IDC School of Design
अभिकल्प विद्यालय

DEP 702

Design Project 2

-Project Report

Border Patrol Vehicle for BSF

Project Guide - **Prof. Nishant Sharma**
Dr. Vivek Kant

Submitted By

Manish Sharma
216390010

IIT Bombay

Declaration

I hereby declare that this written report represents my own idea in my own words, and where others, ideas or words have been included, I have mentioned the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also penal action from the source from which proper permission has not been taken, or improperly cited.

Manish Sharma
216390010
November 21, 2022

Approval sheet

The Mobility and Vehicle Design project report entitled "Border Patrol Vehicle for the BSF" by Manish sharma is approved in partial fulfillment of the requirement for Masters of Design degree in Mobility and Vehicle Design.

Guide :

Chairperson :

Internal Examiner :

External Examiner :

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I am immensely grateful to the faculties, my batchmates and friends at IDC for their suggestions and critique which helped me to successfully devlop this project.

Manish Sharma
November 21, 2022

Content

Introduction

The Border Security Force (BSF) is a border guarding force of the Government of India. Established on December 1, 1965, it is one of the Central Armed Police Forces. Its primary role is to guard India's international borders during peacetime and also prevent trans-border crime. Like all Central Armed Police Forces of India, the BSF is under the administrative control of the Ministry of Home Affairs. It is one of the many law enforcement agencies of India. With a strength of 240,000 personnel in 186 battalions, including women personnel, it is one of the world's largest border patrol forces.

BSF's role during peace time

1. To promote sense of security among the people living in the border areas. 2. To prevent trans-border crimes, unauthorized entry into or exit from the territory of India. 3. To prevent smuggling and any other illegal activities on the Border. 4. Anti-infiltration duties. 5. To collect trans-border intelligence.

BSF's role during war time

1. Holding ground in assigned sectors. 2. Limited aggressive action against Central Armed Police or irregular forces of enemy. 3. Maintenance of Law and Order in enemy territory administered under the Army's control. 4. Guarding of Prisoners of War camps. 5. Acting as guides to the Army in border areas. 6. Assistance in control of refugees. 7. Provision of escorts. 8. Performing special tasks connected with intelligences including raids.

Firstly, I tried to understand **what is patrolling?**

Different types of unexpected situations may occur at the border- peacetime, less than the wartime, wartime. To manage the situations arising at borders effectively, A group of people mainly the military or the police are under the duty to keep a watch over the area at regular intervals of time to corroborate peace and safety.

The army, navy, and air force also get engaged in border management during wartime.

Various instructions and protocols are issued by Intelligence agencies to deal with counterintelligence and counter-insurgency.

India follows the principle of 'One Border, One Border-Guardian force'. In the context of this principle, the burden of India- Pakistan, and India- Bangladesh border is under the hands of Border Security Force (BSF), Assam Rifles (AR) for the India- Myanmar border, and Indo- Tibetan border police for India- China border. Nepal and Bhutan's border is overlooked by Sahsastra Seema Bal (SSB).

The progressive technology acts as a helping hand to make sure that the situation is completely safe. Different creative electronic pieces of equipment are designed such as- Thermal Imagers, Night vision devices, ground sensors, battlefield radars, and telescopes are used by force for better supervision over the contaminated areas.

Out of more than 15,106.7 kms of border shared with the neighbouring countries which offer various challenges to the BSF, the state of Rajasthan shares its western side with Pakistan which is approximately 1037km in length, passing through 5 districts of Rajasthan, Jaisalmer which is the largest district of Rajasthan also presents the most challenging landscape of the thar desert region. To find out these exact challenges and experience them first hand I went to this region to conduct my field research and tried to understand how they affect the job of patrolling BSF carries out in these tough terrains.

Thar Desert

The **Thar Desert**, also known as **the Great Indian Desert**, is an arid region in the north-western part of the Indian subcontinent that covers an area of 200,000 km2 (77,000 sq mi) and forms a natural boundary between India and Pakistan. It is the world's 20th-largest desert, and the world's 9th-largest hot subtropical desert.

About 85% of the Thar Desert is in India, and about 15% is in Pakistan. The Thar Desert is about 4.56% of the total geographical area of India. More than 60% of the desert lies in the Indian state of Rajasthan; the portion in India also extends into Gujarat, Punjab, and Haryana. The portion in Pakistan extends into the provinces of Sindh and Punjab.

Geography

The northeastern part of the Thar Desert lies between the Aravalli Hills. The desert stretches to Punjab and Haryana in the north, to the Great Rann of Kutch along the coast, and to the alluvial plains of the Indus River in the west and northwest. Much of the desert area is covered by huge, **shifting sand dunes**. The sand is highly mobile due to the strong winds that rise each year before the onset of the monsoon.

Climate

The climate is arid and subtropical. Average temperature varies with season, and extremes can range from near-freezing in the winter to more than 50° C in the summer months. Average annual rainfall ranges from 100 to 500 mm, and occurs during the short July-to-September southwest monsoon.
The soil of the Thar Desert remains dry for much of the year, so it is prone to wind erosion. High-velocity winds blow soil from the desert, depositing some of it on neighboring fertile lands, and causing sand dunes within the desert to shift.

