Project 3

Design of CNG Dispenser

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Introduction

Present day scenario - Regulations and cost effective use of CNG in automobiles .
There is a lot of demand for CNG fueling

CNG is different from petrol dispenser .

Current CNG dispenser have to be designed with new interface .
So far no attention in this direction has been given to the CNG dispenser.

Today there are lot of advances in technologies in automobile design and this is not reflected in the CNG dispenser.

Aim of the project:--

This project aims at designing a CNG fuel dispenser for improved user convenience.

Users
1)consumer
2)operator or filler
3)station provider or company provider.

Objectives :-

- The current CNG dispenser will be taken as a reference and user study will be conducted

- All the CNG dispensing components required for CNG dispenser will be studied and improved

- New design requirements will be added as required by the user study

- New technology will be recommended for safety and fast filling operations

Data collection :-

Data collection and analysis were carried out by collecting base literature about CNG dispenser and interviewing manufactures ,buyers, operators and consumers.

- Introduction to CNG

- Study of CNG dispenser and dispensing

- The operating system by the operator

- Study of forecourt layout configuartions and equipments.

- Study of island size ,configurations and traffic flow patterns

- Considering Standard dimensions

- Understanding Industrial manuafacturing process

Introduction to CNG

- CNG stands for Compressed Natural Gas.

- It is one of the most viable alternatives to traditional fuel energy resources for the automotive industry.

- CNG is low in pollutants, high in calorific value and heat yield, economical and available in abundance globally.

The natural gas has less energy density as compared to liquid fuel and hence it is compared to over 200 Kg/cm3 (g)pressure to make it CNG for use in the automobile sectors.

Reasons for switching over to this alternate fuel in India are mainly:

1. Economic benefit:
2. Environment friendly:
3. 100% Income Tax Depreciation
4. Flexibility and ease of use

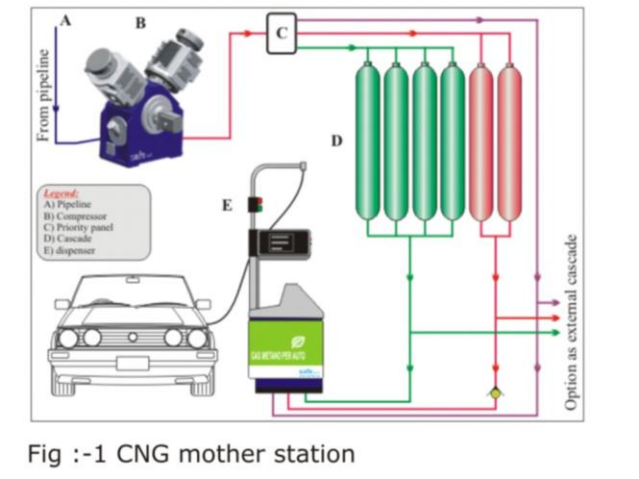
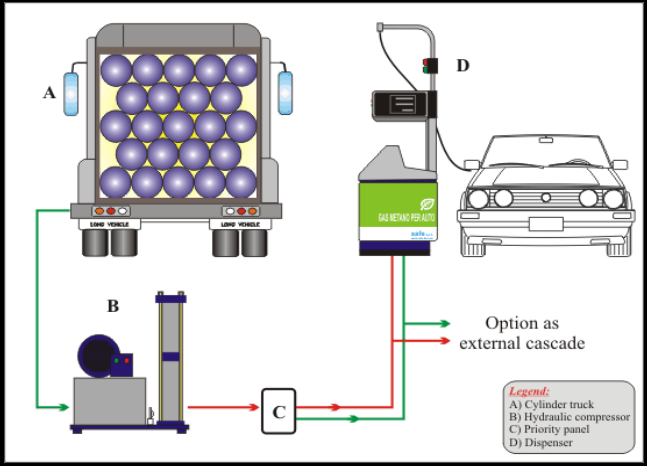


Fig :-1 CNG mother station



Study of CNG dispensing system:-

There are two type of CNG fueling station.

MOTHER STATION:-
Mother station are connected To Main Pipeline And Have High Compression Capacity. It supply CNG to both vehicles and daughter station.
Requires heavy investments towards compressors ,dispenser, cascade, pipelines and tubing etc

TYPICAL CNG MOTHER STATION:-

Online station CNG vehicle storage cylinder need to be filled to a pressure of 200 bars

DAUGHTER STATION:-
The dispenser CNG using mobile cascade

Study of CNG dispenser

Break away coupling

CNG Dispenser

Way valve

Electronic display

Dispenser Box

Lower panel

Pneumatic valve

Pneumatic valve

Study of CNG Dispenser:-

Dispenser lower panel :-

Dispenser has three inlet of CNG compressed gas
1) High pressure bank
2) Medium pressure bank
3) Low pressure bank

These pressure bank are provided with filter and a pneumatic actuator .When the vehicle is hooked by the nozzle the above provided banks senses the pressure in the vehicle with the sensor valve. Once the pressure is sensed by the sensor valve open the similar pressure bank and then it starts filling the vehicle.

Overall dimensions are
Height-1000mm
Width - 1130mm
Depth -300mm

Mass flow meter

Mass flow meter :-

The mass flow meter measures flowing gas mass without disturbing the passage and transform the same in volume units thru a mathematical calculation

Pressure Gauge

The pressure gauge :-

The pressure gauge shows the filling pressure.

Hose pipe

break away coupling

Three way valve hose

Hose pipe :-

The filling hose is ½" diameter with the ½"NPT connectors for CNG use is able for a working pressure of 5000 psi.
The filling hose is composed by two lengths , one of 2750mm and the other of 900mm (with double hose for vent 1/4" diameter).

Break away coupling :-

The break away coupling or quick disconnecting valve is built in stainless steel and purpose is to disconnect the hose.

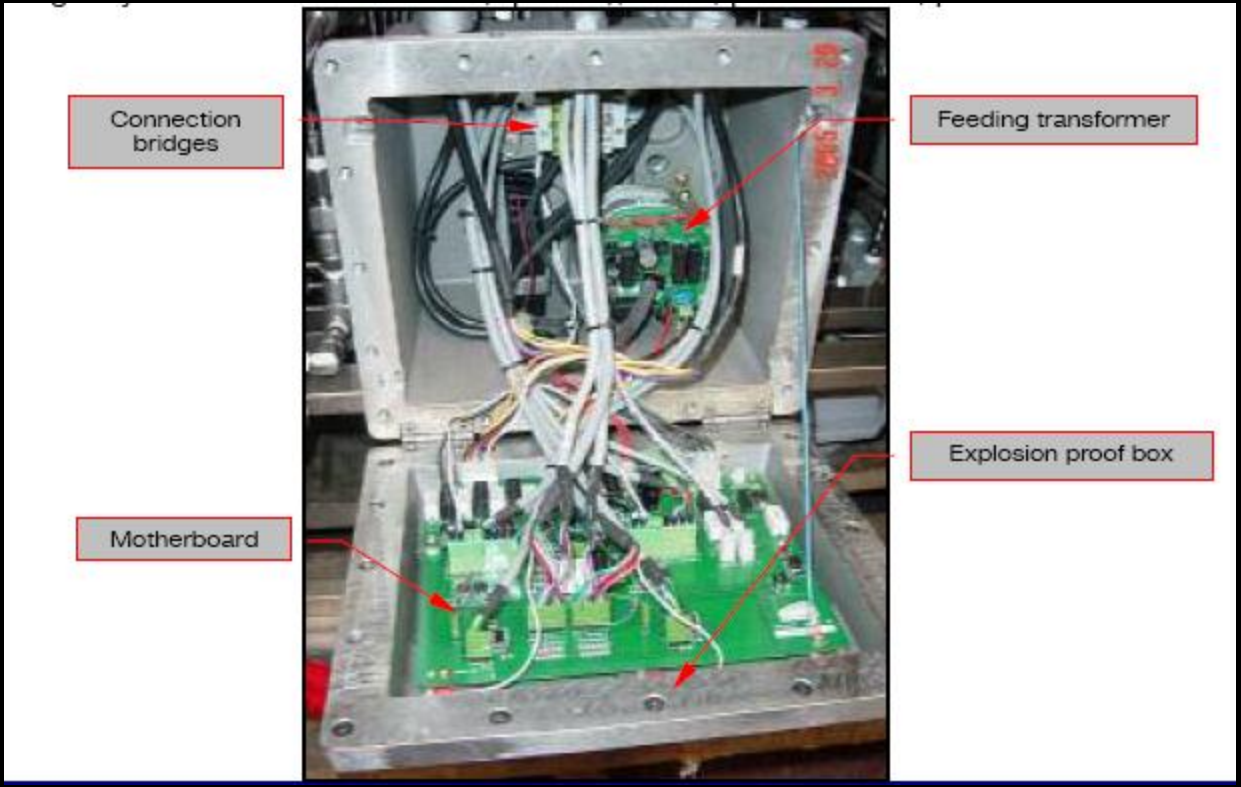
The 3 way valve is installed at the end of the hose and is manually operated to start and finish the filling. The valve is stainless steel 316L psi with Kal -F seats.

Three way valve hose :-

It has three main pipes they are:-
1)filling hose -270mm
2)vent pipe
3)one fit hose i.e the quick coupling.

Electric and electronic system

Inside this explosive proof box is located the power supply inlet connection post and the ground connection . Explosive proof box is usually kept away from the main dispenser.



The operating system of the CNG dispenser by the operator :-

1. Operators need the connector from the dispenser and hook-up to the inlet of the CNG vehicles.
2. The refueling is activated either through manual reset switch or through card reader.
3. Maximum pressure required is 250 bars and minimum required is 150 bars.
4. If pressure drops the fueling system stops and dispensing is started after the required pressure is provided.
5. Emergency knob provided to the dispenser. In case of if leakage accident happens then the operator has to turn off the knob.

For study and understanding of the operators and consumers activity the two type of CNG dispensers were studied.

1) Mahanagar Mother station at Sion
2) Hindustan Daughter station at Ghatgopar

CNG petrol dispenser :-

CNG stations have similar forecourt like petrol pumps :-

- Island parallel to road
- Island perpendicular to road
- Island in diagonal configurations

The CNG stations equipment which is situated on the islands essentially consists of one or more CNG dispensers .

Segregated autorickshow, taxi and heavy vehicles have separate dispenser for ease of service.

Three wheeler traffic is generally very very large as compared to four wheeler traffic and by comparison buys very less quantities of CNG gas as relative to four wheeler.

CNG petrol dispenser :-

Their categorization and distributions:-

They are classified as

Company owned and company run like Mahanagar, Indratprstha etc.

Company owned and dealer run like Hindustan petrol pump.

Dealer owned and dealer run like Indian oil.

Study of island size ,configurations and traffic flow pattern :-

Although overall sizes of island differ , they are typically one meter wide (minimum) and 15 cm from the ground level.

