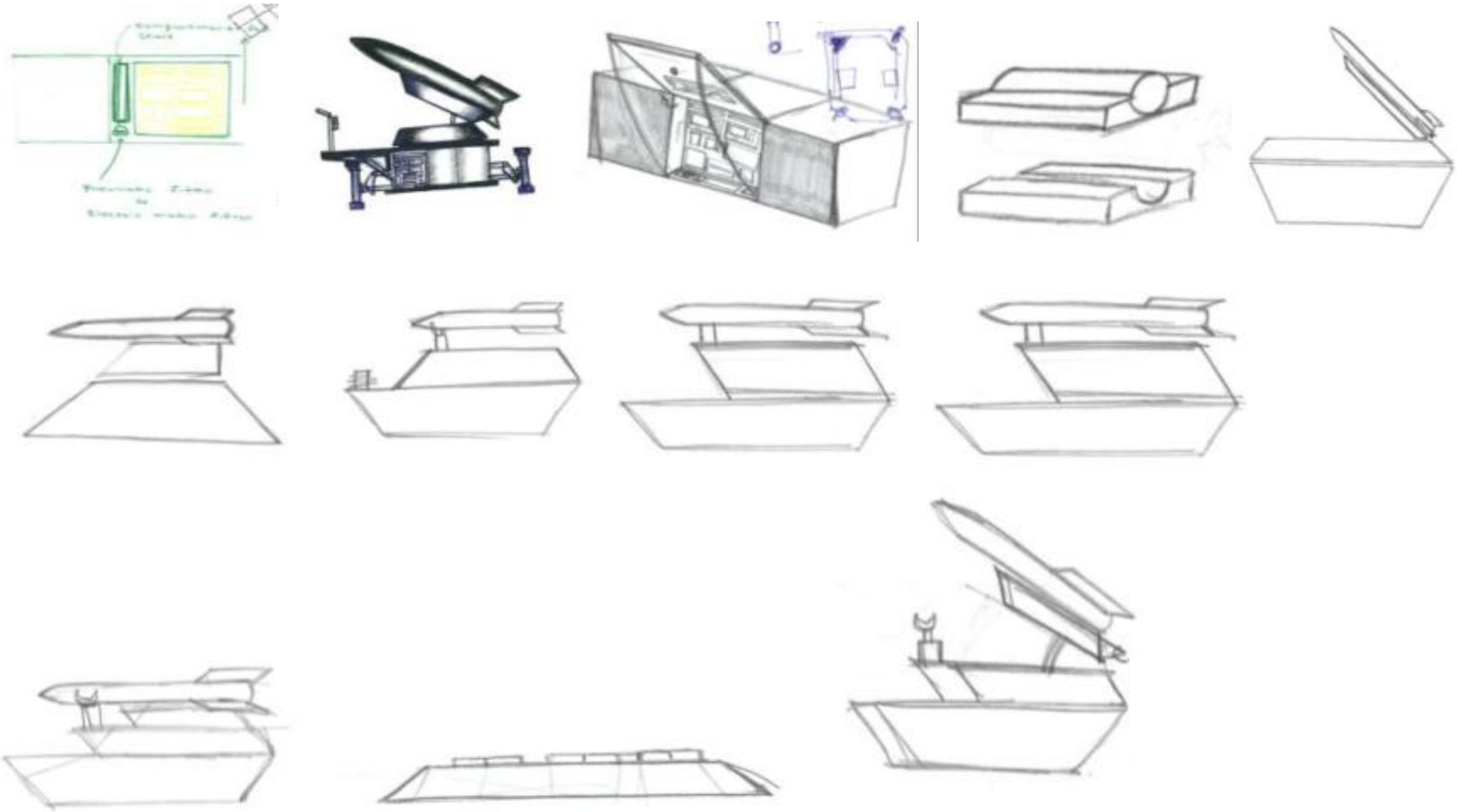
The external form was governed by the components at the base and the launch system above it.