Fauna

Some wildlife species that are fast vanishing in other parts of India are found in the desert in large numbers, including the blackbuck, chinkara etc. This may be partly because they are well adapted to this environment: they are smaller than similar animals that live in other environments, and they are mainly nocturnal. It may also be because grasslands in this region have not been transformed into cropland as fast as in other regions

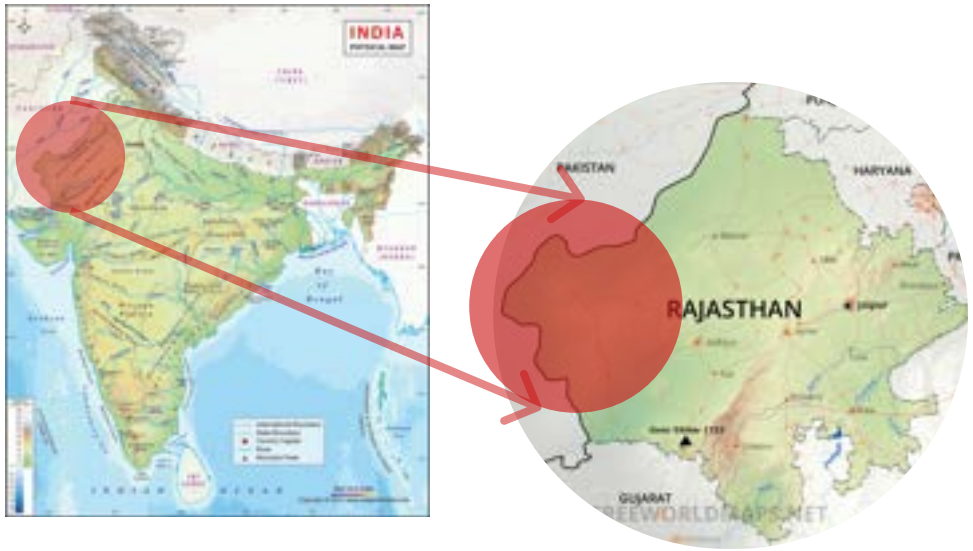
Flora

The natural vegetation of this dry area is classified as northwestern thorn scrub forest occurring in small clumps scattered more or less openly. Density and size of patches increase from west to east following the increase in rainfall. The natural vegetation of the Thar Desert is composed of these tree, shrub, and herb species.

People

The Thar people are the natives of the area. The Thar Desert is the most widely populated desert in the world, with a population density of 83 people per km2. The main occupations of the inhabitants are agriculture and animal husbandry. A colourful culture, rich in tradition, prevails in this desert.
In the true desert areas, the only sources of water for animals or humans are small, scattered ponds - some that are natural (tobas) and some that are human-made (johads). The persistence of water scarcity heavily influences life in all areas of the Thar, prompting many inhabitants to adopt a nomadic lifestyle.

Location


INDIA
PAKISTAN
HARYANA
RAJASTHAN
GUJARAT


609
INDIA


PAKISTAN
BIKANER
Jaisalmer
Pokaran
JODHPUR
PAKISTAN
BARMER
JAISALMER
DISTRICT

Methodology

The aim of this research was to understand the vehicles used by the BSF Rajasthan Frontier for border patrolling, from the primary research done online I got to understand a few problems such as climatic challenges, ever changing geography due to shifting sand dunes but to verify this information and get more of it I planned a visit to Jaisalmer and further on to the INDO-PAK border post No.609 locally known as Bawliyan Border.

Bawliyaan Border which is also being developed as a tourist attraction for Indian tourists (foreign nationals are not allowed to go beyond Jaisalmer). I planned to interview the BSF personnel I could meet on the border post as well as officers present in the BSF units present near the border. I got permission to visit the 173 BF BSF campus which is about 50-55 km from the border.

I started my field trip from Jaisalmer from where I booked a taxi to visit Tanot Mata temple which is under the supervision of BSF and here I got the permission to go ahead to the border post. Took another 20 kms to reach the post. I spent around one to one and half hour there to observe the various details about the post. There were 2 BSF soldiers present on the post, one on the watch tower, and one at the make shift office who was Mr. Yudhveer Singh, also an assistant was present, initially I tried to stay around and observe and later on had an informal chat with the soldier.

From BP609 I went to 173BF BSF situated near Ramgarh which is 68kms from Jaisalmer towards the border. There as planned I met the Deputy commandant Mr. M K Chaudhary who gave his thoughts on the topic and arranged meetings with the people responsible for motor transport in their battalion, that included A deputy commandant Mr. Niteshwar Kumar and 3 drivers namely Mr. Shyam Dev, Mr. Manoj Kumar and Mr. Pradeep Kumar who had first-hand experience of driving patrolling vehicles, they shared their thoughts and talked about the problems that they face while they do the exercise.

Along with that I got the chance to meet the Commandant Mr. Ashwini Kumar who talked about his perspective on problems faced by them during patrolling from his experience over the years. Apart from that I got to interact with 5-6 other personnel present on the campus and tried to understand day to day struggles the ecology presents in front of them.
I tried to keep my questions brief and tried to get most information in form of informal interview, I didn't go in with a set questionnaire but a broad outline of topics such as what is the daily routine, what are the challenges faced by them during patrolling, what kind of vehicles are being used, what are their expectations from a patrolling vehicle and any suggestions for the future vehicles.

Results

With the help of multiple interviews and interactions with different BSF personnel on the field I found out about the regular day of a soldier, how they plan their day, how the patrolling is done and what are the nessesary equipments they have to carry. Along with that the day to day difficulties they face and how they overcome them, how is patrolling on foot different from doing it on a camel and how does they tackle with the incidents of infeltration, smuggling etc.