Two type of dispensers:-

Dispenser with island
A small island with a single CNG dispenser unit
An oblong island with two CNG delivery units mounted side by side on it.
Dimensions- 15cm high from the ground level and 1 meter wide (minimum)

Dispenser without island
Trench duct below the ground level
Dimensions– 400mmx400mm

Orientation of the CNG dispenser:-

1) Island type:-

The dispenser has two hose pipes. Hose pipes are provided on the front panel of the dispensers facing the road . The hose pipe is reachable up to the facing road . The hose cannot be taken to the either side of the dispenser.

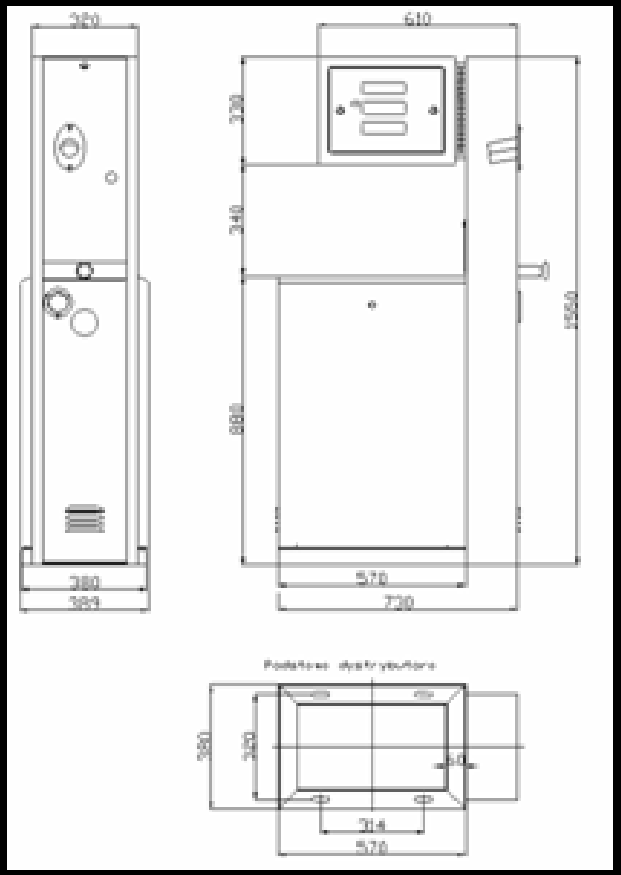
On the panels facing the road has display and printer layouts.

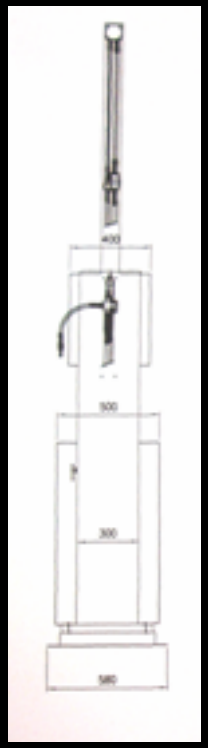
2) lane type :-

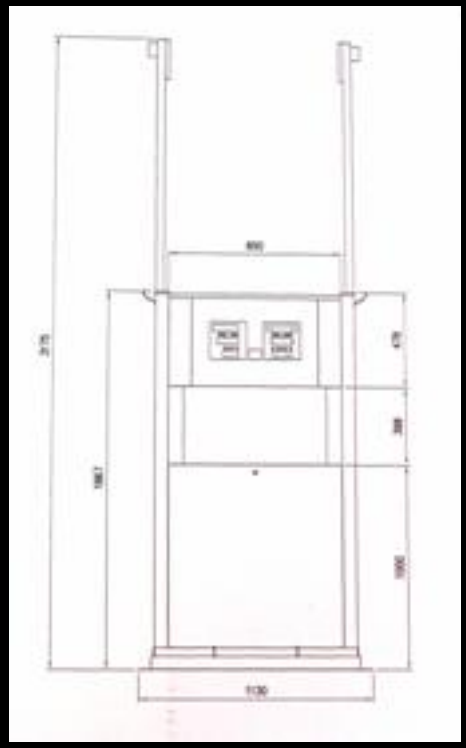
The dispenser has two hose pipe provided on the side panels of the dispenser and the hose pipe served the vehicle on the either side of the dispenser.

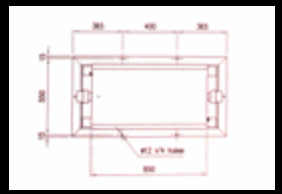
Standards :-

Dimensions of single hose dispenser









Dimensions of single dual hose dispenser

Manufacturing details

Shearing machine for cutting and flattening

Material used for manufacturing CNG Dispenser body:-
There are two type of material :-
1) CRCA :- Cold roll coil Alloy
2) Stainless steel
3) Aluminum

CNC punching machine

CNC bending machine

Nuts and bolds welded after the CNC

Emboss done during CNC punching

Activity flow chart :-

Total time :- 56.51sec
Filling time :-41.52 sec

1st :-
The operator unhooked the nozzlefrom the nozzle stand (dispenser)

2nd :-
The operator takes the hose pipe near the vehicle and bend to hook up the nozzle to the inlet of the three wheeler.

3rd :-
He turns the knob to start the nozzle

4th:-
He goes back to the dispenser to switch on the dispenser.

5th:-
He stands near the dispenser electronic display

6th:-
He switches off the dispenser after the required kg of CNG gas is filled.

7th :-
He goes near the vehicle and bend to turn off the knob, remove the nozzle from the inlet of CNG vehicle.

8th :-
After removing the nozzle and the operator takes it to the another vehicle parked behind

1st:-
The consumer parked the vehicle in a row.

2nd :-
Once the nozzle is hooked up by the operator the consumer has to move out of the vehicle which is the regulation to be followed.

3rd :-
The consumer stand near the display

4th:-
Since he knows the required rates so he goes near the operator and pay off the bill.

5th :-
He goes back to the auto after removing the nozzle from the vehicle.

CNC dispenser hose pipe

Activity study Observation, problems and inferences: -

1st observation: -The operator unhooked the nozzle from the nozzle stand (dispenser).

Problem :-
Nozzle rest provided on the dispenser does not hold the three valve nozzle only the flexible end remains fixed

Inferences :-

The nozzle should be provided with a stand

Nozzle rest on Q.C / dispenser

2nd observation: -The operator takes the hose pipe near the vehicle
Problem:-
For each vehicle he has to bend to place the nozzle.
Push the nozzle to hook up it to the inlet of CNG vehicles which are generally at the backside or below the seat.
Inferences:-
The dispenser should be provided with flexible length pipe for maximum reach.

3rd observation: -
He turns the knob to start the nozzle
Problem:-
Unstable knob operation
Inference :-
The nozzle should be operated with less intervention by the operator

4th observation: -
He goes back to the dispenser to switch on the dispenser.
5th:-
He stands near the dispenser electronic display
6th:-
He switches off the dispenser after the required kg of CNG Gas is filled.
7th :-
He goes near the vehicle and bend to turn off the knob and remove the nozzle from the inlet of CNG Vehicle.
Problems :-
Every time to fill up CNG Vehicles the operator has to move near the dispenser to switch it on and switch it off. To remove the nozzle he has to return back to the vehicle.
Inferences:-
The nozzle should be provided for quick and easy operation for the operator.

8Th observation: -After removing the nozzle the operator takes it to another vehicle parked behind the previous vehicle.
Problem :-
The operator hook the nozzle to the inlet of the immediate vehicle.
The vehicles are sometimes parked in the unreachable area.

Inferences :- Hose pipe should have maximum reach ability.

Consumer stands outside vehicle

Consumer stands near the display and watch electronic display

Consumer :-

1st observation: -
Once the nozzle is hooked up by the operator, the consumer has to move out of the vehicle

Problems:-
The consumer stand in between the area of dispenser
Inferences:-

While filling the vehicle the hose pipes should not be interfering by the consumer.
Proper instructions for the consumers during filling time to avoid there intervention.

2nd observations :-
The consumer keep watching the electronic display.

Problems:-
The consumers' intervention during the filling causes lots of congestion in the surrounding space of dispensers.

Inference :-
Display should be seen from the required distance (consumer is standing near the vehicle).

After filling the consumer starts the vehicle

3st observation: -
While removing the nozzle the consumer goes back to the vehicle and move the vehicle from the place.

Problems:-
Sometimes the consumer before removing the nozzle starts the vehicle and moves this might causes pipe to busting.

Inference:-
Breakaway coupling should be provided to automatic shut off the dispenser during such accidents.

User study: -

Level one: -Operator
Level two: -consumer
Level three: -Station mangers
Level four: -Serves a provider & company provider.

Problems faced by users
Level one: -

1no. Operator(3yrs of experien
Every time pipe leaks due to continuos' abrasions

Easy to supply CNG From the back side of the auto rick.

No shades and it become difficult to supply CNG in rainy season.

CNG dispenser and nozzle interaction is very bad

The nozzle is too thin to hold properly

The driver has to stand out and he stands near the operator

Sometime consumer’ wants gas on money bases.

Problems faced by users:-

Level 2 :- Consumer

-Every time has to stand in a long queue for CNG filling and sometime if pressures drops then have to return back.

-Driver has to come out while filling and has to stand near the display as the display cannot be seen clearly from distance during the day time

-Stand on long queues which is loss for them.

The consumer stands near the vehicle.

Problems faced by users:-

Level three: - Station the manger

-long queues of three wheelers take most of the space of the stations.
-long queues have created wrong impact of CNG station
-Most of the time pressures drop and CNG stops working .

Long queues of auto rickshaws during CNG filling

Main issues related to CNG dispenser:-

Nozzle :-

Three way nozzles have to be unhooked first from the dispenser and then hook up to thee inlets of CNG Vehicles.

Three way nozzles are always handled by both the hand's

Nozzles have to reach the vehicle in different position

The nozzle has knobs on the flexible end which is not stable

The nozzles does not have not hooks and unhooked properly by the operator is not safe

Main issues related to CNG dispenser:-

Dispenser:

A current dispenser has maximum operator intervention

The filling process includes long procedures

The hose pipe always in contact with the ground causes abrasions

Displays are not seen properly in the day time

Nozzle rest is not designed as per the current nozzle

Hose and nozzle gas has gas leakage at the joint due to improper handling

Product brief:-

Nozzle :-

-The nozzle should provide one hand operation
-Should provide a palm grip for effort less locking the nozzle.
-Knobs should be operated from both the sides of the vehicle.
-nozzle operation should be operating with safe and fasten the filling procedure.