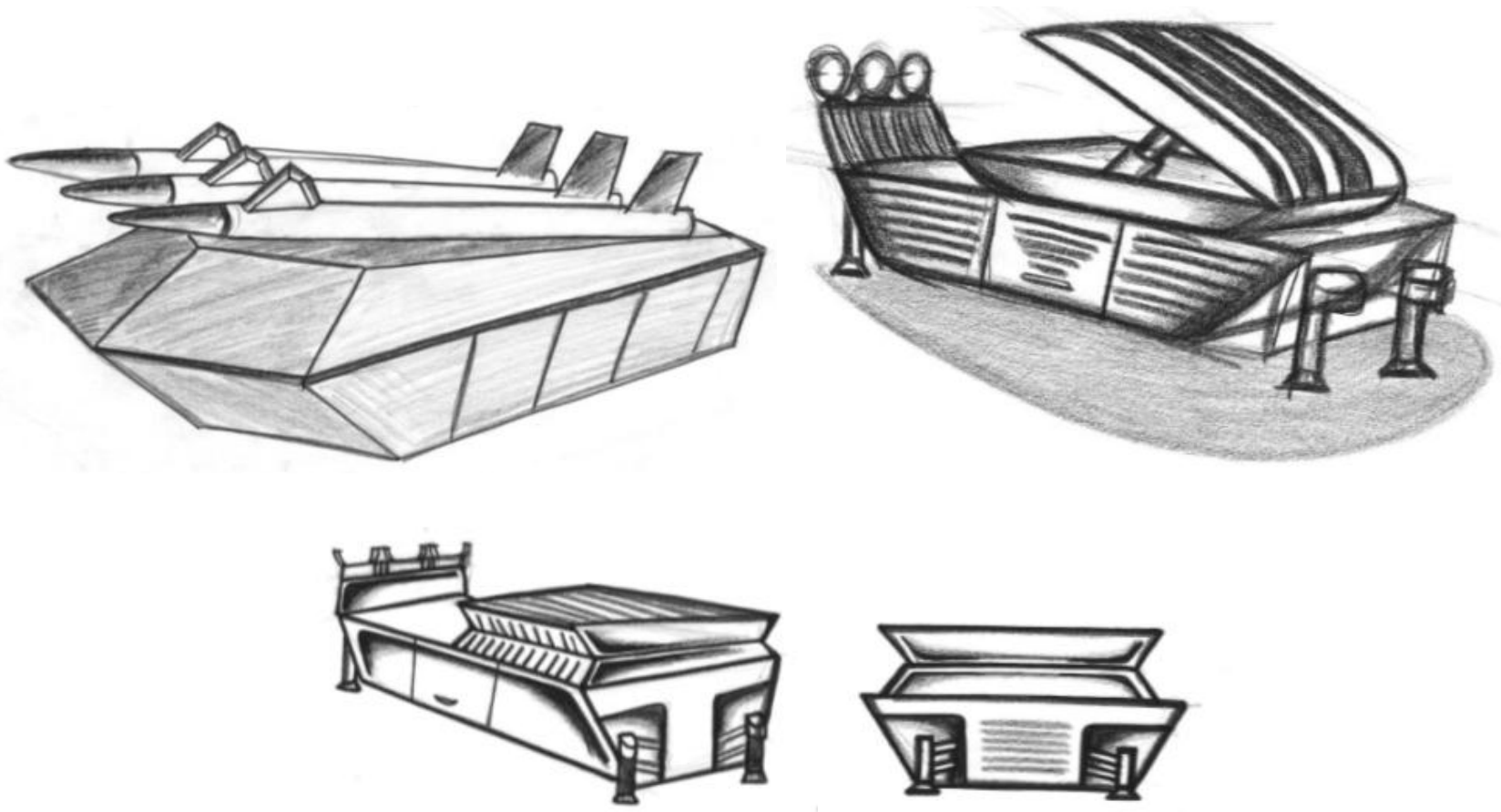
Following aspects were considered while ideating for external form:

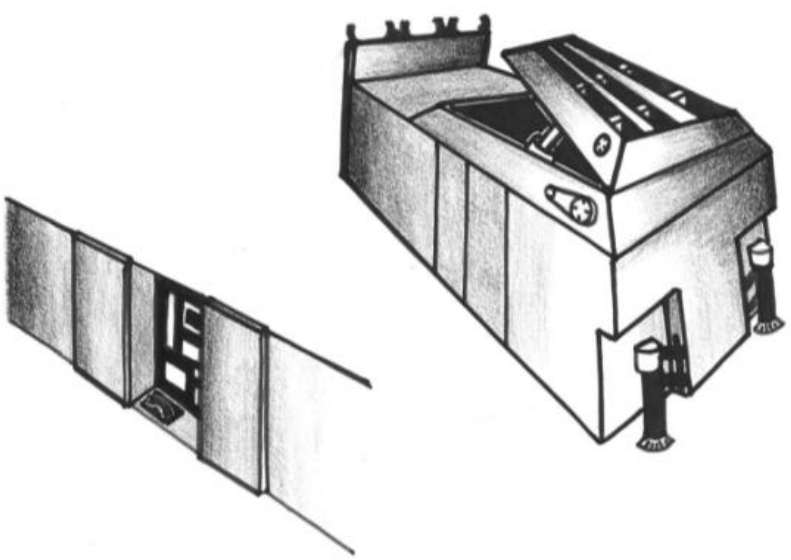
- Theme for the entire launch system.
- Ease of use and accessibility.
- Camouflaging.
- Utility spaces.

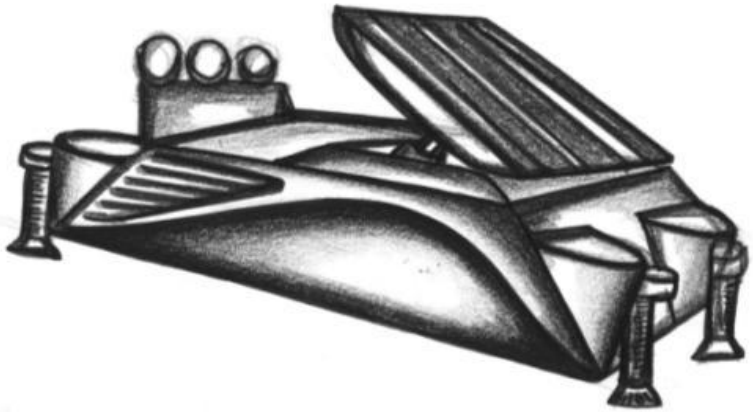
(Due to time constraint not sufficient details were worked out and the external form was done till ideation and rough concept generation stage)

Ideation:









Conclusion

This training provided me with excellent exposure in field of Industrial Design. It gave me a good understanding of client-customer relationship and the multiple levels of interaction taking place. It gave me a great opportunity to know the practical scenario and understand my shortcomings. This will surely help me to improve as professional.

During this period I was able to utilize and improve upon my skills. It also improved my interactive skills and the ability to convey ideas to the client.

This will help me long way in my future projects.