During my field trip it was raining heavily in the region which was quite unusual and brought in some short term new challenges for the BSF, although weather is the most challenging aspect of the region but I could also list out multiple inferences and insights. i have divided these into different catogeries and tried to explain then individually.

1. Topography and its effects

The Weather conditions in the region are one of the harshest climates faced anywhere in India, the summers get as hot as 58 to 60 degrees Celsius, whereas winter nights are chilling at 0 degrees. Spending long hours on the border needs a tough skin and the personnel needs to adapt to the conditions. Along with the hot sun the sand storms present a major challenge in the task, it makes hard for the soldiers to see and move, camels however are adapted to such storms and can reach back to the post even in such weather. The water is the single most important commodity while the patrolling is being carried out, soldiers have to plan their

patrolling in such a way that they can come back to the post before the water get over. Another aspect which is particular to this region only is the shifting sand dunes, during windy climate the sand dunes change their place rapidly and make It hard for the soldiers to patrol along the fencing, they have to clean the fencing also sometimes if the sand is accumulated over it, roads also get covered in the sand and needed to be cleaned and maintained.

2. Fencing Situation

During patrolling the watch is supposed to be kept on the both sides of the fencing as crossing over from Pakistan is equally likely to someone crossing over into Pakistan, to tackle such challenge in a better way a wired fencing was build after 1970's towards Indian side of LOC at a distance of 150 meters from the actual line of control. The fencing has electric current running through at night so it is highly unlikely for someone to touch the fencing, during day time the current is stopped as there are lots to animals which can unknowingly get near the fencing and die due to electric shock. For day time to avoid any one from tempering the fencing there are glass bottles tied to the wires, if anyone tries to touch the fencing the bottles make sound which acts as an alert to the patrolling personnel. There are high light posts at a distance of every 50 meters which throw strong light beams on the both sides of fencing, along with the lights there are CCTV cameras installed on each post to detect any movement. The border road association has built a road along the fencing i.e., 50 to 200 meters inside the fencing for quick movement of military vehicles, although there are some regions where it is impossible to construct roads, however the attempt is to make the whole border accessible with roads. Sometimes due to sand storms if the patrolling party is lost in the desert, they start moving towards west so that they reach the nearest fencing.

3. Personal Experience from different BSF personnel

The main moto of patrolling is domination on the ground with eye on the enemy, patrolling is always done in a straight line along the fencing. Every solider has to do his 12 hours of duty in a day, which is divided into 2 shifts of 6 hours each. The 6 hours at night are assigned to do the patrolling duty. Most of the patrolling is done on the foot only. No single person is assigned the duty of patrolling rather it is always done in at least a pair of 2 soldiers. Foot patrolling pugmarks are later removed with use of camels or sometimes tractors. The BSF maintains almost 1000 camels till date as well but only trained personnel are allowed to patrol on camels, they are expensive to maintain, train and transport, camels are very sensitive animal and a little carelessness might result in the death of the animal. Two soldiers and their kitbag weight around 200kgs but a camel is capable of carrying load of more than 500 kgs. It can survive without water for days and their feet

are evolved in a manner that they can walk on the sand effortlessly. A Border post requires 3 to 4 camels for patrolling, camels also patrol in a straight line one after other. Although camels are effective in this region there could be better ways to patrol the border.

4. Existing Vehicles

Apart from patrolling on foot and camels there are other vehicles as well which are used by BSF now for tacking any emergency situation better as well as occasional patrolling by senior officers. The Maruti gypsy was the go-to vehicle for the BSF to move around in the desert for longer distances, gypsy being a 4X4 vehicle running on patrol was easy to maintain for the soldiers. It was a low cost, light weight vehicle with a small turning radius, due to its light weight it was also easy to rescue if got stuck in the sand, the wheels were bigger for the vehicle and the soldiers were trained to disassemble and reassemble the vehicle in less than a minute to cross a heavy obstacle, how ever with the introduction of BS6 norms by the government, the use of BS4 vehicles is prohibited to be used by the BSF.

There are newer 4X4 alternatives to gypsy such as TATA Xenon, Bolero Camper, Scorpio etc but none can come close to the gypsy as they are either heavy or have low ground clearance. Getting the Xenon cleaned up is really difficult the underbody and parts of engine are hard to access. Although gypsy too missed on features such as Airconditioning which could be helpful in such harsh weather and for any vehicle to be successful in sand the wheels need to be big and wide.

5. Major challenges faced with existing vehicles

The major problems faced with the existing vehicle are multiple, heavy vehicles get stuck in the sand easily as the hot sand gets loose and makes it really hard for the soldiers to move, although there are a few makeshift techniques such as using stones or shrubs thrown under the tires to give them traction or the sand is removed manually and the vehicle is pushed. Also due to sand storm the sand gets into the vehicle radiators and intakes which leads to affect the whole engine of the vehicle. With sand everywhere its highly likely that the intakes get chocked up, it makes the maintenance hard for the users. The speed of patrolling vehicle should be around 40 to 60 kmph which results in dust getting into the cabin if the cabin is not properly insulated and in turn marks the occupants uncomfortable if there is no air conditioning. 4X4 vehicles also are sometimes unable to climb high sand dunes and make it hard for the soldiers to move quickly from one place to another.