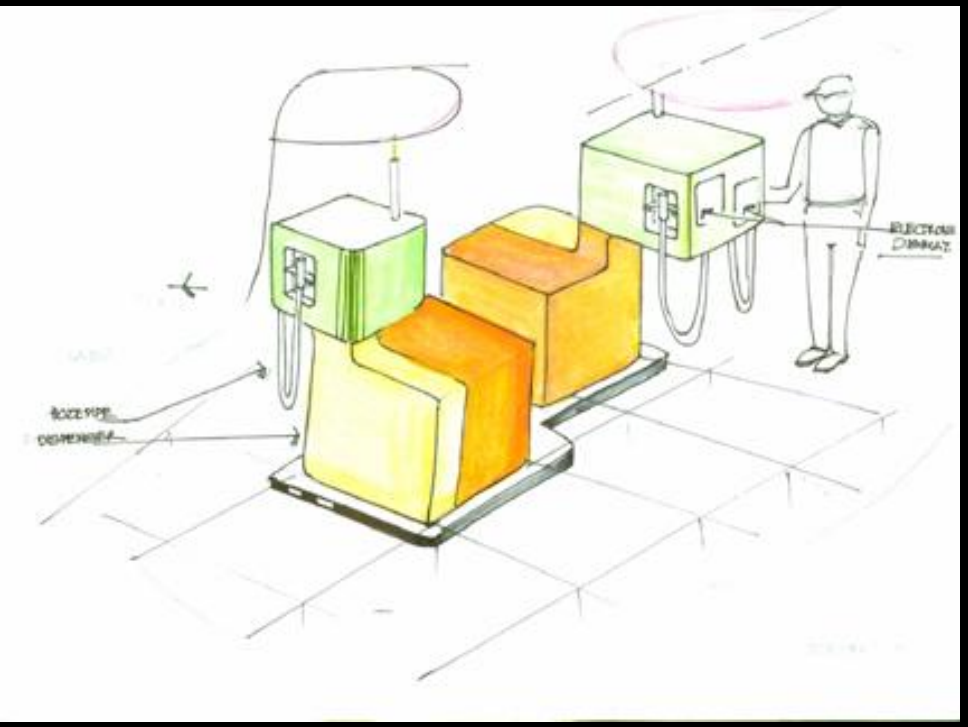
Dispenser

-The dispenser should be design to reduce the no. of a step of CNG filling procedure without much intervention of the operator.
-Design should provide proper rest for the nozzle holder.
-Hose should be added with hose retrievals and reach should be maximum
up to 3no. Of three wheelers. Technology allows the direct flow of CNG once the nozzle is on.
-The dispenser should provide bigger display and also should provide better credit pay system.
-Design a rest where it is should provide convenient access and removing from the rest.
-Autos cut off system provided for clear credit and pay system
-The dispenser should lend itself to various stations layout mostly in case of daughter station where space is less provided for CNG dispenser.

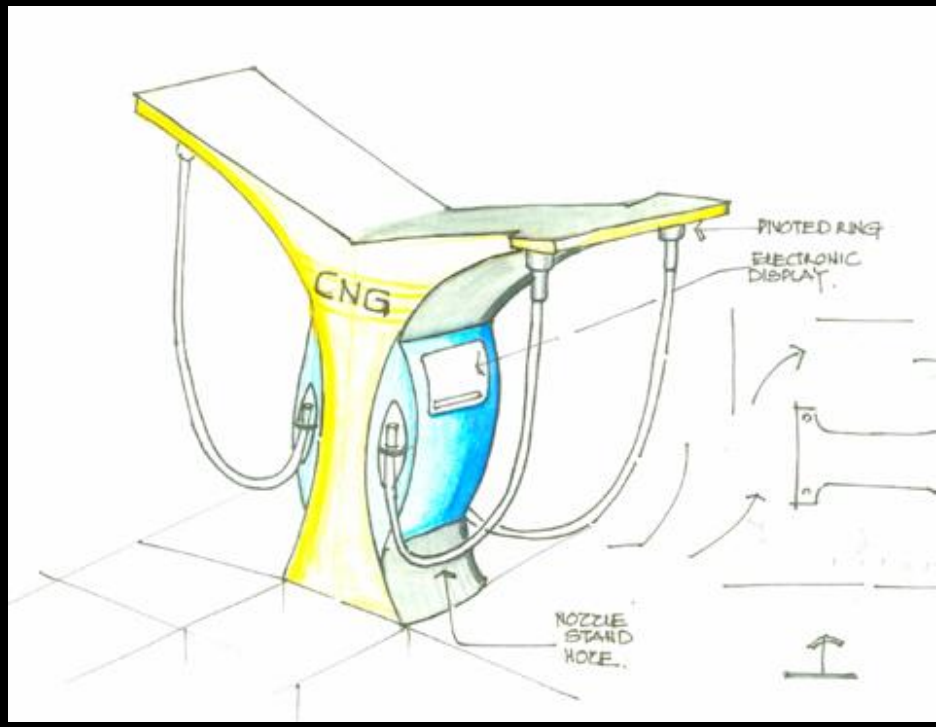
Safety and regulations :-

-Flame proof electronic display
-Rupture proof hose
-leakage proof joints for nozzle and hose

