

# Design of GUI and MMI for a Weapon Launch Platform

Summer Internship at Larsen & Toubro Limited, Powai, Mumbai

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Industrial Design 2007-09

Industrial Design Centre

Indian Institute of Technology Bombay



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## LARSEN & TOUBRO LIMITED

HEAVY ENGINEERING DIVISION

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

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June 16, 2008

### CERTIFICATE OF TRAINING

(TO WHOMSOEVER IT MAY CONCERN)

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**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 missile launcher

for LARSEN & TOUBRO LIMITED

(Somraj S. Roy)

Deputy General Manager – HR

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## 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 all the Staffs of IDC for providing me their wonderful support.

**Abhishek Prasad**

IDC, IIT Bombay

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## Index

Certificate

Acknowledgements

About Larsen & Toubro ( 01 )

- ~ Operating Divisions 03
- ~ Heavy Engineering ( HED ) 03
- ~ Defence 04
- ~ My Department 04

Project Brief ( 05 )

Approach Strategy ( 07 )

About the Weapon Launch Platform ( 08 )

Control Panel ( 09 )

- ~ About the control panel 09
  - ~ Study of Existing Control Panel 09
  - ~ Ideation 10
  - ~ Concept Generation 18
  - ~ Final Concept 21
-

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## Operator Console (OC) ( 23 )

- ~ About OC 23
- ~ Study of existing OC 23
- ~ Colour Scheme for GUI 23
- ~ OC Layout and GUI 25

## Final Control Panel ( 27 )

## External Body (Form) ( 28 )

- ~ Ideation 29

## Conclusion ( 32 )

## 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

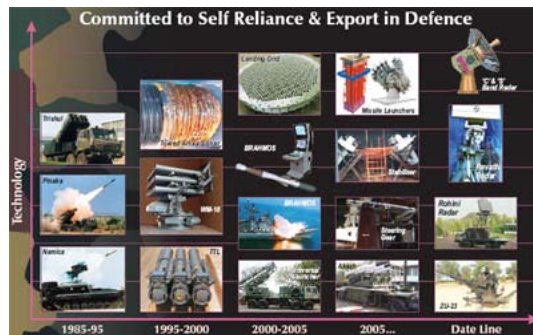




China and the Gulf region. The company's businesses are supported by a wide marketing and distribution network, and have established a reputation for strong customer support. L&T believes that progress must be achieved in harmony with the environment. A commitment to community welfare and environmental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



- World's longest gas pipeline



**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.



## Project Brief

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 I 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:

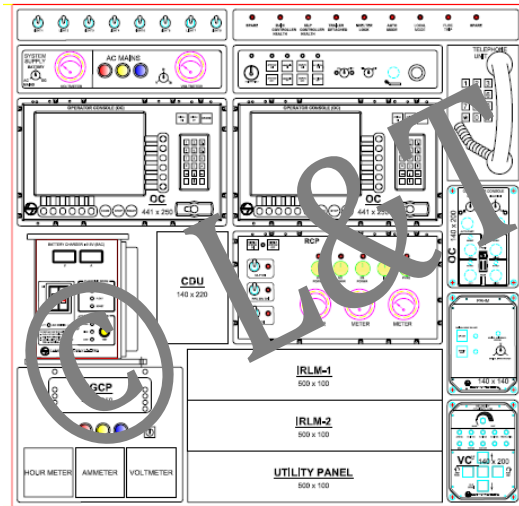
1. Man-Machine Interface :
  - Layout of control panel of the launcher
  - Modularity of control panel
  - Selection of various control elements
2. Graphical User Interface :
  - Operator Console colour scheme
  - Study of logic of operation of the launcher
3. Aesthetics :
  - Overall form of the launcher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

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## 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.

## Control Panel



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.

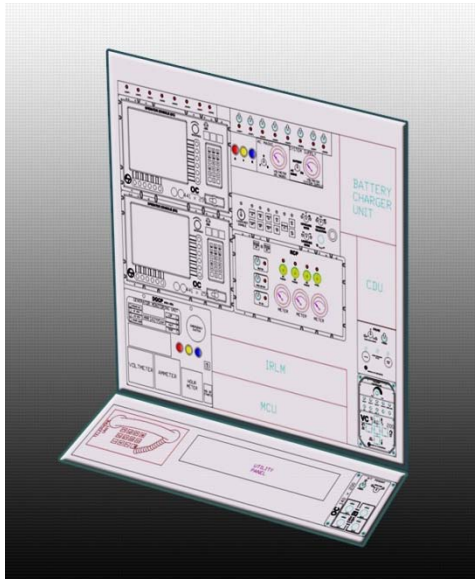
### Study of Existing Control Panel:

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.

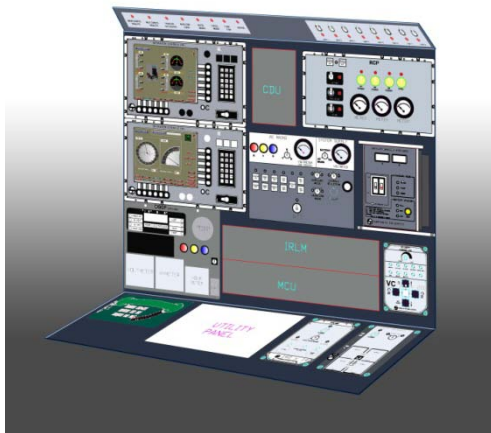
#### Ideation:

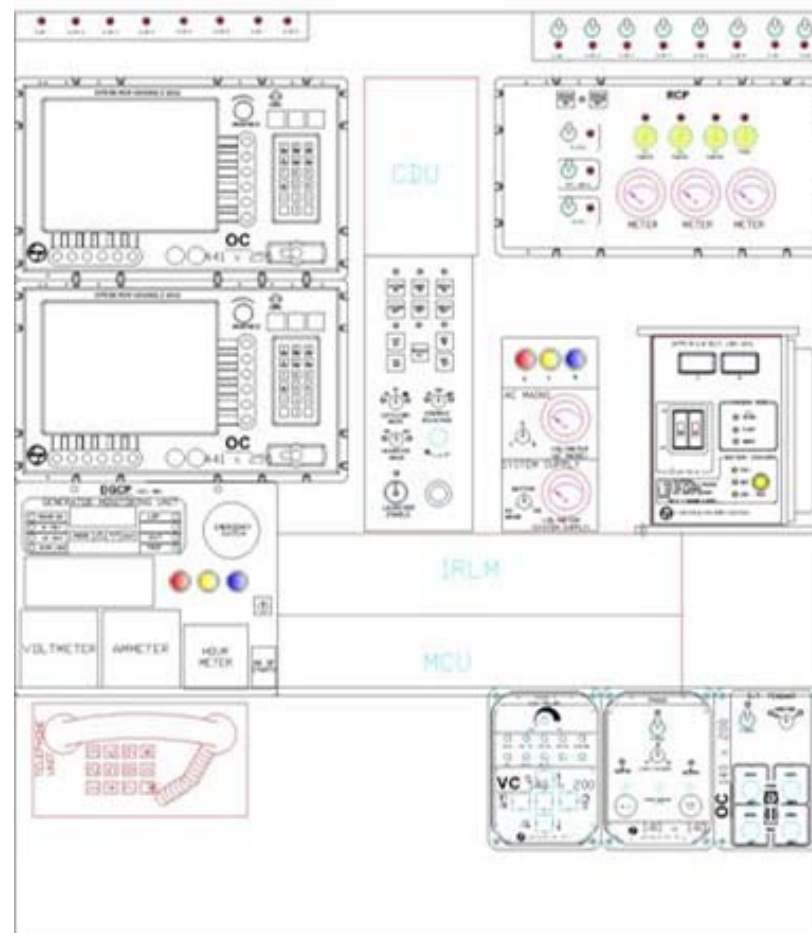
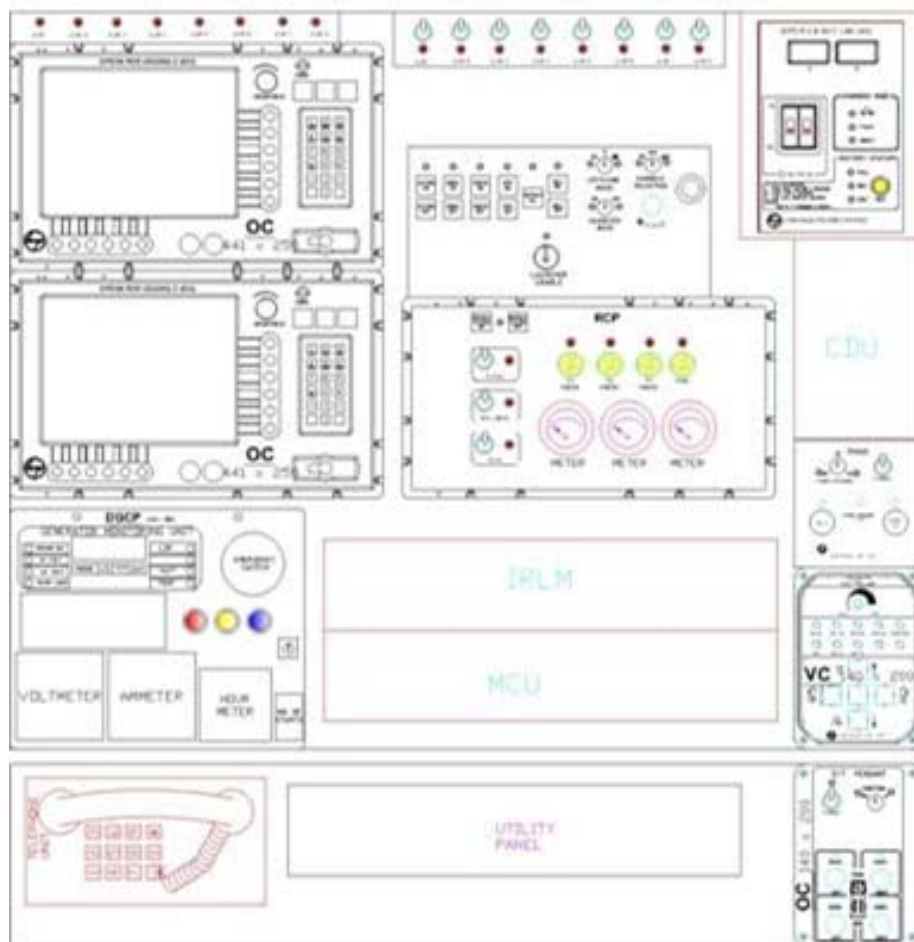
The external dimension of the control panel being limited, hardly any layout using the existing modules and considering ergonomic and operational constraints was possible. Hence the shape of the panel had to be changed all together.

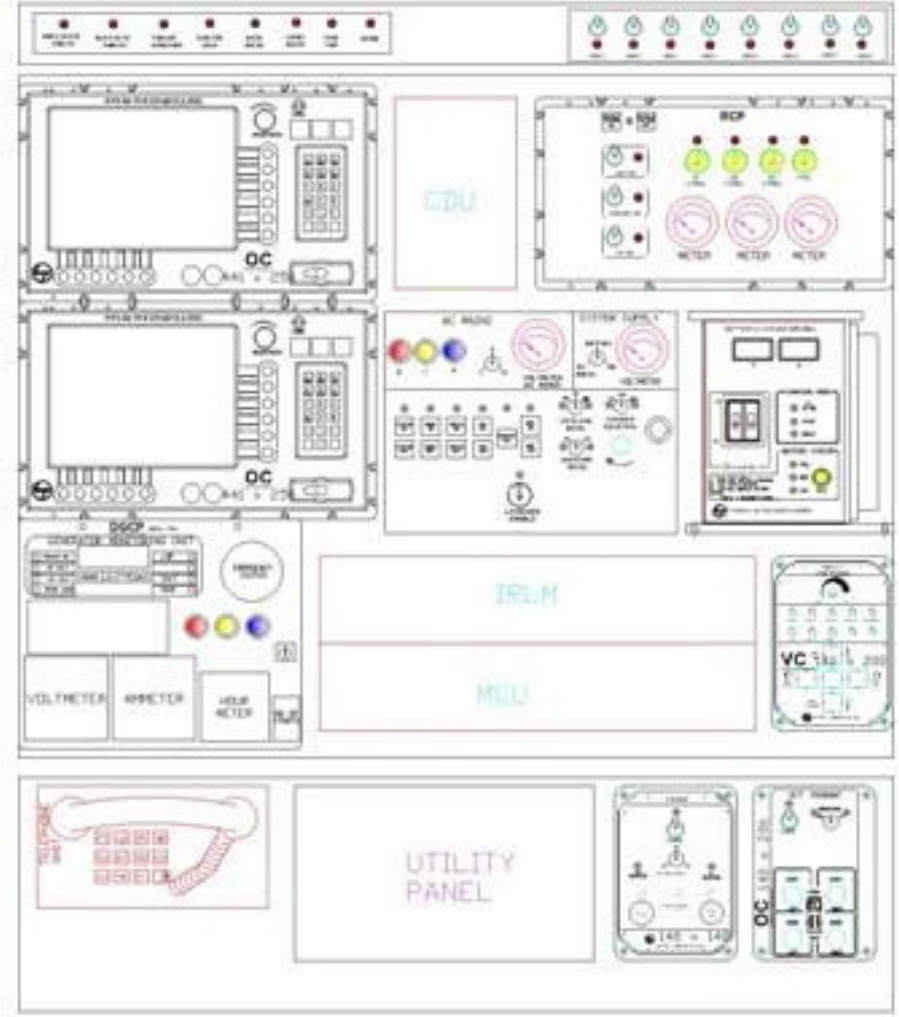
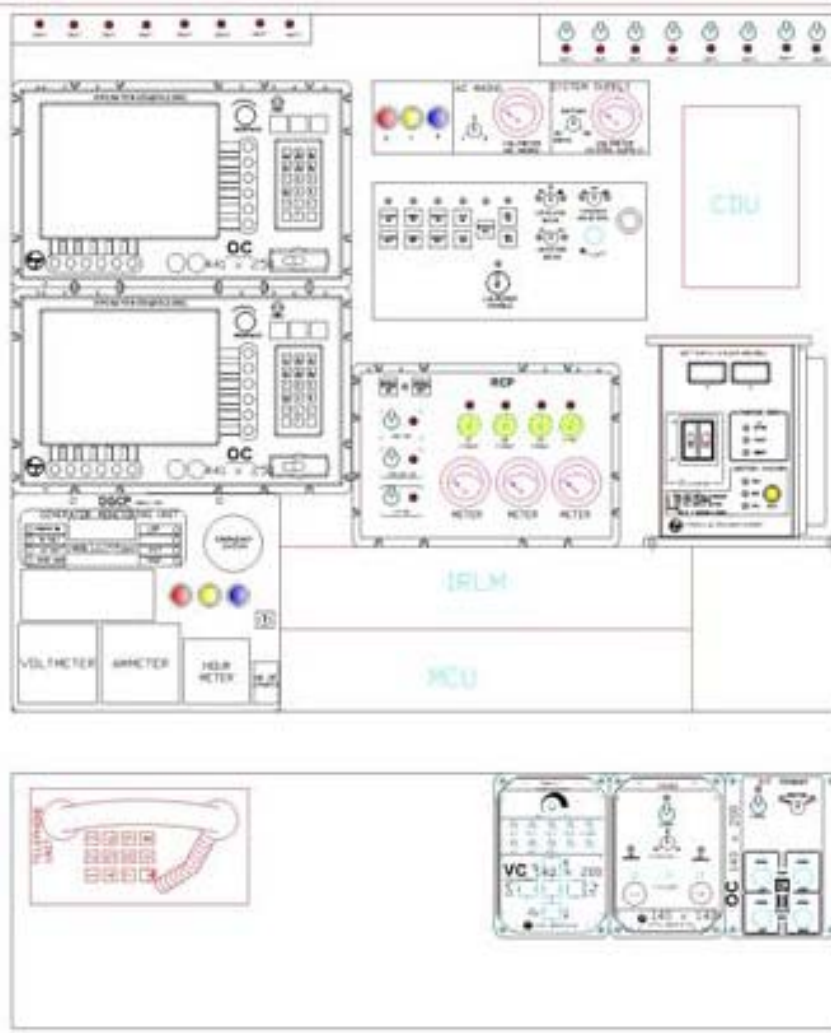
Hence two staged and three staged panel was considered as shown on the R.H.S.