6. Sand Scooters

In 2015, the BSG introduced 2 sand scooters which are very useful during night also for strict vigilance as its long beam of

light will enable jawans to keep a keen watch on the borders. Border Security Force has deployed "sand scooters", that run smoothly on sand dunes, to step up vigil in the Jaisalmer and Barmer sector along the Border. Presently BSF using scooters Polaris range of vehicles – Ranger crew 800 (6 seater) and Model RZR 4 – 900 (4 seater). Each of these scooter cost BSF 36 lakhs, which in turn is very expensive as a Gypsy was priced around 5lakhs at that time, the scooters had a high maintenance cost as they were imported and their parts also needed to be imported. Low fuel efficiency and lack of service were also major factors of concern, along with that due to its diesel engine they were found unsuitable owing to their loud engine sound which doesn't help in patrolling.

The wheels of these scooters were wide but small resulting in getting stuck in the sand, storage space also is less and there is no protection from sandstorms or heat from the sun. "If sand scooters could be made cheaper in the country it self keeping in mind the needs of BSF it would be a great initiative," said the officer.

7. Suggestions and Expectations

In simple words "A simple and powerful Vehicle is required". Getting more into understanding what is simple and powerful multiple suggestions were provided by the users. Firstly, a Vehicle with maximum torque is required which could climb up sand dunes as steep as 45 degrees, the vehicle should protect the user from sand storms and heat from above, also there must by armoury mounting points available to keep the weapons up and ready to fire.

Additional storage space is required to keep the important equipment's such as binoculars, water containers, radio transmitters, etc. Suggestions such as using solar panel on the roof to power the vehicle were also received, electric vehicles batteries might get heated up due to temperature outside hence proper insulation must be provided to keep them cool, along with that the tires can be filled with light gases such as nitrogen to run smoothly on sand. Apart from vehicles a soldier suggested to provide them with special shoes so that the feet don't pain after 6-hour long shift of patrolling is over.

A vehicle deployed at the border for patrolling is expected to have a certain feature such as proper suspension with long travel to move on sandy tracks. A seating capacity of up to 5 people is preferred with additional storage to keep their kits and the tires shall provide maximum traction, maximum surface area should touch the surface, of achieve that currently they keep the tire pressure at 50 % so that tires run flatter providing maximum grip. Also, to get the grip tires with big treads needs to be used specially designed for off-roading. Movement in emergency situation is necessary to be quick and its hard to cover long distance fast on foot or on camel hence a quick response vehicle is required.

8. Additional information

All the Light poles installed on the fencing have CCTV camera with night vision to capture any movement on the border, if any movement is detected on camera, then the patrolling personnel has to rush to the spot immediately and also inform the sub station about the same. If a person is seen walking towards the fencing, they are asked three times to stop moving or else are shot down immediately. Border fencing is checked regularly to see if there is no tempering is done along with that officers from both India and Pakistan conduct joint exercise to evaluate the condition of border pillars every 3 months, they exchange notes and suggest necessary maintenance, although there is no fencing on the Pakistan side of LOC. Villagers near the border have relatives living across the border, special attention is paid so no infiltration takes place in such areas. There have been incidents in the past where BSF has discovered tunnels opening in the middle of villages.