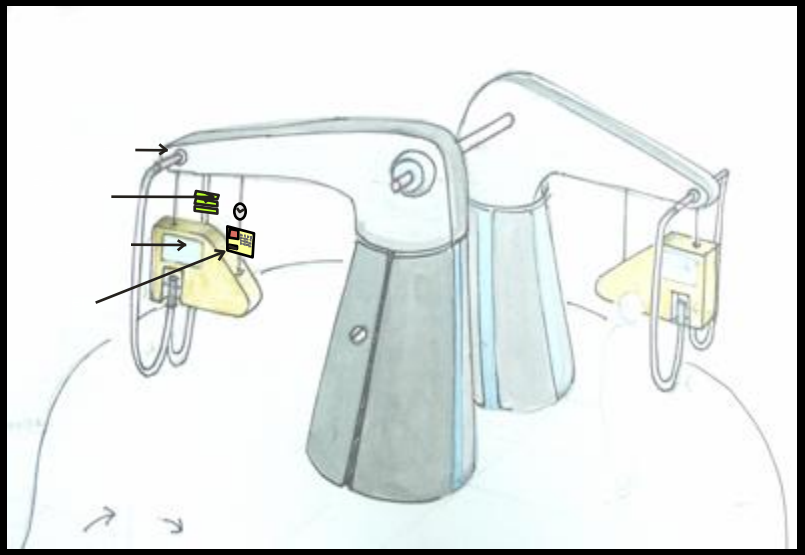
Idea generation



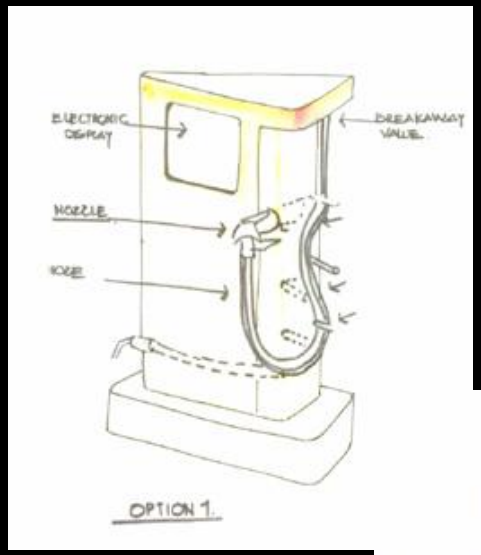
Idea1: Out of the box



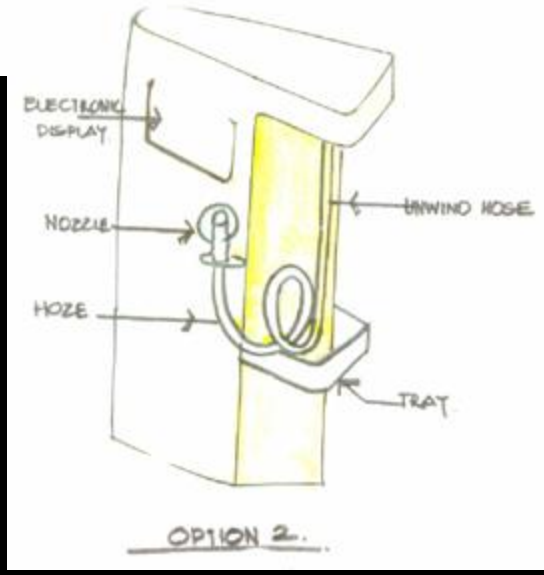
Idea 2: Single Structure



Idea 3: Balance

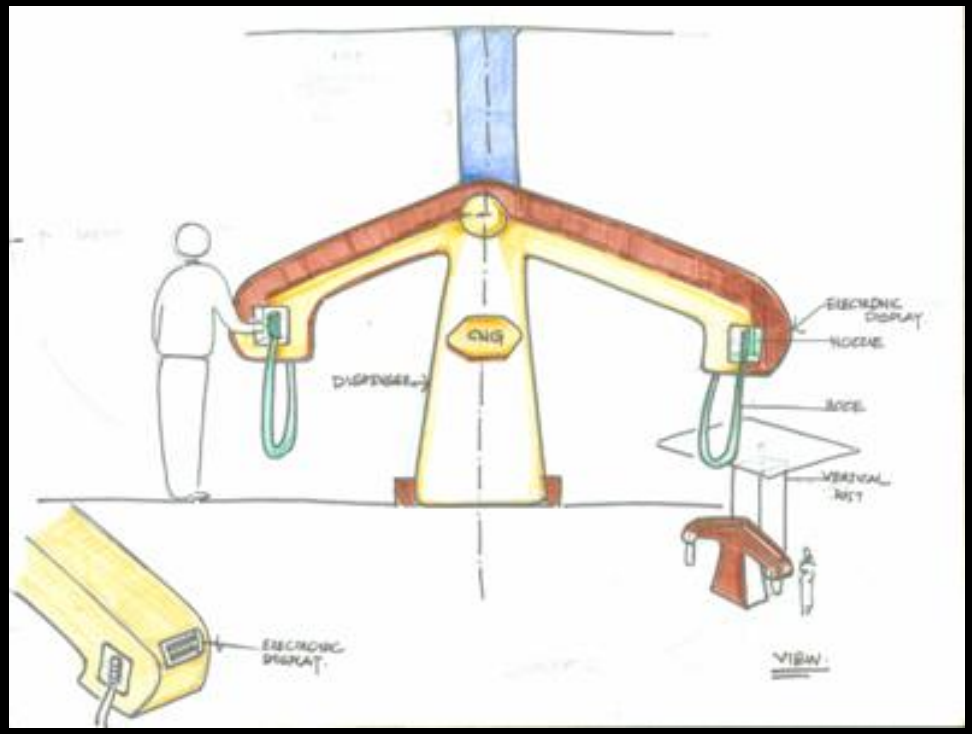


Spring back

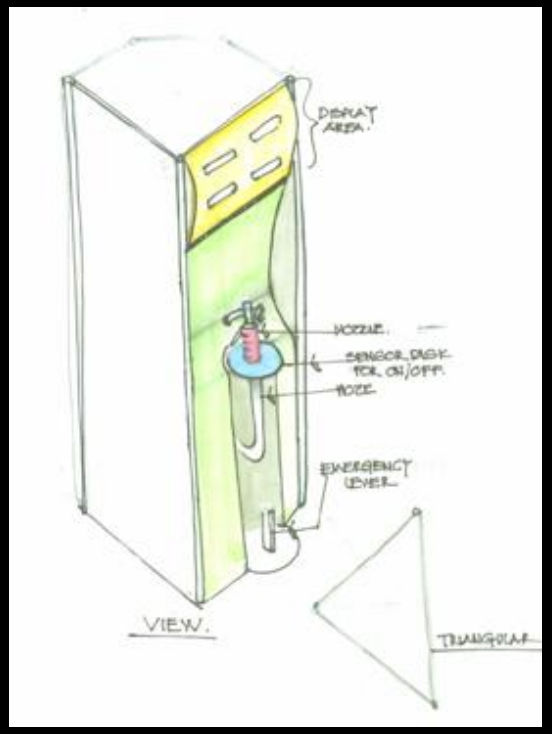


Hose tray

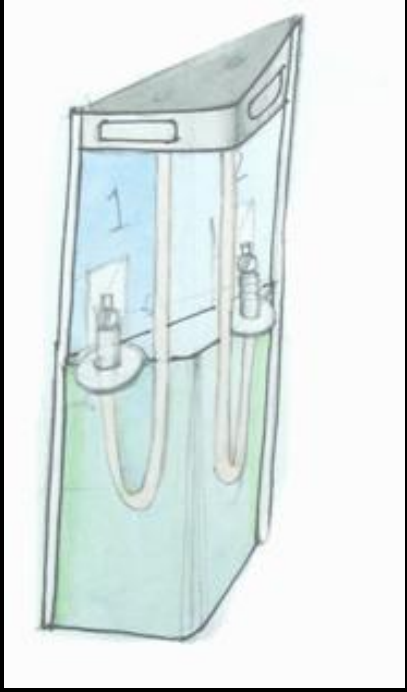
Idea 4: Hose retrieving



Flexible end



Modular concept

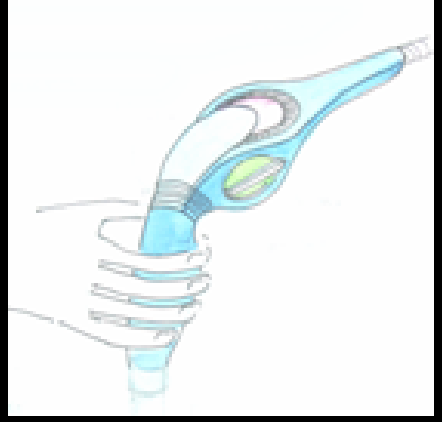


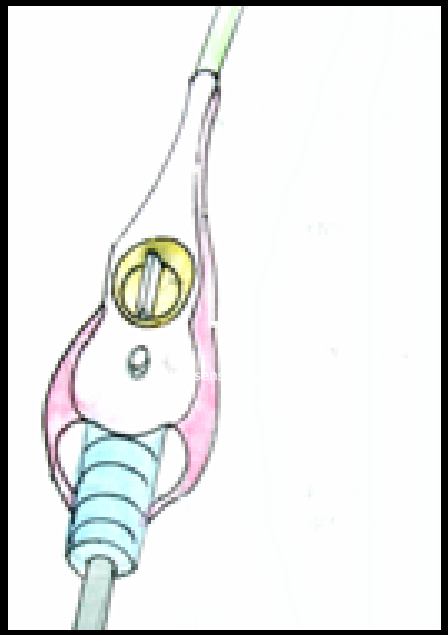
Triangular dual hose dispenser

Idea comparison :

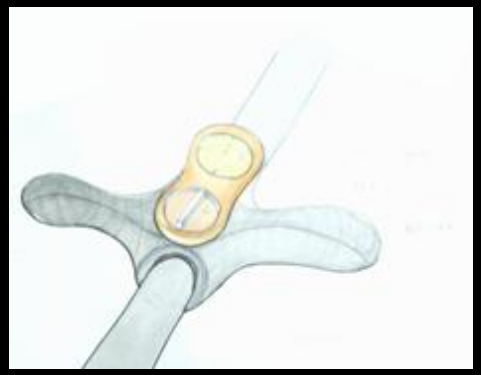
	Idea 1	Idea 2	Idea 3	Idea 4	Idea 5	Idea 6	Idea 7	Idea 8
Nozzle rest	6	6	7	7	7	7	8	8
Nozzle accessibility	7	6	8	6	7	6	7	7
Hose reachability	8	8	7	4	7	8	6	8
Display	7	7	4	7	4	7	6	6
Layouts	5	7	4	7	4	4	7	7
Operators Intervention	8	6	7	5	7	4	7	7
Total	41	40	37	36	35	36	41	43

Nozzle idea generations

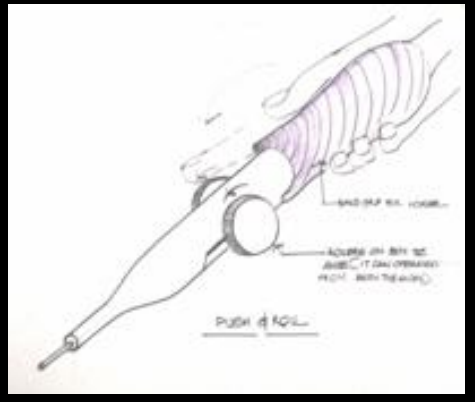


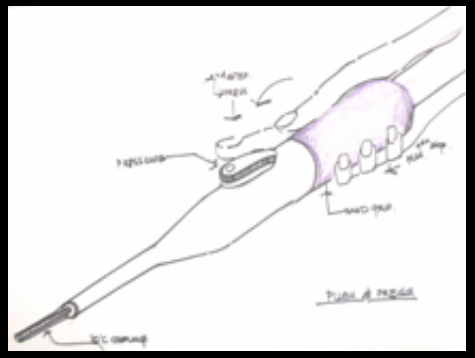


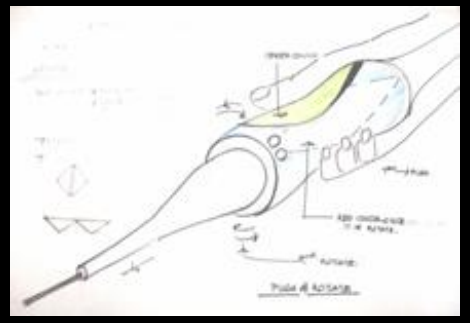
Idea cluster 1:- Nozzle with operating knob and emergency dispenser off button



Idea cluster 2:- Nozzle with operating knob and electronics display button







Idea cluster 3:-One hand operated nozzle with new technology.

Handle grip nozzle

Thumb operated nozzle

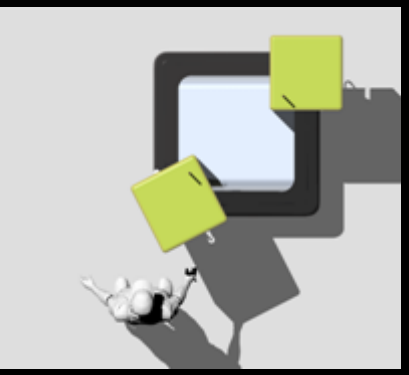
Technology :-

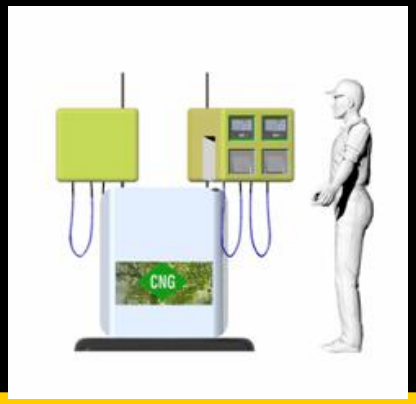
MFM sensor inside the dispenser

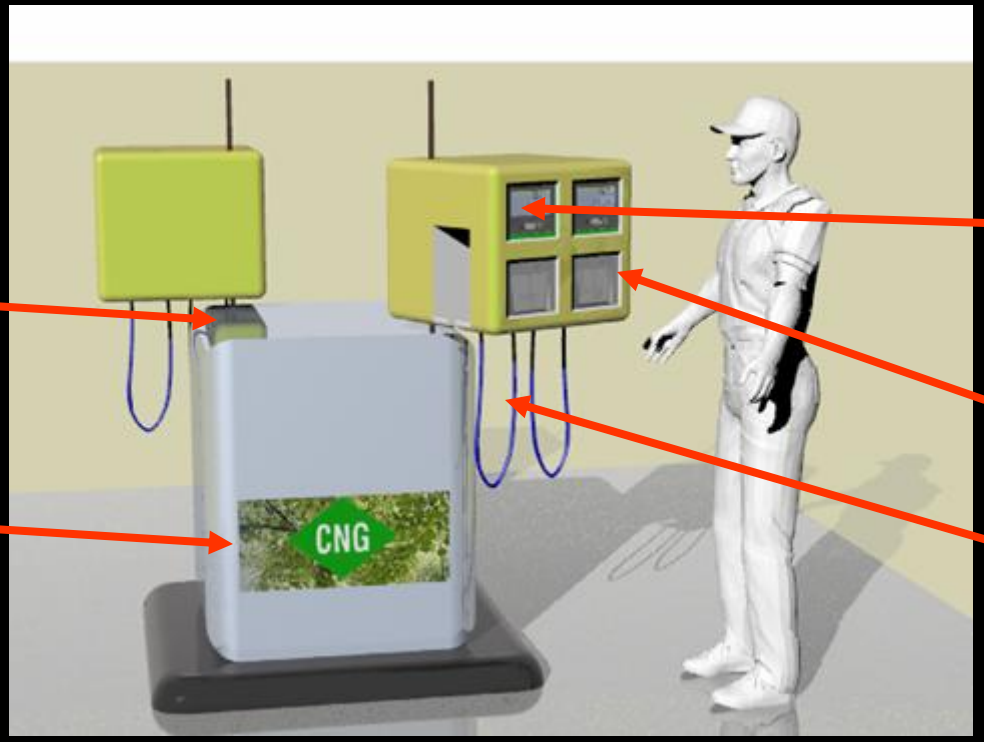
Long flexible nozzle

Single handle nozzle with knob operating system

Single handle nozzle with rotating knob for easy and one hand operation







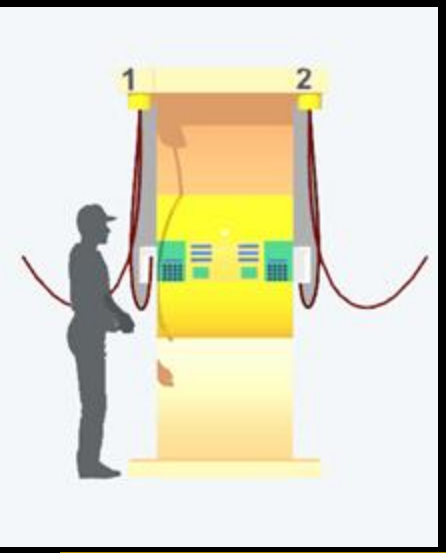
Idea 1:-

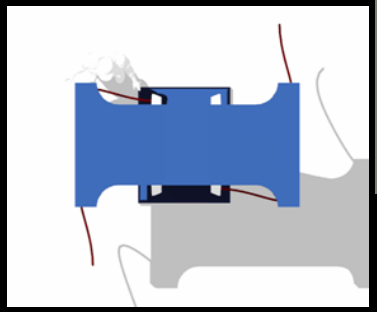
-The single dispenser with dual hose out box box with LCD display and credit display.
-The display and nozzle rest box can be oriented in any direction or it can be provided with the pivoted joint with the main lower panel . This will increase its feasibility.