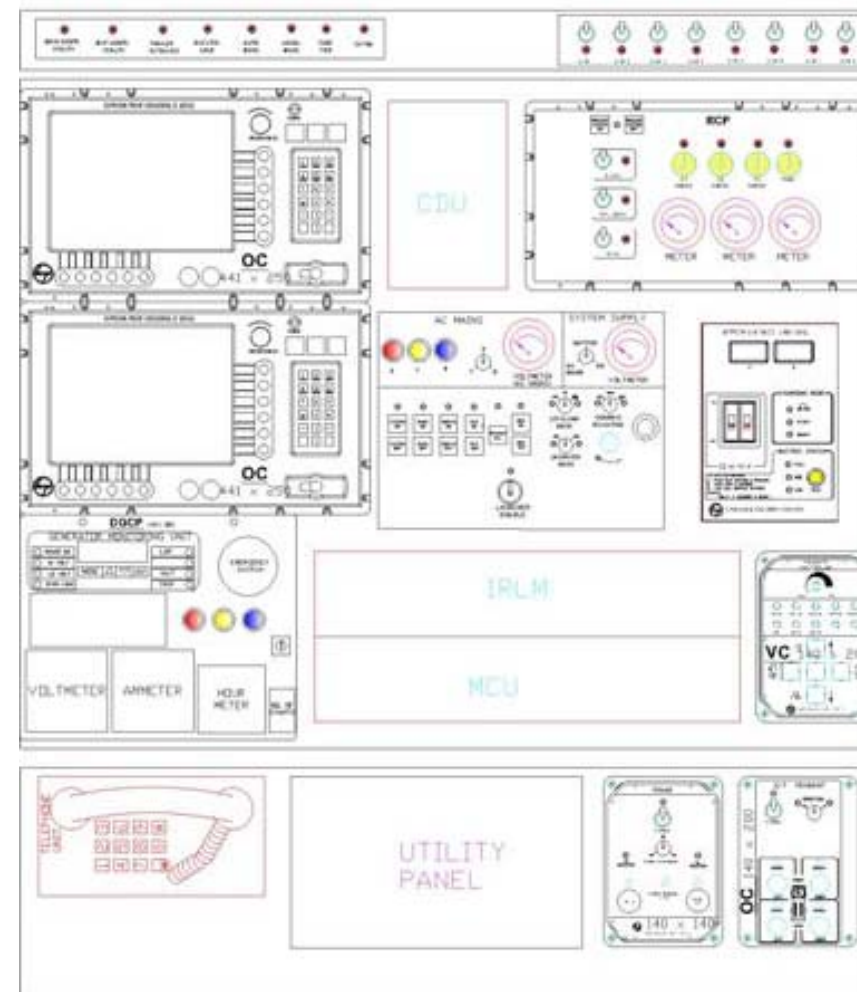
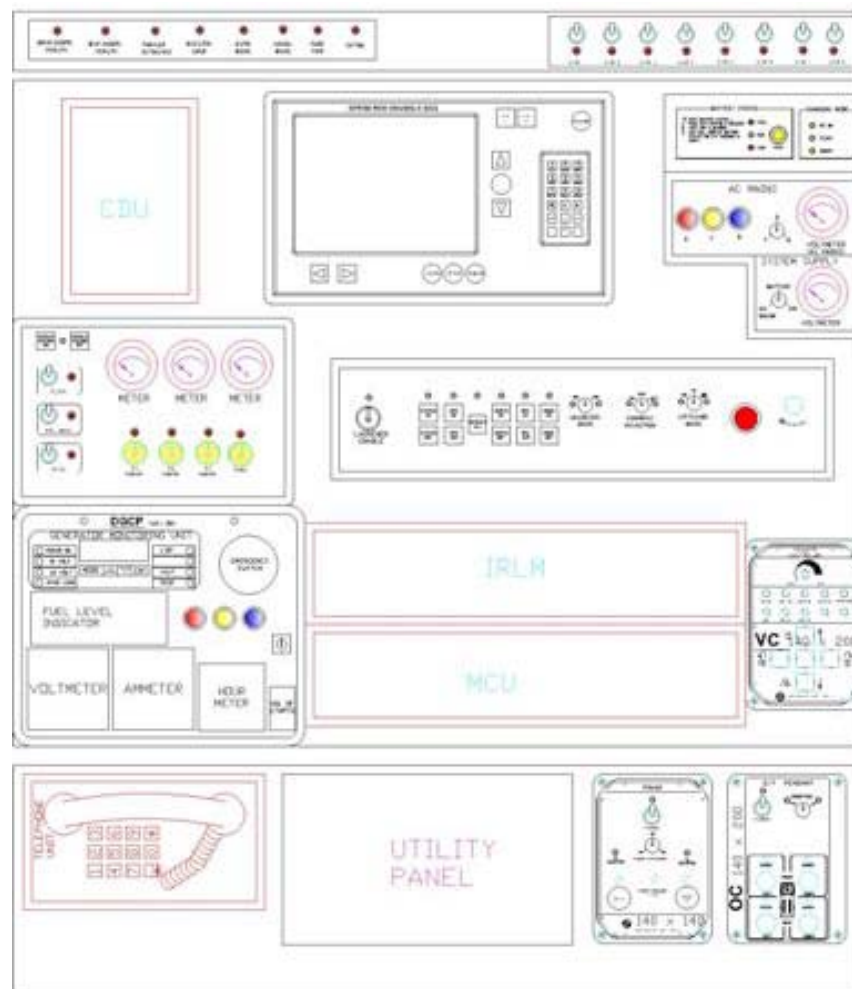
For purpose of generating various layouts, Tangram method was used wherein each module was cut from paper and played with in the constrained area.

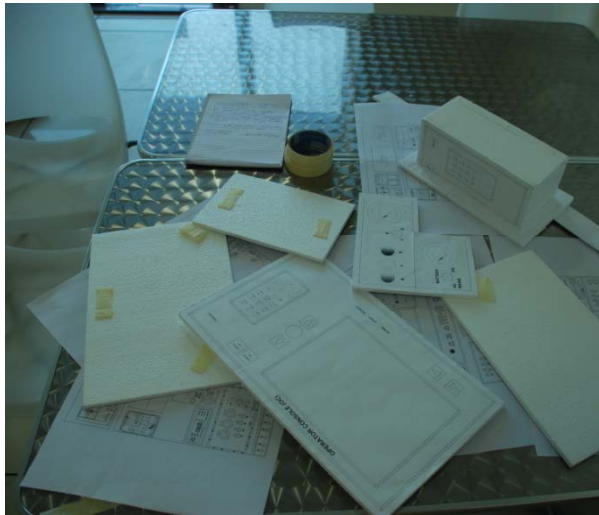
As a result following layouts were generated:











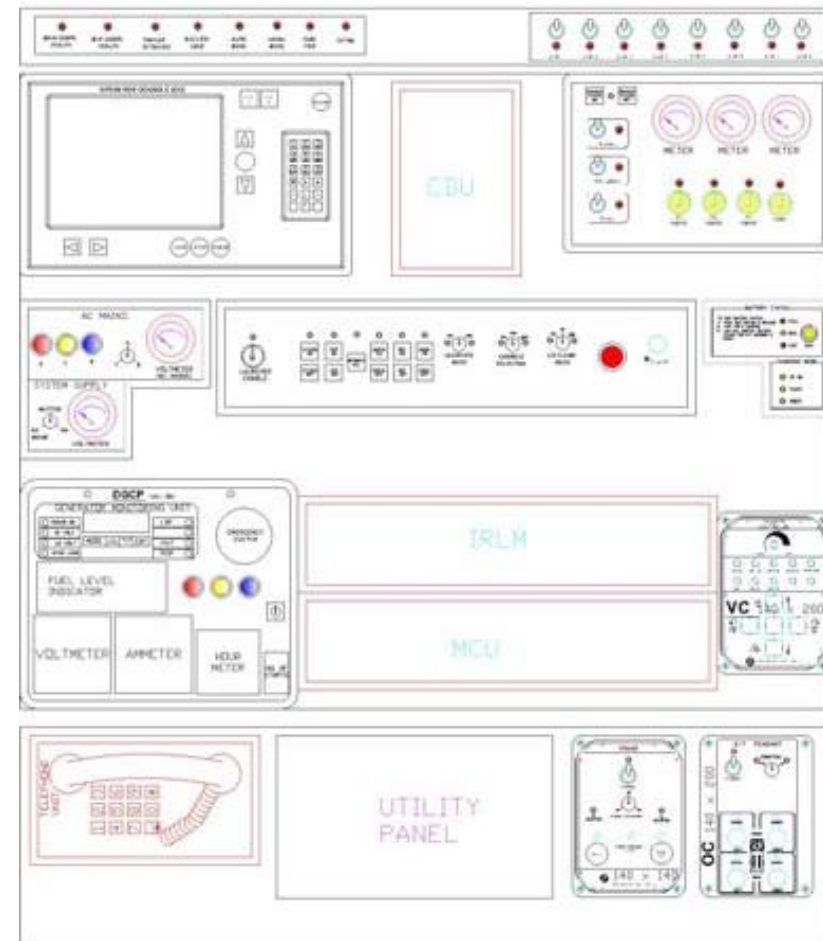
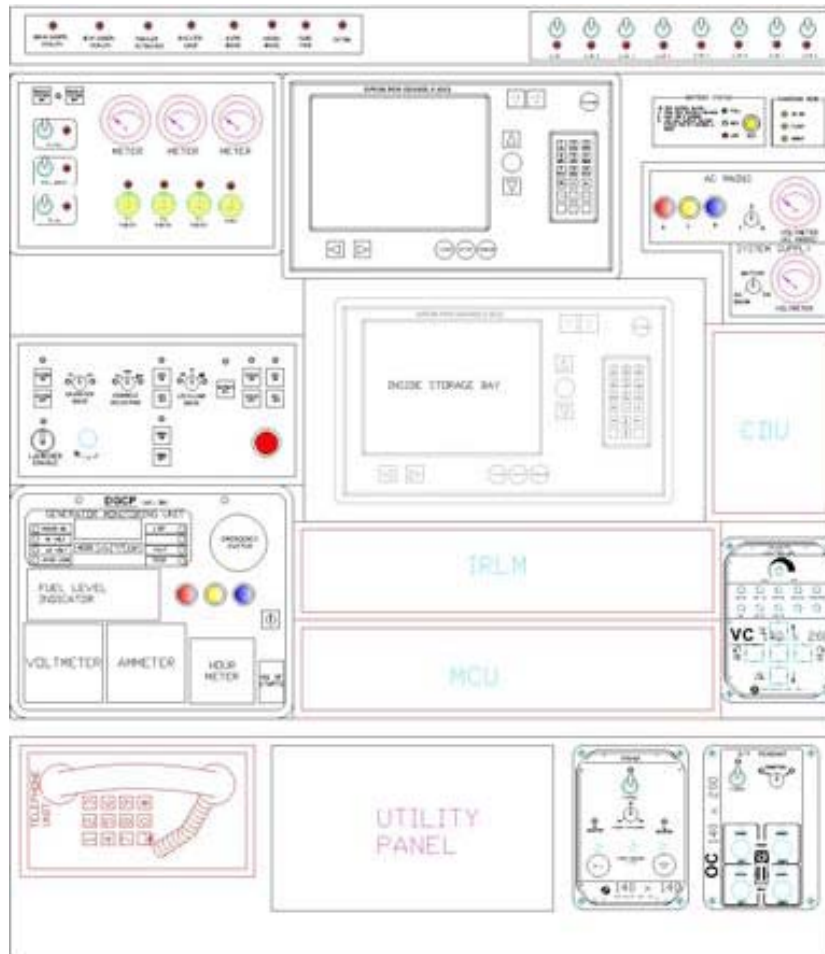
After initial ideation a full scale model of the three stage control panel was made. Also each module was made out of thermocole sheets and the same tangram method was used but on actual scale.

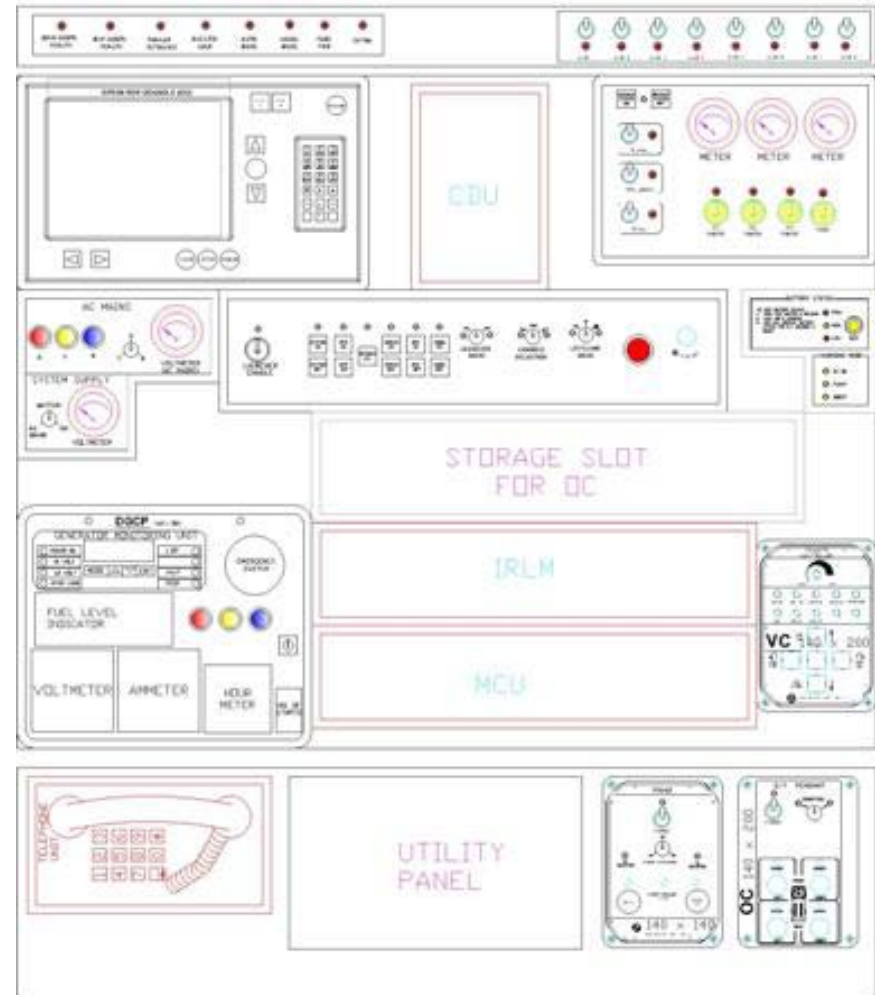
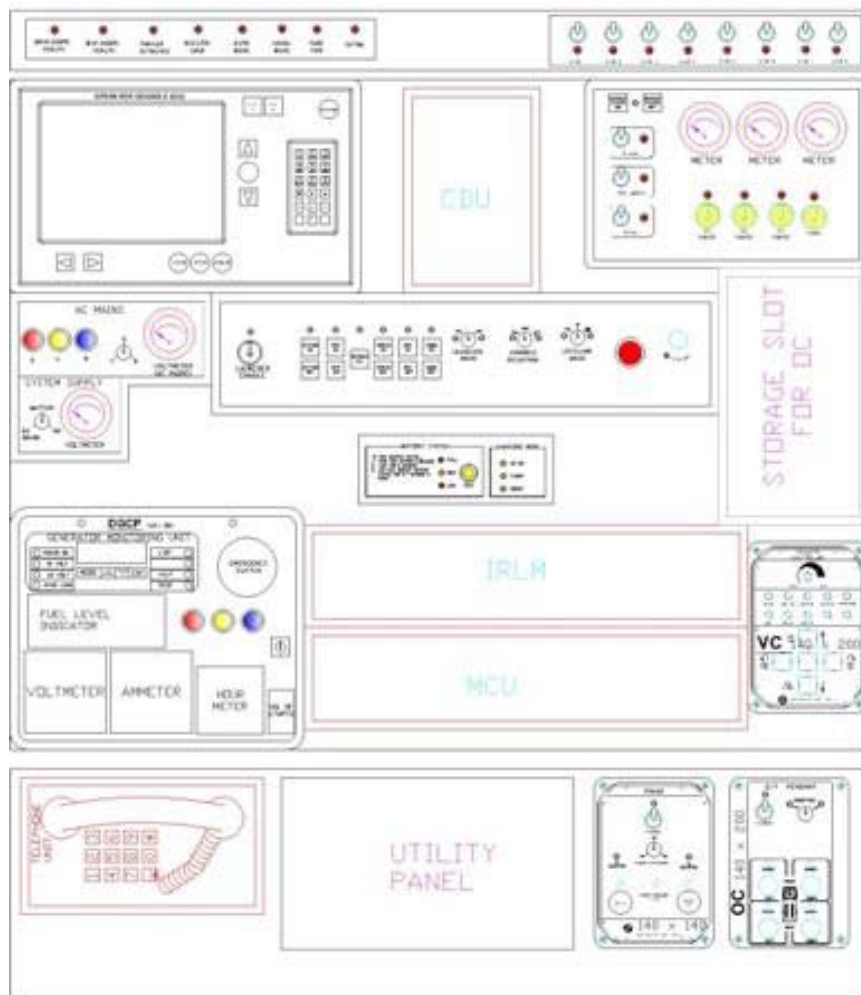
The actual scale of the model gave a better idea of space between the modules and the actual size of various elements making it easy to visualize problems faced while operating the control panel.