Pictures From Field Visit

With State transport hustle i reached jaisalmer

Enroute Tanot Mata & Bawliyan border

Tanot Mata Temple Maintained by BSF

BP609-Bawliyan border Main Entrance

Pictures From Field Visit

BP609 - During Mansoon

Road on the Border post

Looking towards Pakistan

Light Post and Fencing from a distance

Pictures From Field Visit

View from the watch tower

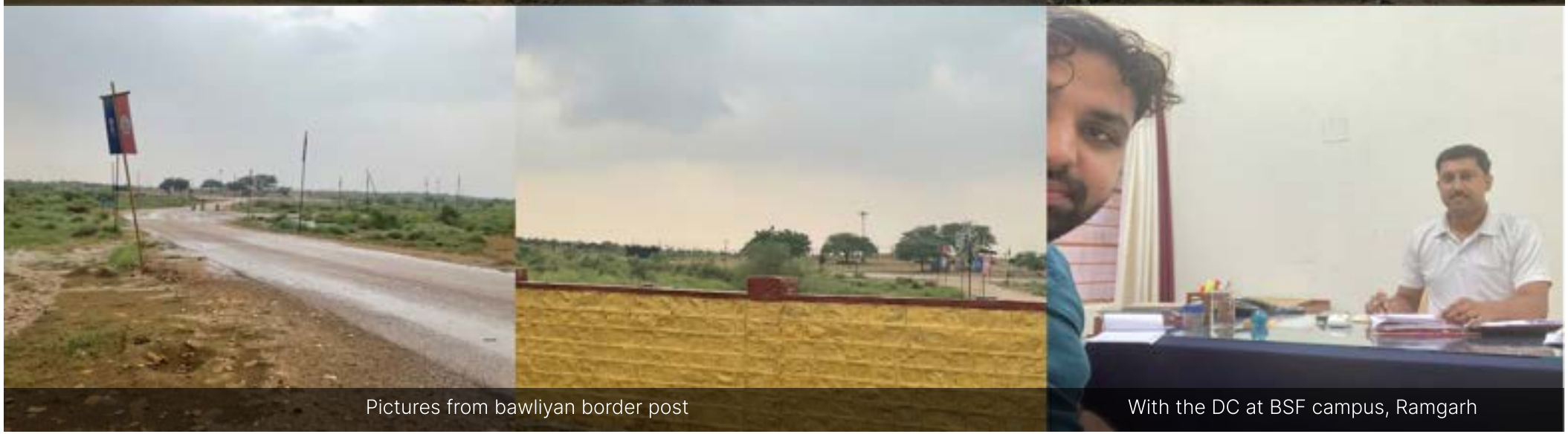
Sand Dunes in some regions

Post and nearby area

View from the watch tower

Pictures From Field Visit

Pictures from bawliyan border post



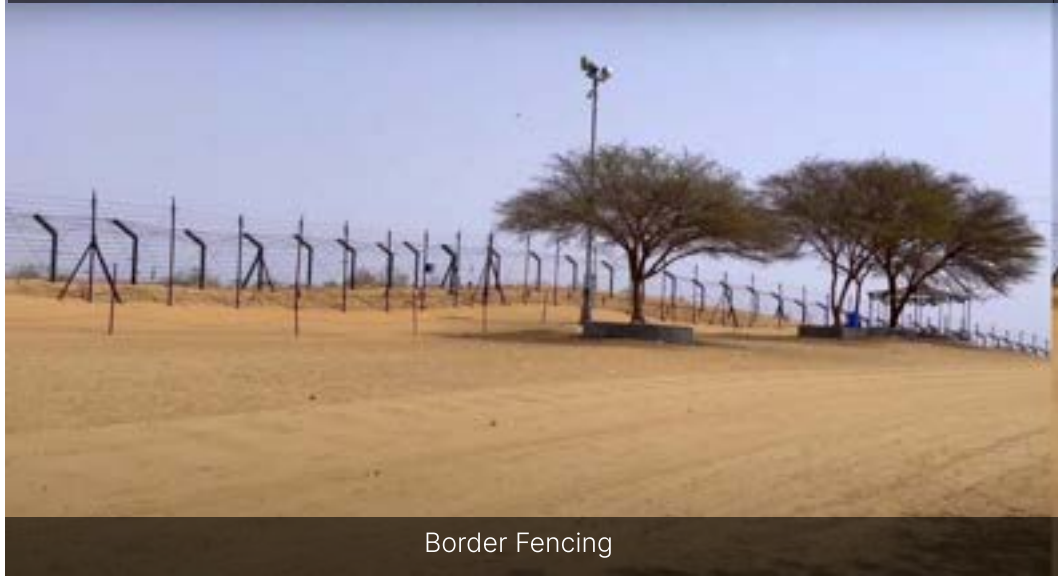
Pictures from bawliyan border post

With the DC at BSF campus, Ramgarh

Pictures From Other Sources

Border Piller 609

Road to the fencing



Border Fencing

Gate to the Zero Point LOC

Pictures From Other Sources

Border Piller 609 board

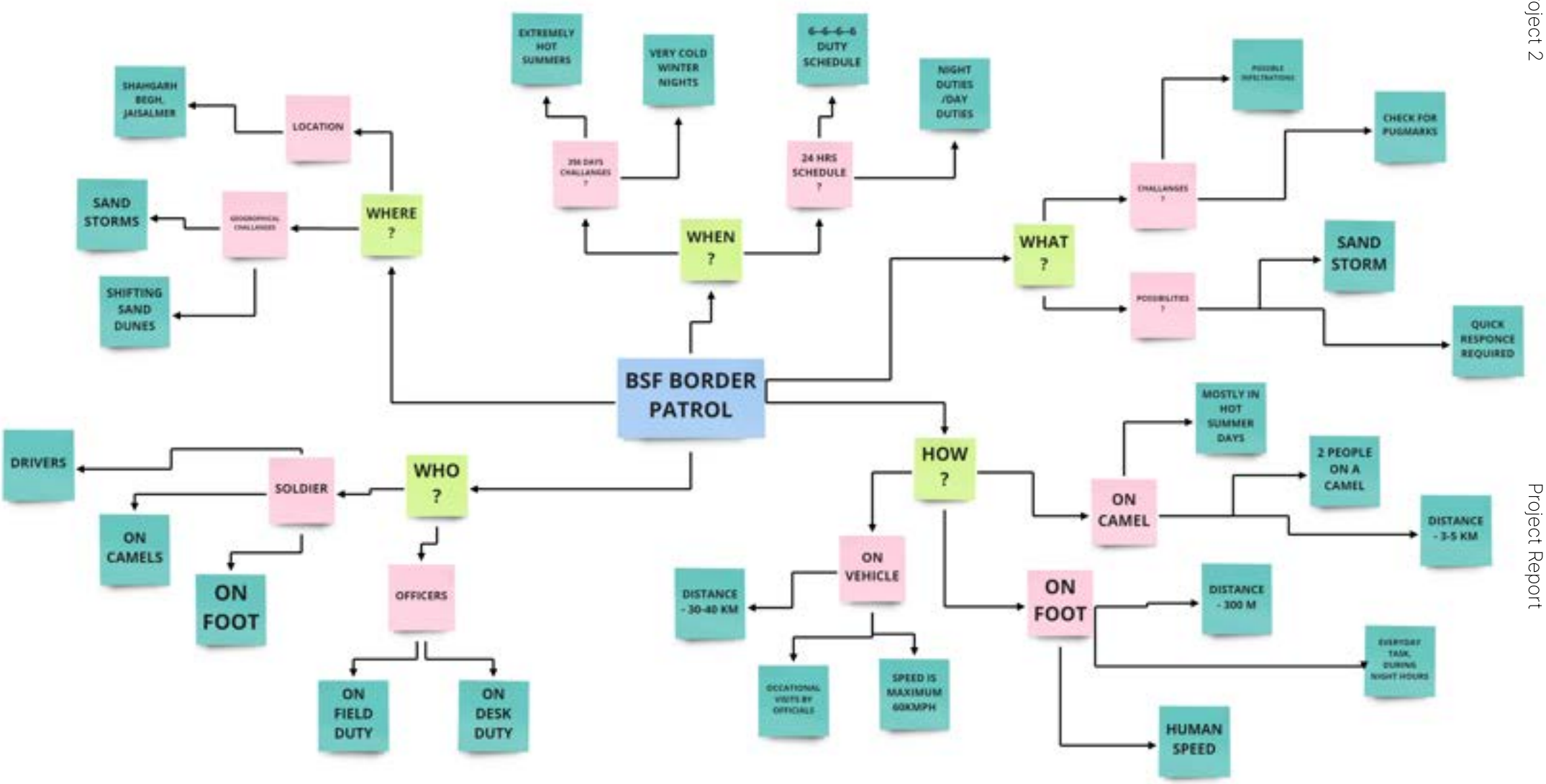
Indo-pak border gate

Watch tower near the fencing

Gate to the Zero Point LOC

Mind Map

A Mind Map was created to help in understanding each and every scenario in a much more deeper sense and identify gaps in the process.



Insights

Going over all the results and recordings from the field study we have tried to gather as many as possible insights to better understand the problem at hand. Insights help us to understand and measure the magnitude of the situation and analyse which problem is more important then the other.

Has a small turning radius

Wheels are big and wide

Big GUDDI tires are successful in sand

Maximum surface area of tire should touch the surface

Air pressure is kept at less than 50% for maximum traction in the sand

Maximum torque is required.

Additional storage space for keeping important equipment's

Old Thar, Isuzu Dmax, Bolero camper are also "good vehicles"

Air conditioning was missing from the gypsy

Tata Xenon has less ground clearance

Sand gets light in high temperature

Heavy vehicle gets stuck easily in loose sand

Maintenance becomes hard

The sand scooter costed 36 lakhs per vehicle.

Sand scooters were found to be unsuitable owing to their loud engine sound.

High maintenance cost, low fuel efficiency and lack of service centers were also a major factor of concern

"We could buy a tractor for 10 lakhs than buying a ATV for 36 which our jawaans cant repair"

Sand scooter parts need to be imported

Air intake system (radiator) chocks up easily

BSF jawaans are trained so they can disassemble and reassemble a gypsy in under a minute. Presented it in Republic Day parade.

For electric vehicles batteries might get heated up due to the outside temperature

Use of light gas such as nitrogen in the tires is appreciated