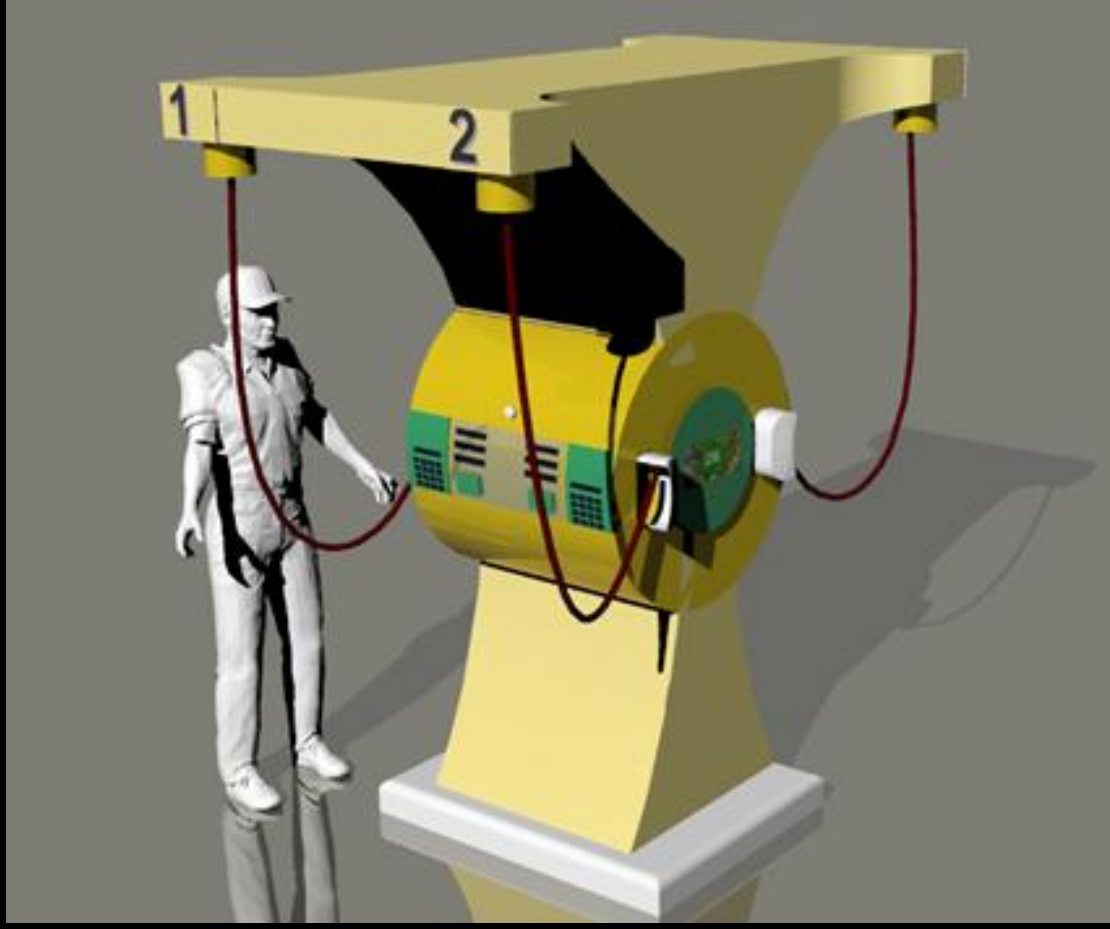
Disadvantage:-
The hose pipes coming from the lower panel obstruct the area surrounding the dispenser

IDEA 2

3d exploration of idea of single structure



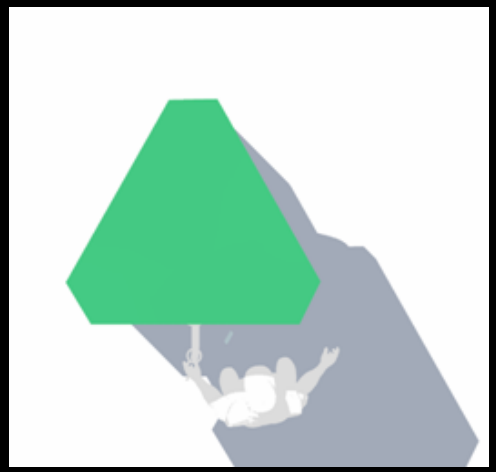




The self standing dispenser can be oriented in any direction which similar to other existing dispenser.

Disadvantages :-
-The self standing dispenser occupies lots of space.
-Also the hose pipe coming from roof top obstructs the surrounding area of the dispenser.

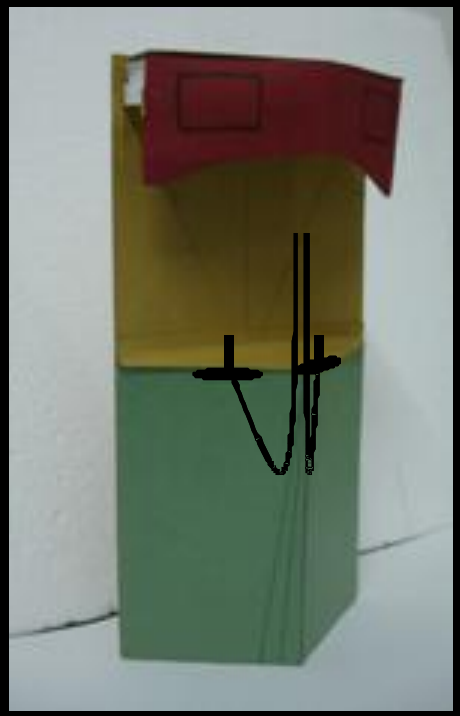
IDEA 3



There will be no side panels and all the services are provided on the front panel of the module.
The nozzle rest in the front panel provide easy and quick reachability by the operator.

Disadvantage:-
-The modules provided with single hose

IDEA 4



-The hose pipe coming from the roof provides maximum reachability

-The display on roof top unobstructed view .

-The nozzle rest in the front panel provide quick and better excess for the operator

-The main operator's interactions can be provided on the front panel for fewer operators intervention

-The side panels are not provided with the service hence it can be placed in series as perpendicular to the each other.

-This has maximum no of advantage towards the better CNG dispenser hence it is considered as a final concept.

Final concept variation 1:-

-Hose pipe are provided from the roof top

-The display panel are provided below the roof top for unobstructed visibility.

-Nozzle rest is provided on the vertical post

-Oriented both in land and island type

Final concept variation 2:-

-Hose pipe are provided from the roof top

-The display panel are hanging from the the roof top for unobstructed visibility.

-Upper panel consist of nozzle rest and printer and credit panel .

-The vertical column are used for supporting the structural roof.

-Nozzle boot is jetting out for quick and easy reach for the operator

Final concept variation 2:-

-The display of dispenser in lane type orientation cannot be viewed from the center.

-In cross filling the display cannot be view by the consumer due to its orientation.

Final concept variation 3:-

-Display on the vertical column provide better visibility for the consumer as well as operator .

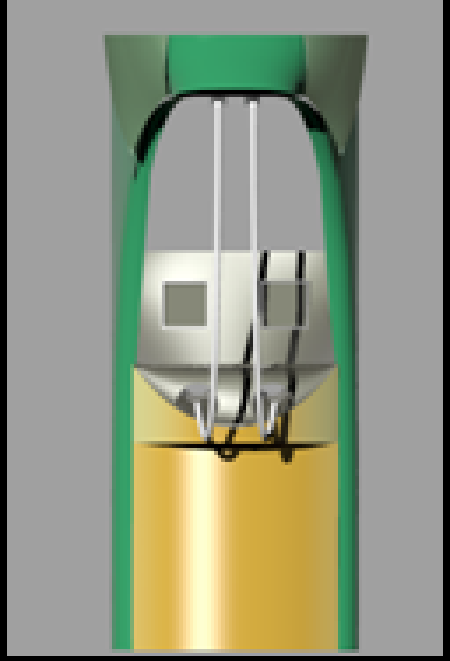
-The printer are also provided on vertical column for easy use.

-The pressure gauge is provided above the nozzle rest.

scale model Problems

-The display cannot be viewed from close distance.

-The vertical columns were too broad and the dispenser consume lot of space.



Final concept variation 3:-

-The nozzle rest and printer panel are provided on front panel for quick and easy service of the operator.
-The electronic display is place in the viewing angle of the operator
-The dispenser can be can be lend in lane as well as island type -
Nozzle rest and nozzle provided with sensor for preset the display panel

Hose automatic retrieval system

Hose pipe

Viewing the display

During filling the display is visible to the operator

During cross filling the operators has to move the hose pipe to view the display

Activity flow






Inferences drawn from Rig structure studies :-

-Provision in the nozzle boot for lifting the nozzle during filling

-Hose pipes does not wind with each when it is hose retrival system because it has short length

-Large LCD display is visible from all angles also the hose pipes are brought near to the dispenser

-The roof structure should be visually stable

-Single hand operated nozzle is becoming too obvious to operate which might cause accidents hence double operations with locking system should be provided