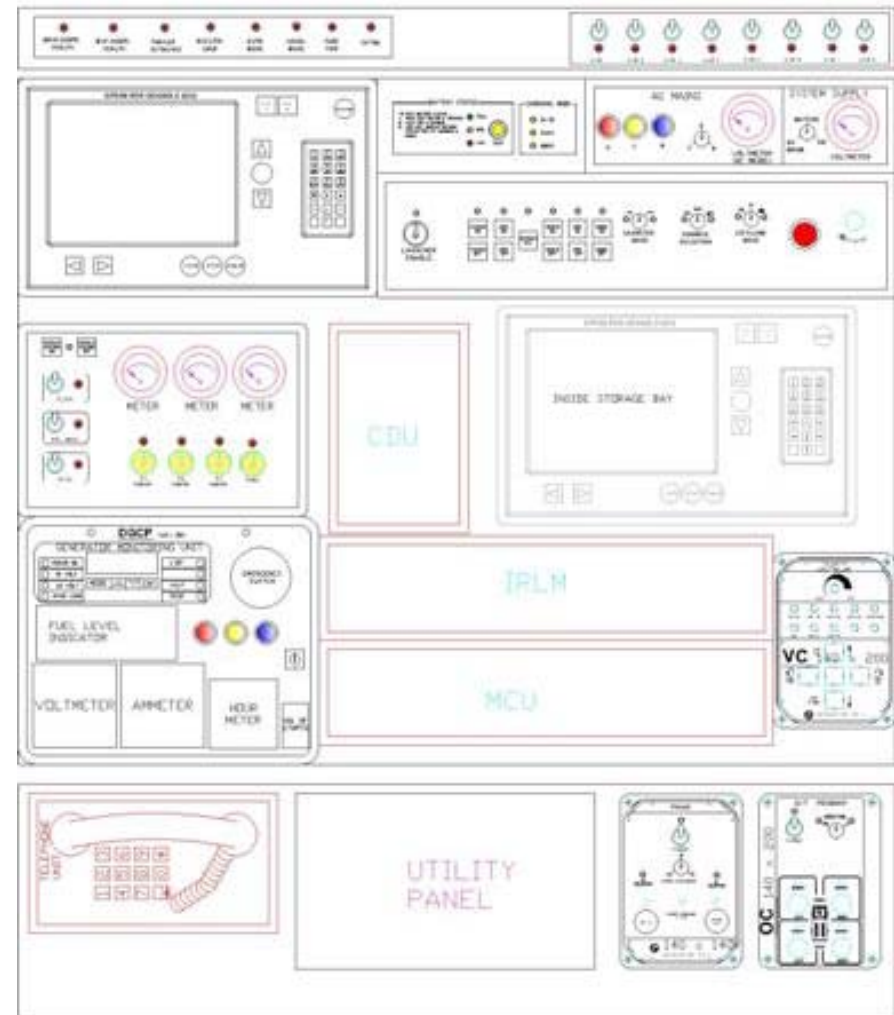




Following layouts were generated as a result:







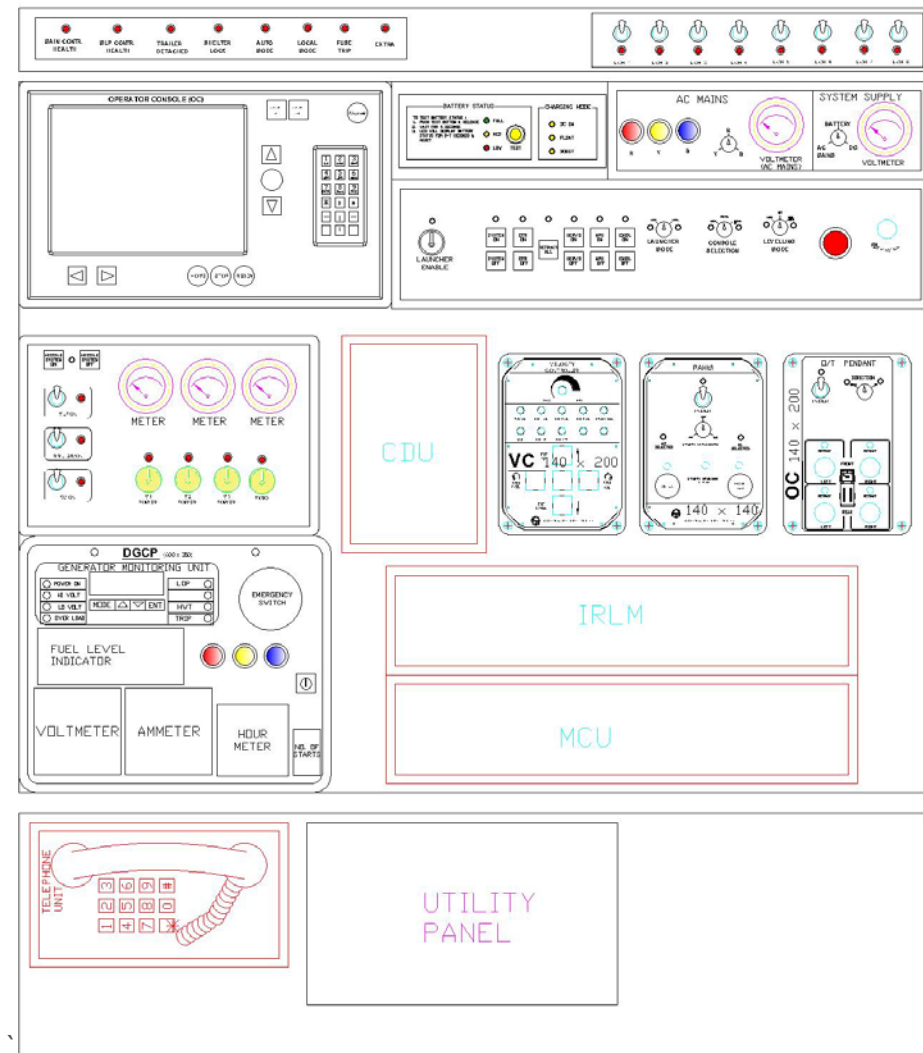


### Concept Generation:

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

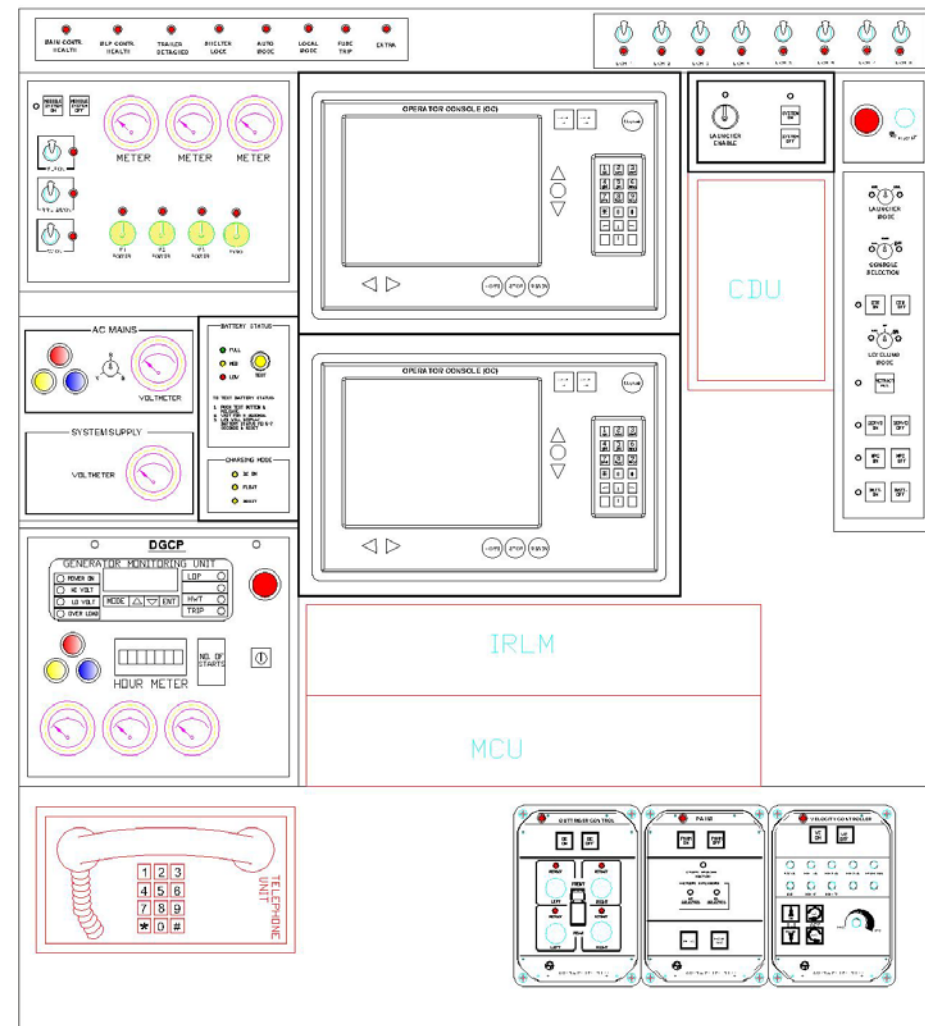
### Concept 01:

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 02:

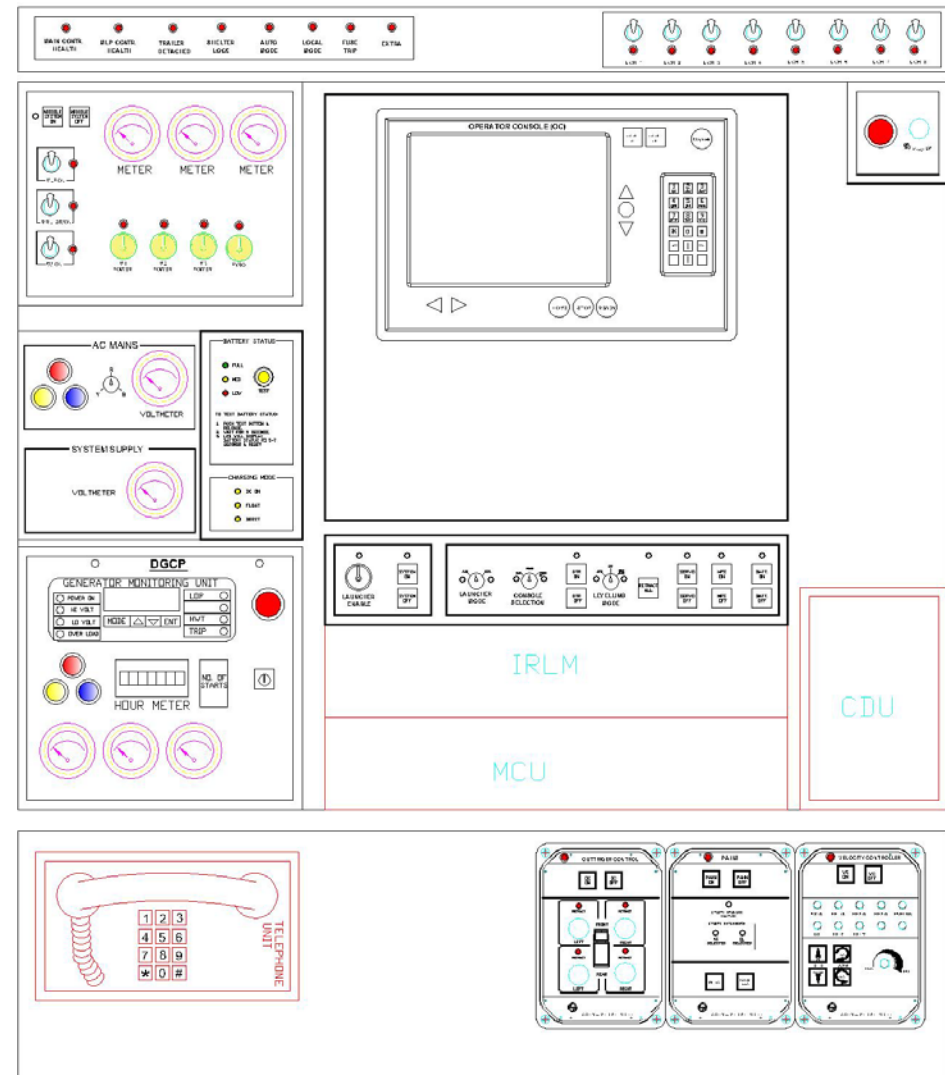
Here only one display was visible at a time other being covered by an open able lid. Here both the displays were connected all the time. Also the dual display arrangement one above the other made of good usage when the system had to be raised keeping the 2<sup>nd</sup> screen still in vision.