Solar panel can be installed on the roof to charge the vehicle battery

Sand scooter should also have storage space

Armory mounting points should be provided

camel can carry upto 500kg+ on their back

Proper suspension is required for sandy tracks

A seating of 5 people is preferred

One single person doesn't go for patrolling, its always done in minimum a pair of 2 jawaans.

Patrolling is done on foot during night hours.

Border fencing is checked every 3 months where both Indian and Pakistani officials walk along the LOC and exchange notes

A border post requires 3 to 4 camels for patrolling

Cleaning is difficult in xenon as underbody is hard to access.

Sand particles getting in effect the whole engine of the vehicle

CCTV cameras with night vision are also installed on light poles

If any movement is detected on camera installed on light post than the patrolling soldier has to rush as the spot immediately

Electricity in the fencing is stopped during the day time so the animals coming near the fencing don't get stuck to the fencing.

BSF still maintains more than 1000 camels in cavalry

Gypsy costing 5 lakh does better work than any imported vehicle.

Sand storms make it difficult to patrol

Gypsy is the king

Gypsy is light weight

Why sand scooters are not popular in India among Indian brands.

2 Soldiers and their kitbags weight around 200 kgs

A simple and powerful vehicle is required.

Speed of patrolling vehicle should be 40 to 50 kmph

Patrolling is Domination on the ground + eye watch

Patrolling is done in a straight line

Weather conditions are really harsh (goes above 55 degrees in peak summer)

In winter nights are as cold as 0 degree Celsius.

Only trained personal are allowed to patrol with camels

Camels are expensive to maintain as they need continuous care and take high toll when fallen sick

The border road association has built a road along the fencing ranging from 50m to 200m inside the fencing.

The fencing is 150 m from the Zero line (LOC)

Water containers are a must while patrolling.

Shifts last for 6 hours.

Every soldier has to do 12 hours of duty in shifts of 6 hours

Feet start paining after 6 hrs of duty

Special shoes that avoid feet pain.

Light posts are installed on every 50 meters

Movement is slow in emergency situation as covering long distance on foot is hard

4X4 vehicles such as Maruti gypsy, TATA Xenon, Mahindra Bolero etc. are preferred for quick movement from nearby post

The Maruti Gypsy is the most successful vehicle for such a condition

4x4 vehicles also sometimes get stuck in high sand dunes

Shifting sand dunes present a major challenge in some areas.