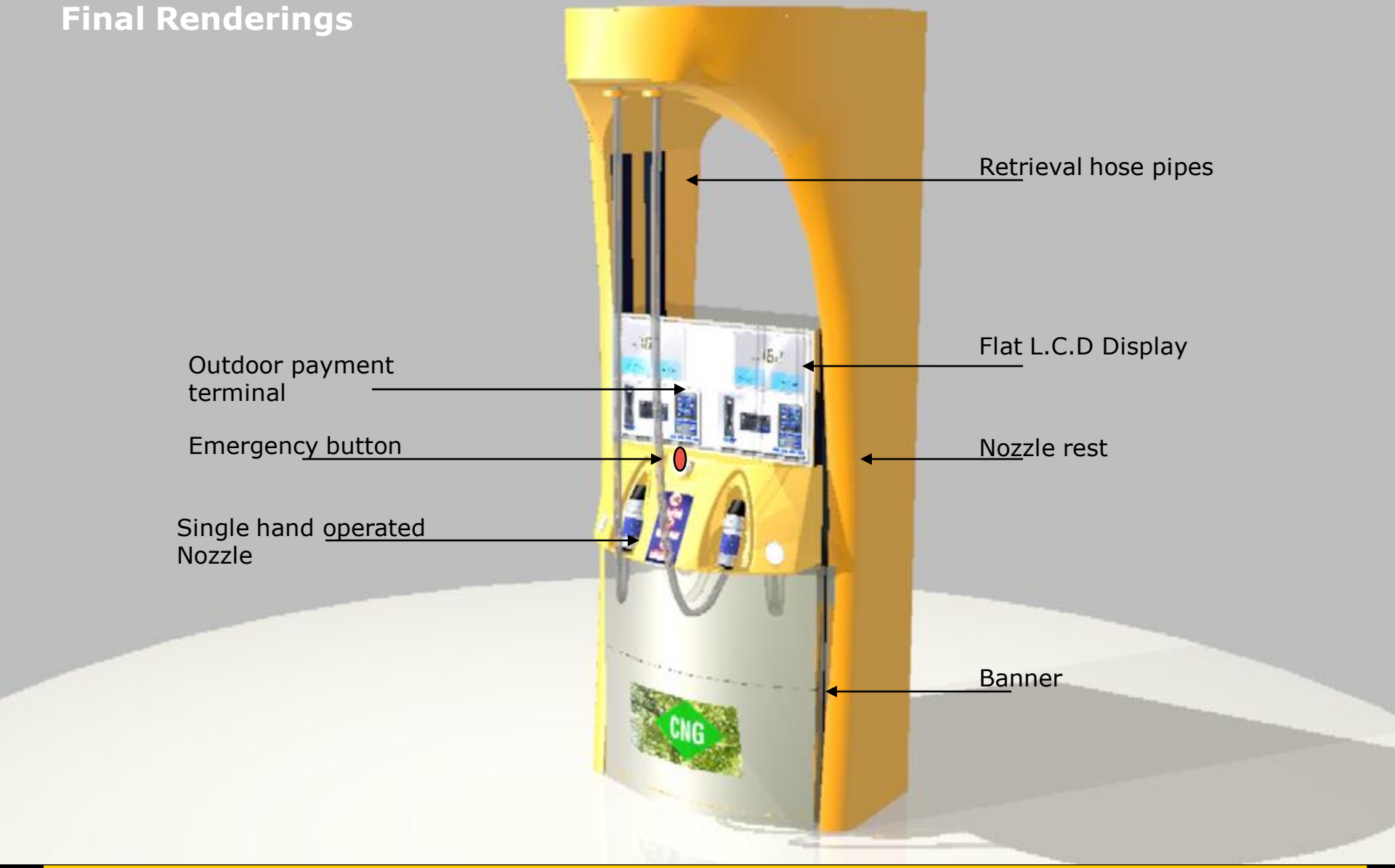
-Placing nozzle in auto-rickshaw inlets is difficult hence it should be provided with a proper flexible fitting end

-Emergency button should be directly approachable for quick cut off of the gas

-The pressure gauge should be provided along with the nozzle rest

Final product

Final Renderings

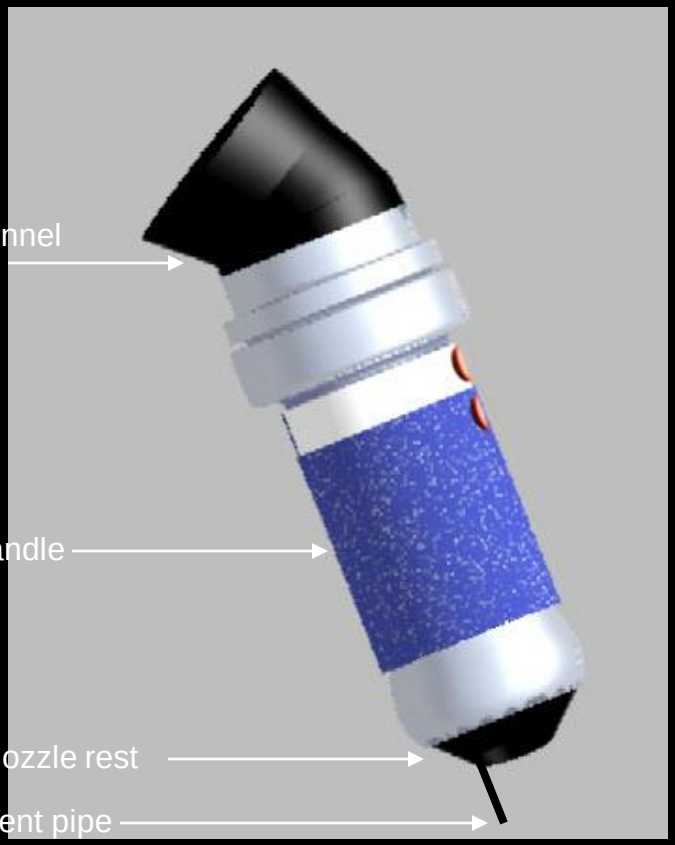


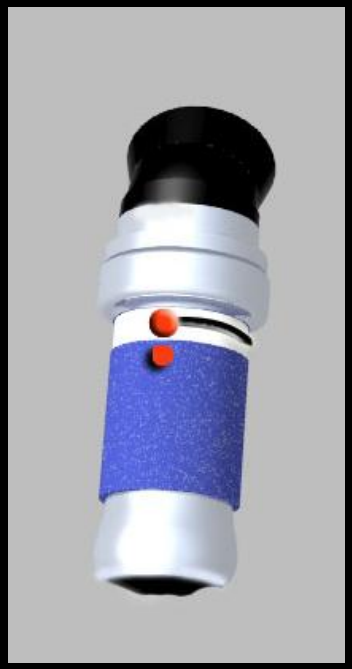
Final Renderings of nozzle rest

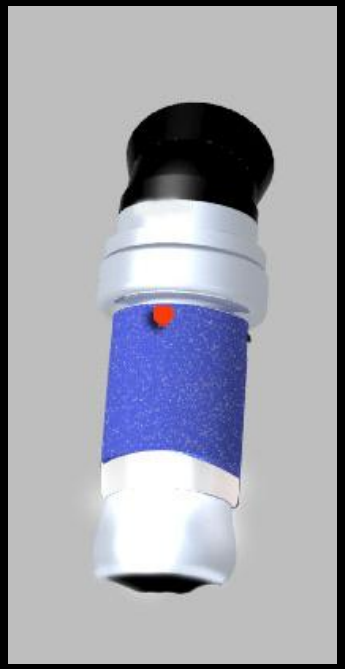
Warning signage

Digital pressure gauge

Final **Renderings** of nozzle rest







Dual operated nozzle :-

1st push –place the nozzle on the inlet

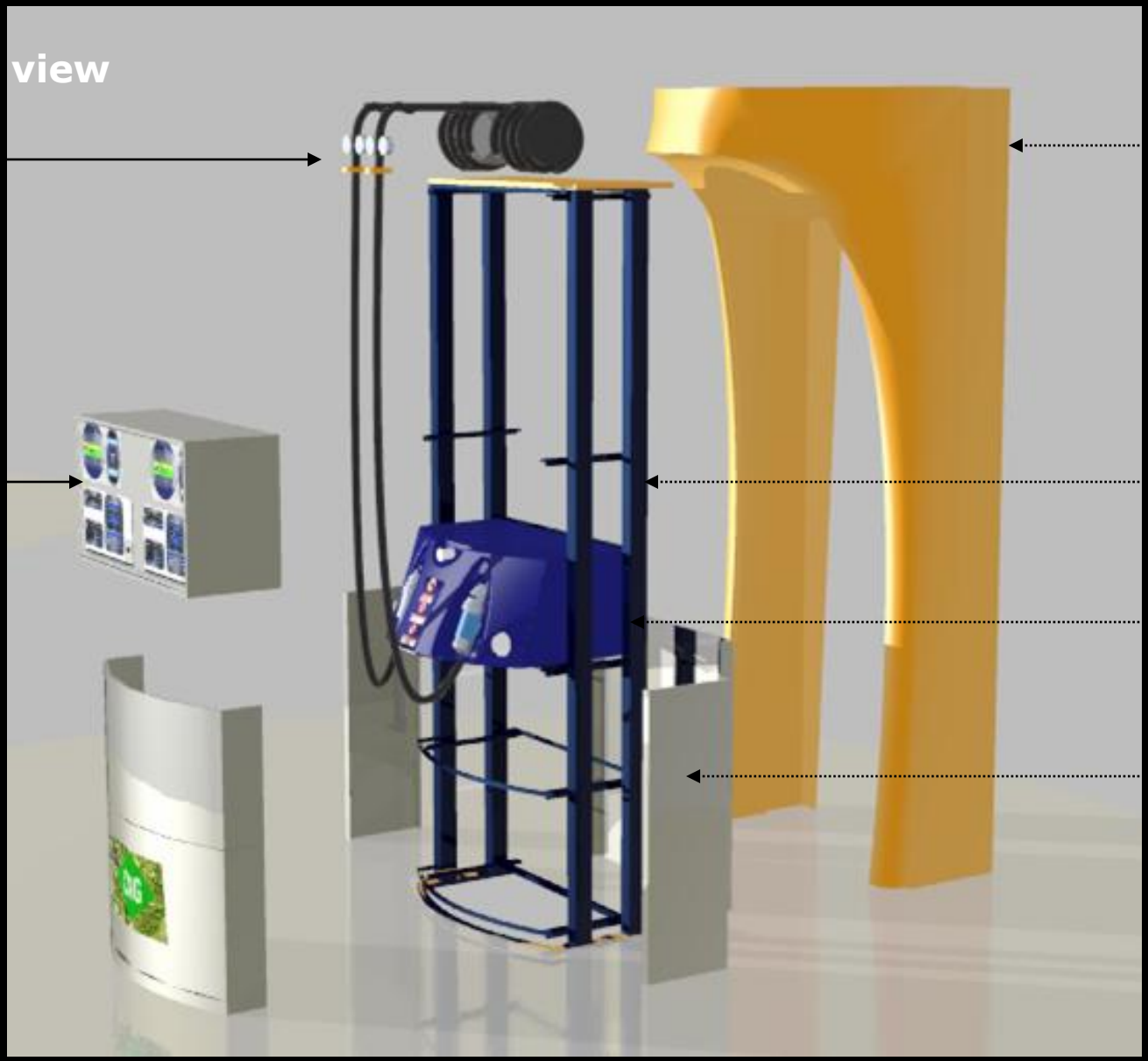
2nd push –open the nozzle to pass CNG

3rd rotation – open the dispenser by the MFM sensor in the dispenser.