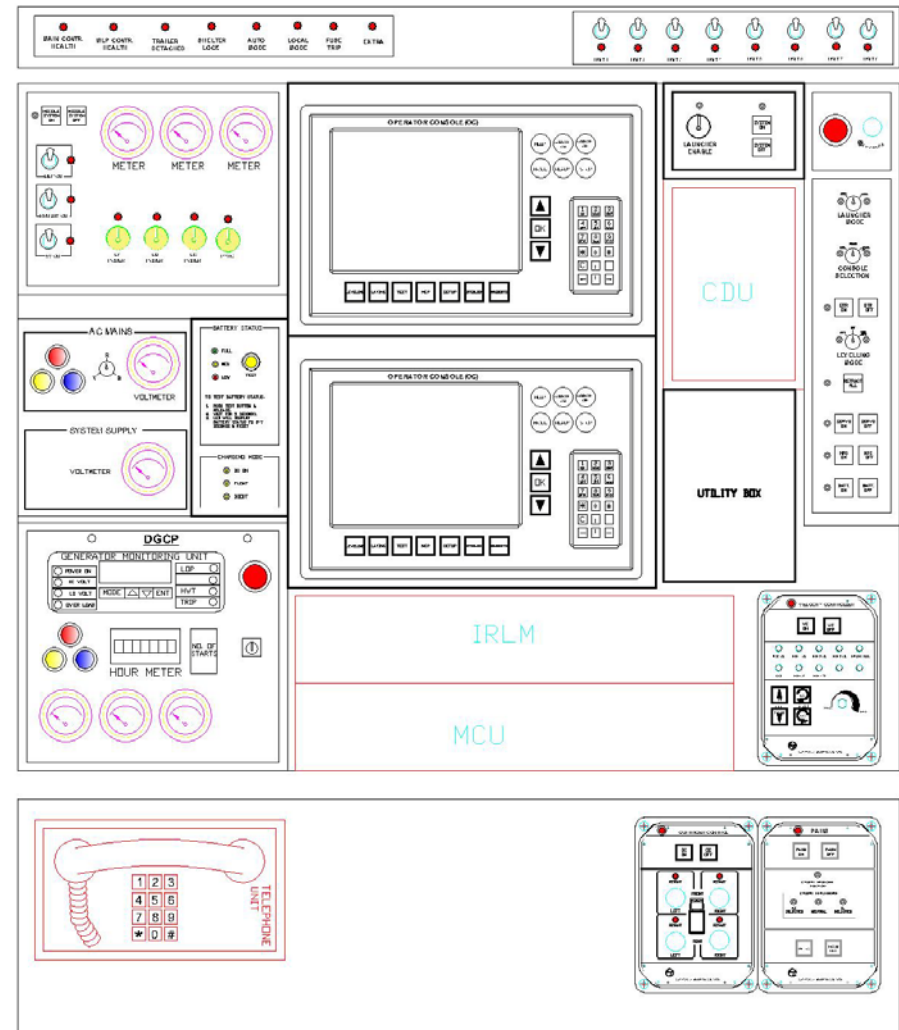
### Concept 03:

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 1<sup>st</sup> 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.



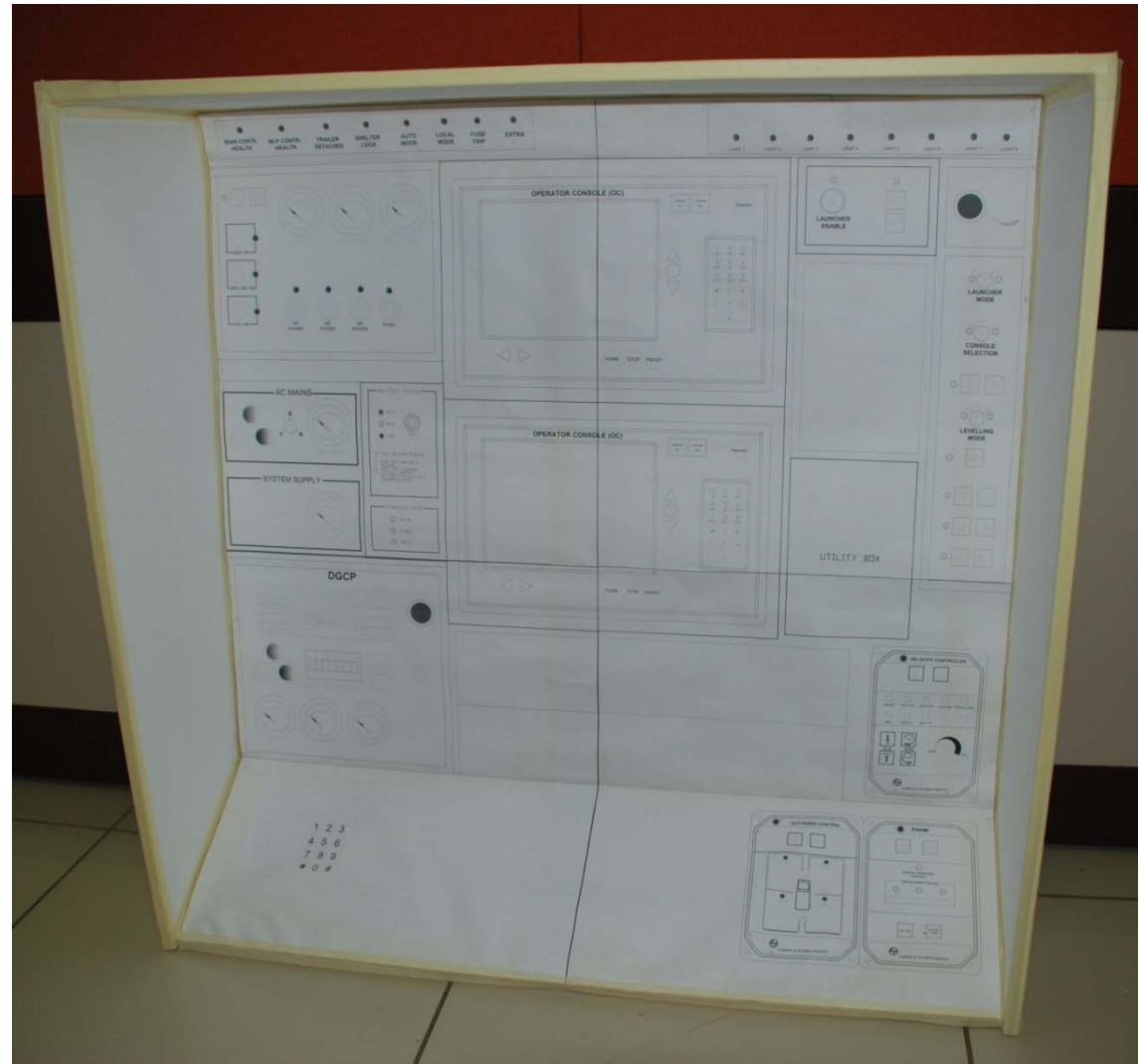


Fig: Final Layout was plotted and pasted on the model.

## 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 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:

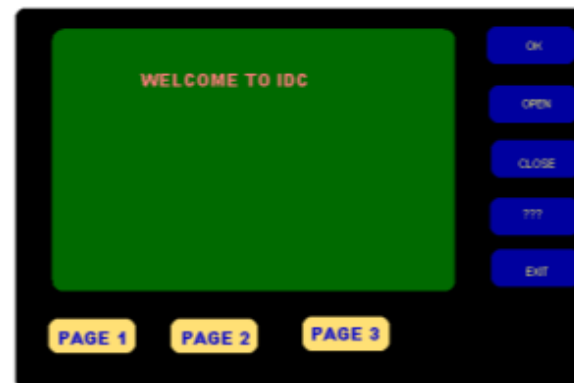


Normal viewing



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.