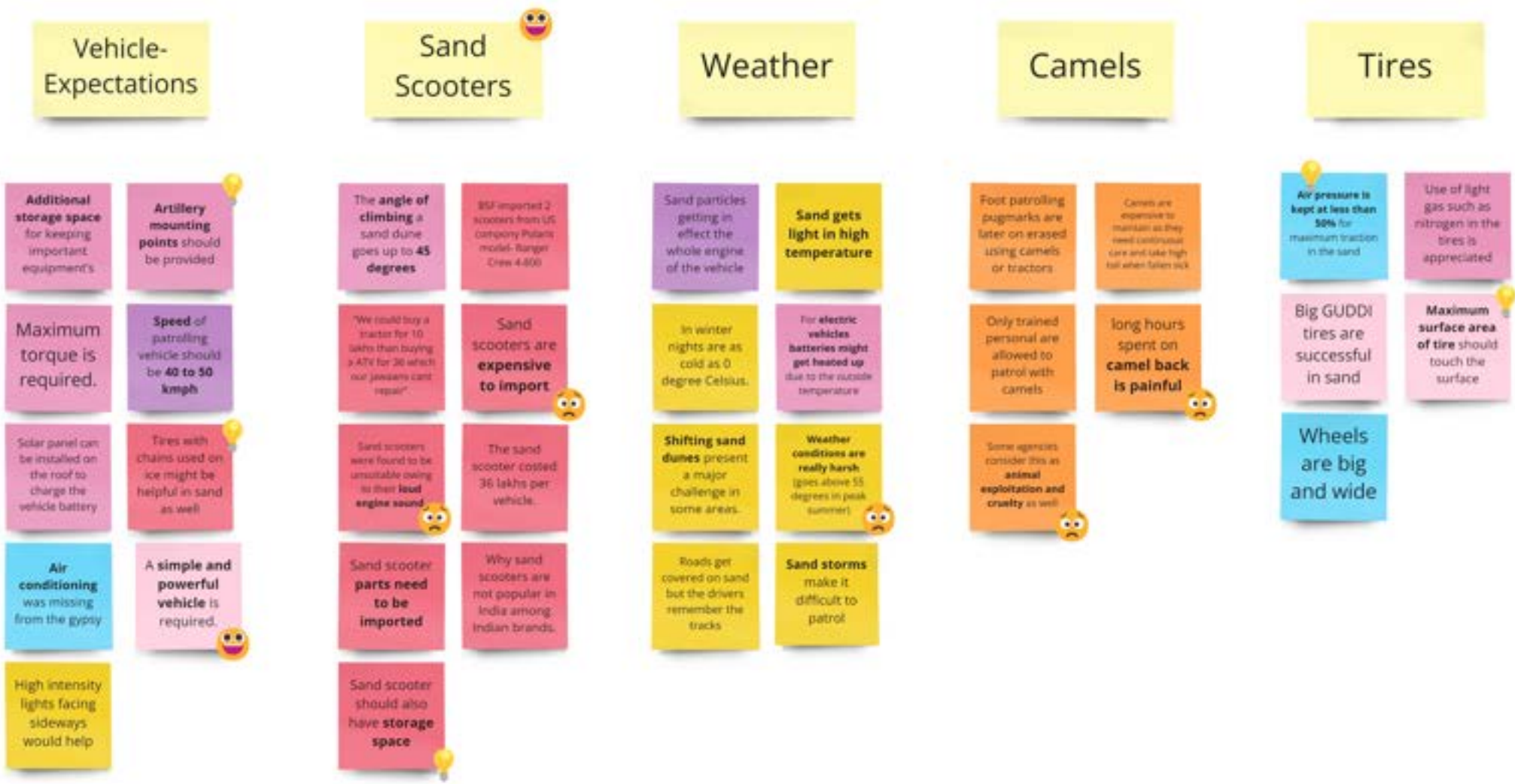
With BS6 in place govt. also stopped to buy gypsy for BSF

BSF imported 2 scooters from US compony Polaris model- Ranger Crew 4-800

If you are lost in the dunes just walk towards west and u will reach the fencing.

Analysing Insights

The insighs were grouped into similar categories to analyse and arrive at finer insights nessesary for the designer to arrive at a brief.


Vehicle-Expectations
Additional storage space for keeping important equipment's
Artillery mounting points should be provided
Maximum torque is required.
Speed of patrolling vehicle should be 40 to 50 kmph
Solar panel can be installed on the roof to charge the vehicle battery
Tires with chains used on ice might be helpful in sand as well
Air conditioning was missing from the gypsy
A simple and powerful vehicle is required.
High intensity lights facing sideways would help
Sand Scooters
The angle of climbing a sand dune goes up to 45 degrees
BSF imported 2 scooters from US company Polaris model- Ranger Crew 4-800
"We could buy a tractor for 10 lakhs than buying a ATV for 30 which our jawaans cant repair"
Sand scooters are expensive to import
Sand scooters were found to be unsuitable owing to their loud engine sound
The sand scooter costed 36 lakhs per vehicle.
Sand scooter parts need to be imported
Why sand scooters are not popular in India among Indian brands.
Sand scooter should also have storage space
Weather
Sand particles getting in effect the whole engine of the vehicle
Sand gets light in high temperature
In winter nights are as cold as 0 degree Celsius.
For electric vehicles batteries might get heated up due to the outside temperature
Shifting sand dunes present a major challenge in some areas.
Weather conditions are really harsh (goes above 55 degrees in peak summer)
Roads get covered on sand but the drivers remember the tracks
Sand storms make it difficult to patrol
Camels
Foot patrolling pugmarks are later on erased using camels or tractors
Camels are expensive to maintain as they need continuous care and take high toll when fallen sick
Only trained personal are allowed to patrol with camels
long hours spent on camel back is painful
Some agencies consider this as animal exploitation and cruelty as well
Tires
Air pressure is kept at less than 50% for maximum traction in the sand
Use of light gas such as nitrogen in the tires is appreciated
Big GUDDI tires are successful in sand
Maximum surface area of tire should touch the surface
Wheels are big and wide

Insights for Designer

From all the insights collected and ananlysed we arrive at a few finer insights important to us going forward.