Exploded view

Hose retrieval system

Explosive proof box



FRP

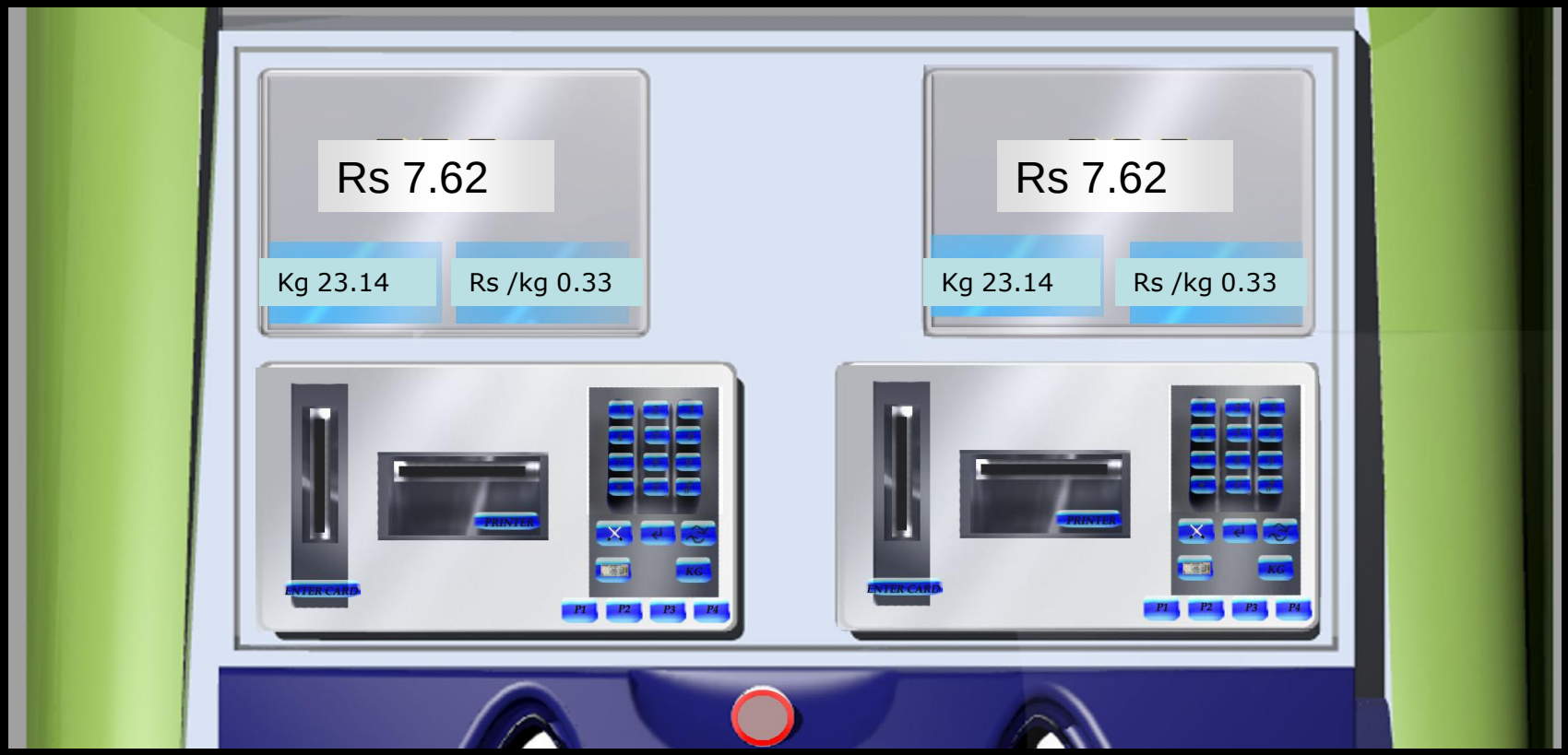
Ms frames structure

FRP

CRCA or stainless steel sheet

Layouts

Island layout


Rs 7.62
Kg 23.14
Rs /kg 0.33
Rs 7.62
Kg 23.14
Rs /kg 0.33
PRINTER
ENTER CARD
KG
P1
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PRINTER
ENTER CARD
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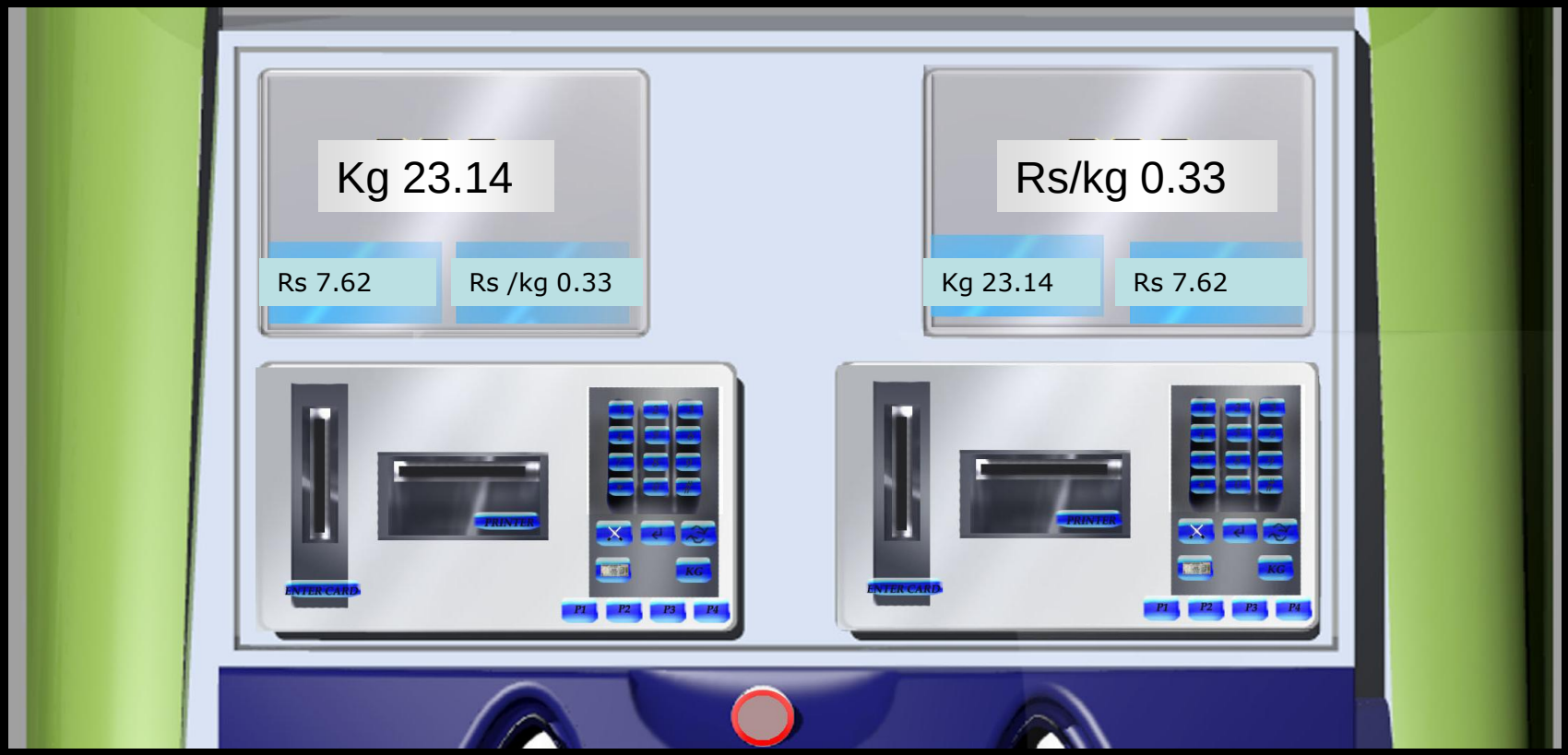
Kg 23.14
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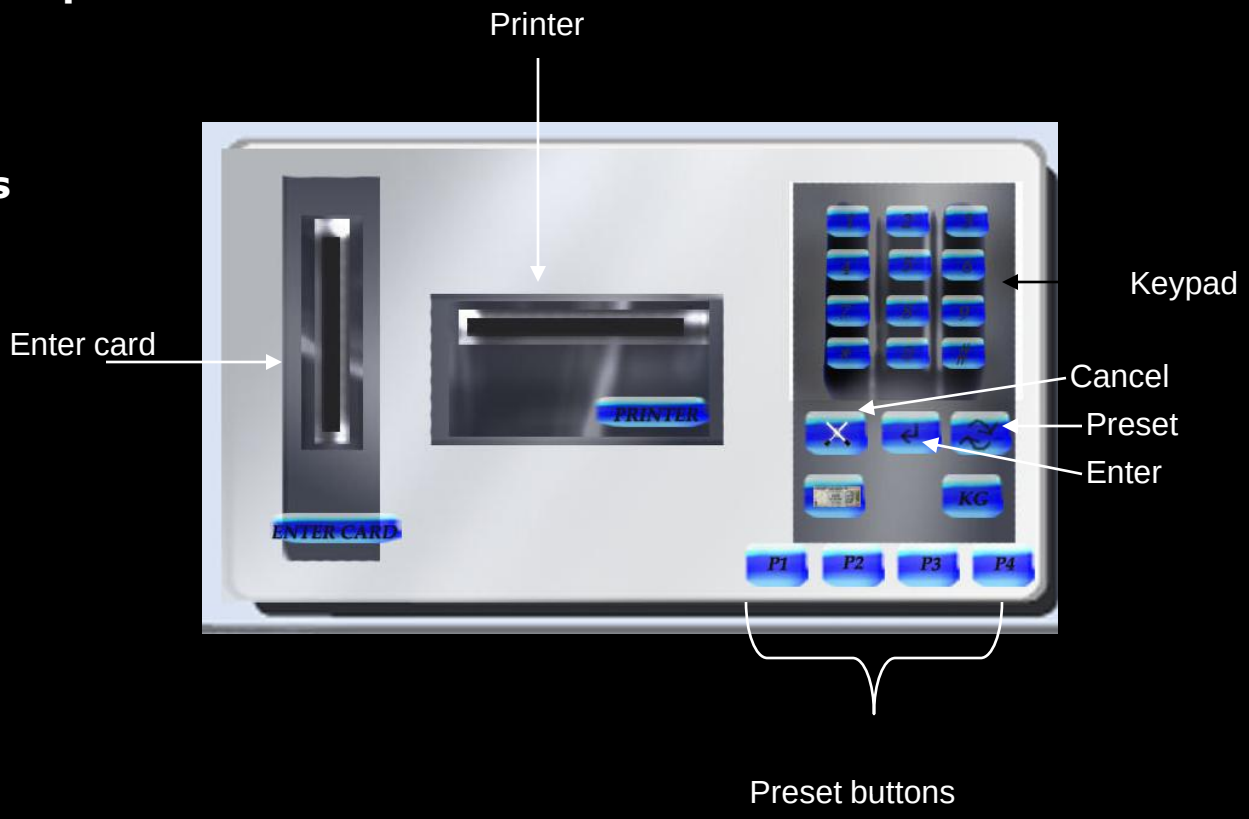
Rs 7.62
PRINTER
ENTER CARD
KG
P1
P2
P3
P4
PRINTER
ENTER CARD
KG
P1
P2
P3
P4

Outdoor payment terminal :-

1) **Enter card/swipe card**
2) **Printer**
3) **Keypad**
4) **Control keys**
5) **Preset keys**



Final Model

Features of CNG Dispenser

-Operators and consumer services are provided in the front panel for quick and easy CNG filling operations.