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## External Body (Form)

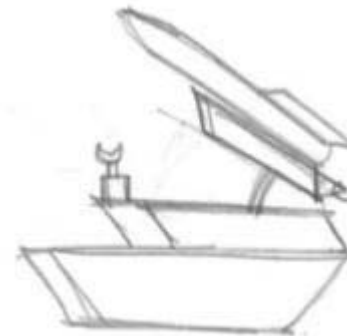
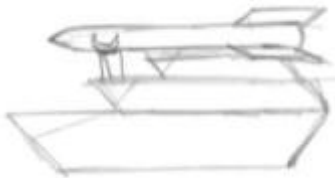
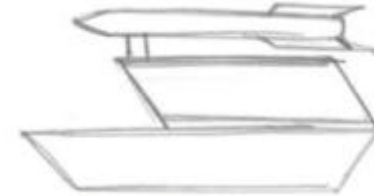
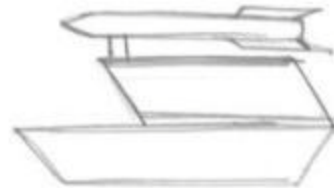
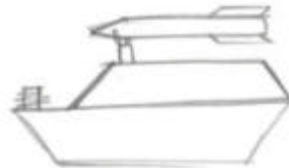
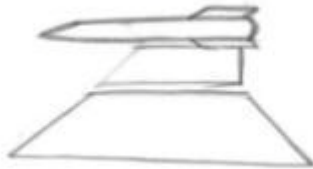
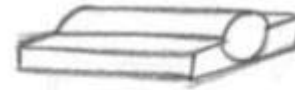
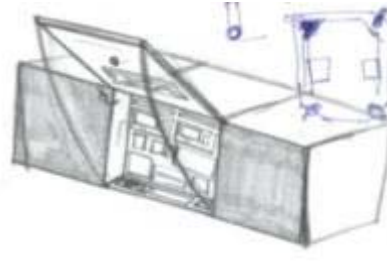
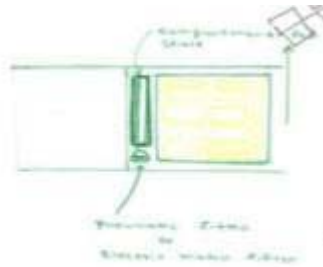
The external form was governed by the components at the base and the launch system above it.

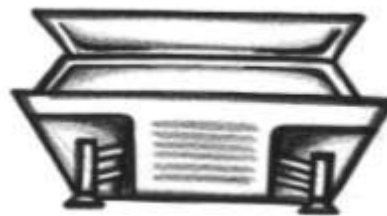
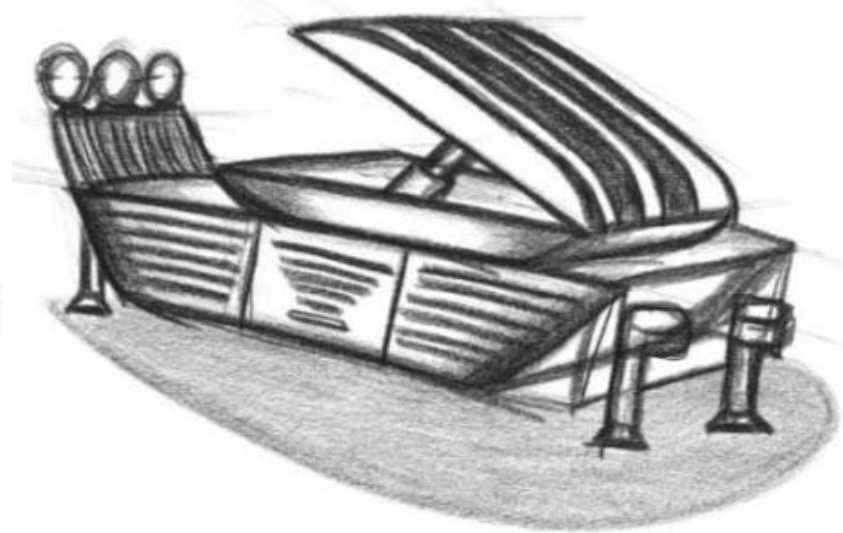
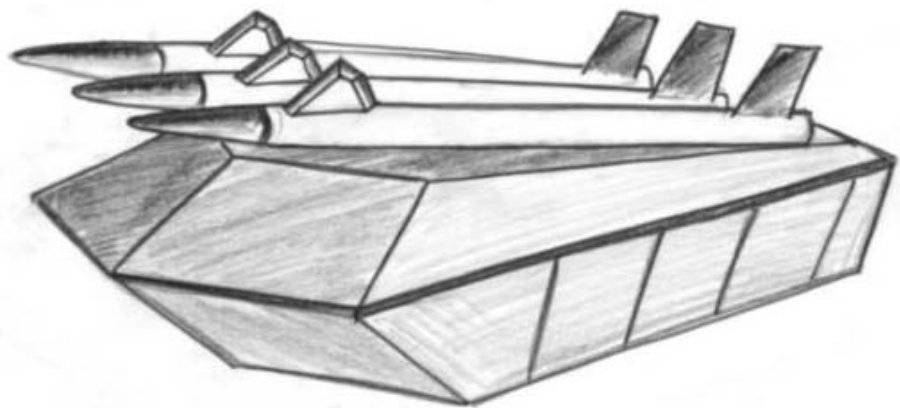
Following aspects were considered while ideating for external form:

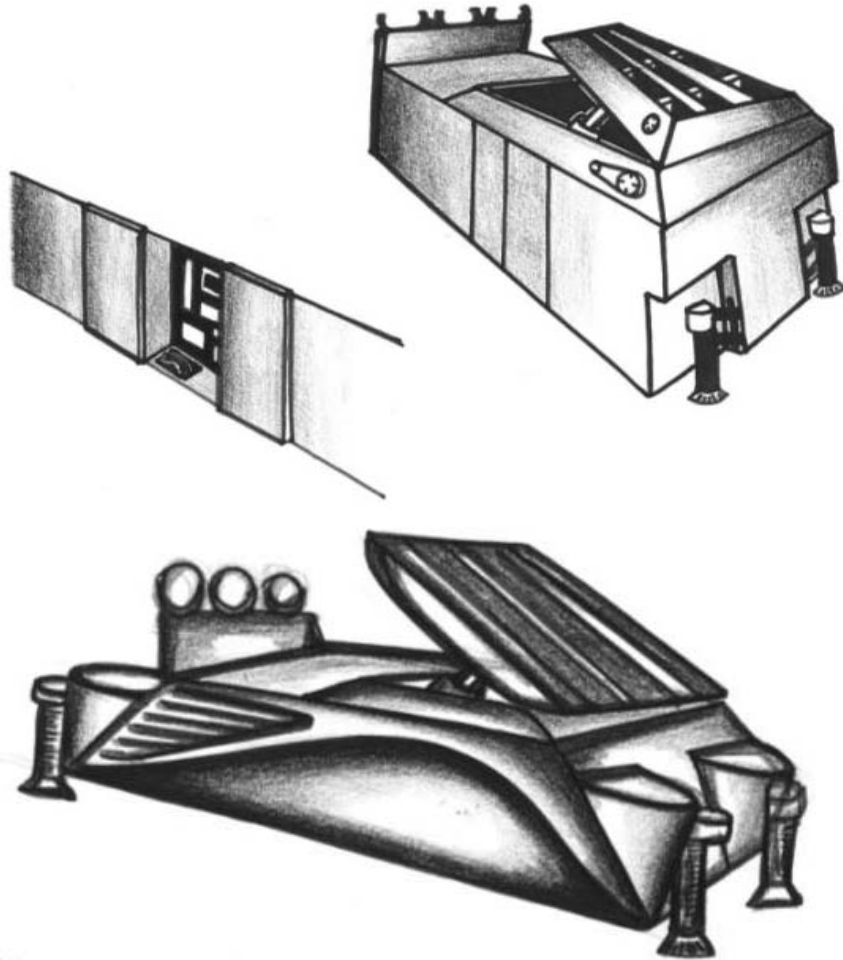
- Theme for the entire launch system.
- Ease of use and accessibility.
- Camouflaging.
- Utility spaces.

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

## Ideation:







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## 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.