-It is a single self standing structure provided with the hose pipe jetting from the roof top for its maximum reachability to CNG inlet of the vehicle.

-The center location of the hose pipes allows the cross filling during more traffic congestions of vehicle.

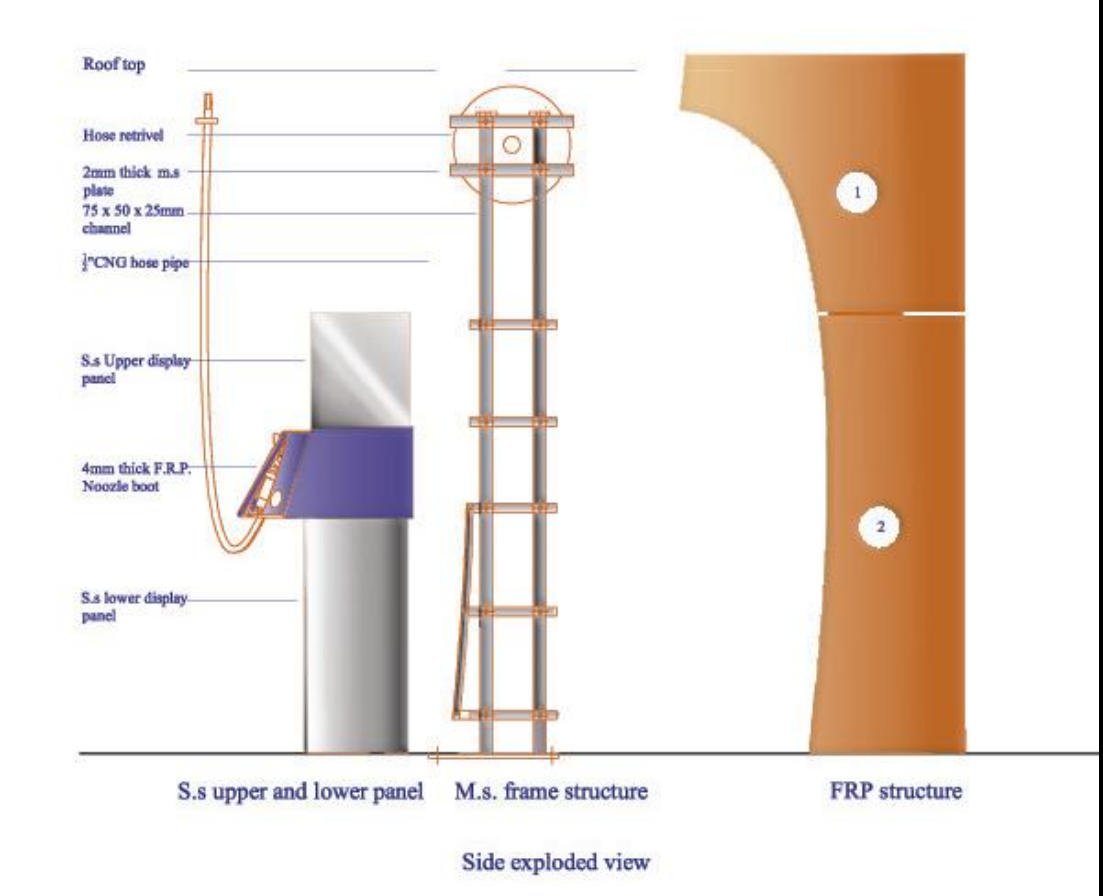
-The nozzle boot is placed of the front panel and hence ease for the operator.

-The flat multi utility display panel and outdoor payment terminal provides maximum visibility angle.

-For maintenance the lower panel is open able from front and the rear side.

-The self standing structure provides ample space for banners and advertising.

Manufacturing details:-



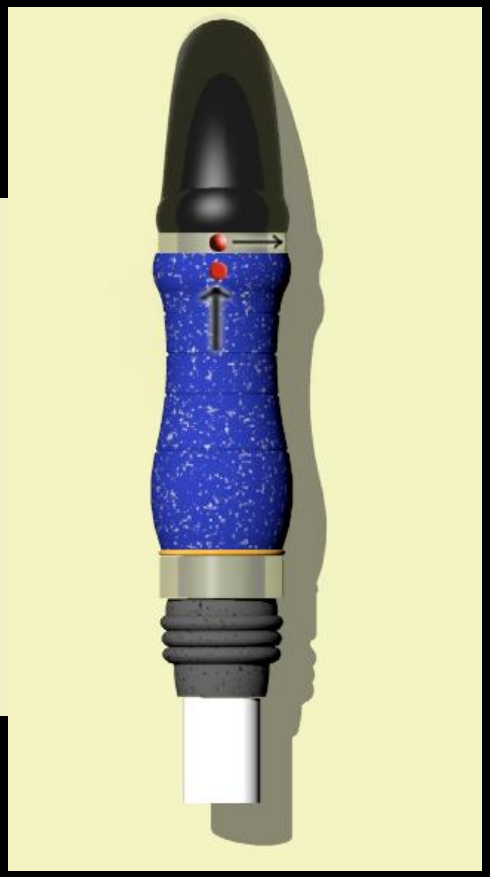
Line of assembly :-
1)Frame structure
2)FRP nozzle boot
3)RSC lower panel
4)Fire proof box of display panel
5)Roof structure lower part 1
6)Roof structure upper part 2

Material specification:-

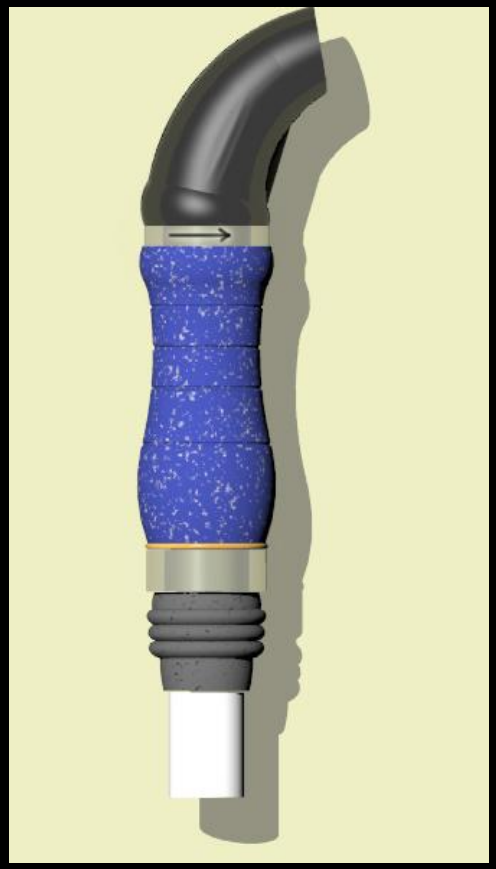
Main roof structure and nozzle boot - FRP
Lower panel - Rolled steel coil
Display panel - Fire proof box
Frame structure - M.S box pillars and m.s angles

Final Nozzle

View of Nozzle



Front View of Nozzle



Side view of nozzle

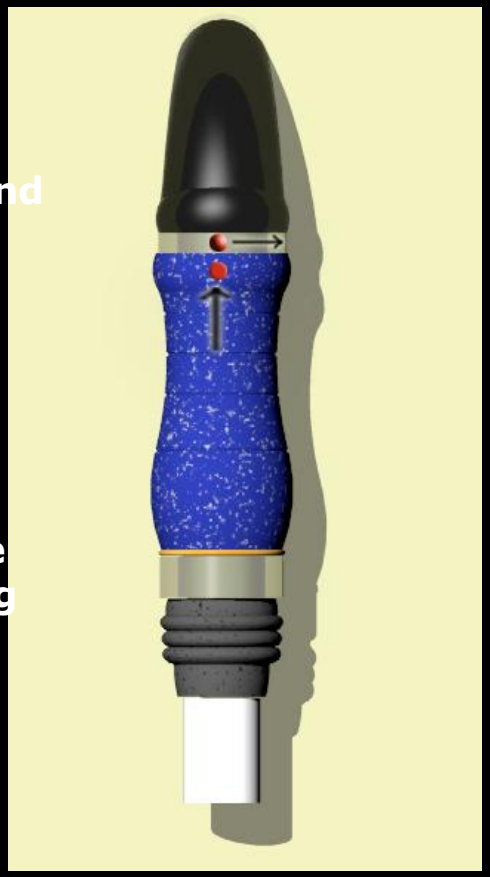
Final Nozzle

Features

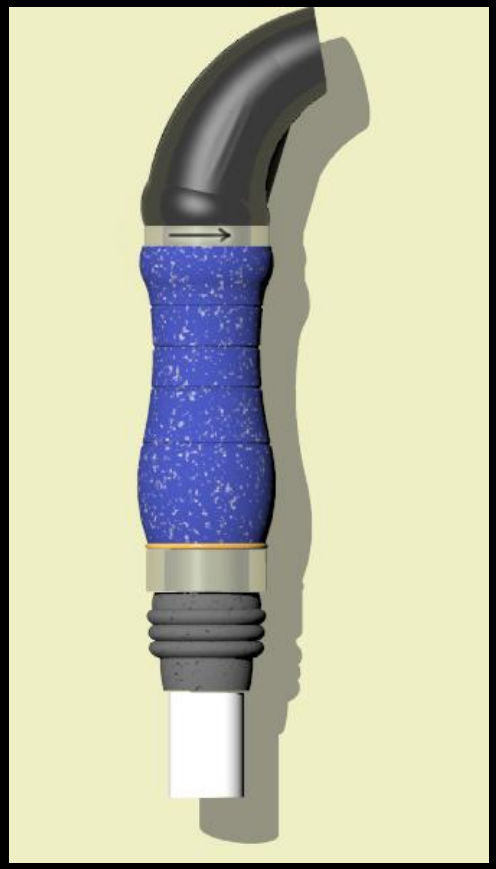
-The single hand operated nozzle and better reach of controls provides quick CNG filling operation for the operators.

-The nozzle is provided with comfortable handle grip.

-The funnel at the end of the nozzle helps in directing the quick coupling to the inlet of the vehicle.



Front View of Nozzle



Side view of nozzle

Fin