The Eisenhower Matrix

Possible Directions
Pros and Cons

From the Eisenhover matrix there are 2 possible directions for this project, one is working on a sand scooter and second is a 4X4 Multi utility Vehicle, to get better clearity i tried to identify pros and cons for each of them.

PRO's	Can be a direct replacement for camels	Can be used as a quick response vehicle	Can be made in a module of 2 seater or 5 seater with variable storage	Can be made light weight and compact	Can be transported easily (airdrop is easy)	Assembly and disassembly can be easier
CON's	Special purpose vehicle only	Not suitable for long distance commute	Less likely to carry very heavy artillery			

PRO's	Can be an upgrade to already existing vehicles	Can travel long distances	Better for officers	robust and tough			
CON's	Can not be a replacement for camels	Providing each post with such vehicle can be a expensive affair	heavier than scooters so getting stuck in sand is more likely	More expensive as will require bigger batteries and motors (if electric)	Bigger vehicle is easy to spot from a distance	More or less Conventional	

Project: Border Patrol Vehicle for the BSF

Purpose

The border Security force of india has keep a continuous watch on the border shared with the neighboring countries, Rajasthan is one such state and has a unique challenge in form of the thar desert. Traditionally camel, also known as "the ship of the desert" are used as they can bear the harsh hot summers but with the advancing technology and ever increasing challenge from across the border an advance vehicle for patrolling is required.

Objective

The objective of this project is to provide the BSF jawaans on the western border on india in the region of thar desert with a vehicle suitable for harsh and challenging conditions offered by the topography, also speed up the process of patrolling and help them do it in a more precise and sharp manner so they can have an edge over the enemy.

Target User

Currently the BSF jawaans assigned to do the job of patrolling on the border do it either on foot or use camels. Both ways it is very tiring for the personnel, as well as the speed is slow in both cases, although camel can run upto a speed of 40mph but only for a short sprint. The vehicle will provide the BSF with a faster way of patrolling and will help to quickly response to any distress call near the fencing.

Deliverables

The idea is to come up with an affordable 4X4 All terrain Vehicle for a seating capacity of upto 2 BSF Personnel, with available storage space to keep the necessary equipment's such as binoculars, water containers, radio transmitters, artillery etc. capable to run on sand dunes at speeds of 40 to 60 kmph, produce less noise (preferably electric or hybrid powertrain) and provide maximum protection against sand storms and harsh sunlight from the top.

User Persona

Dharamveer Jangir

From: Shah Ganj, **Utter Pradesh**

Occupation: Senior Constable, BSF

Posting: Jaisalmer, **Rajasthan**

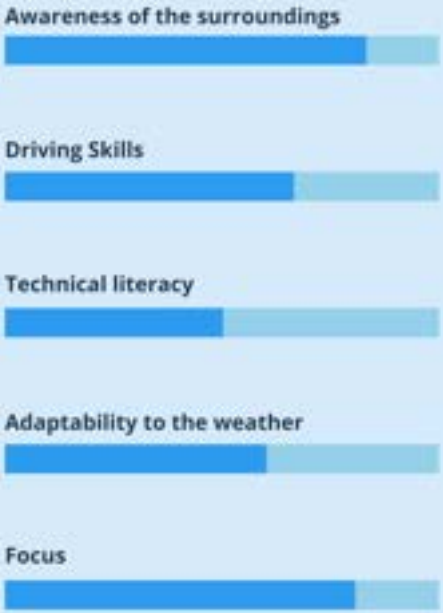
Scenario:

Dharamveer is a 39 year old senior constable of one of the Indo-Pak Border posts in Jaisalmer region. He has to do his 6 hours of patrolling duty twice (day & Night) everyday.

Goals and Aspirations:

- Use a less tiring and faster way to patrol
- Use a Vehicle capable for quick response
- Use a vehicle that can maneuver in sand dunes easily
- Use a Patrolling vehicle which is more stealthy and robust

Personality Attributes



Benchmarking

Vehicles Used by the BSF Currently

The **Polaris Ranger Crew 800** is a 6-seater Side by Side, created to carry 50% more people and gear across rough terrain than any other similar machine out there.

The **Maruti Suzuki Gypsy** is a four-wheel-drive vehicle based on the long wheelbase Suzuki Jimny SJ40/410 series.. It was primarily built as an off-road vehicle and all models were built with selectable 4WD.

The **Polaris RZR XP4 900 EPS** is a side-by-side ATV which was built with a strong chassis, longer suspension, and an powerful motor. One of the key aspects of this vehicle is that the harder you push it, the better it sticks to the trail.

Benchmarking

Vehicles Used by International Armed Forces

The **Plasan Yagu** can accommodate up to three personnel. The forward crew cab is protected by a single wind shield, while either side of the hull is provided with a single door for crew to enter/exit the vehicle. The cameras fitted around the protected capsule and windows on doors ensure excellent situational awareness and rapid response against threats.

The **Polaris MRZR 4** incorporates a tubular frame and a conventional layout with engine in the front, crew seats in the middle and cargo compartment at the rear. The roll cage can be collapsed without tools to reduce the vehicle height. The rear modular cargo section can support the installation of up to two seats/ litters or a single seat and a litter.

The **Tomcar TX** vehicle is easy to drive and maintain and comes with high safety rating. The design of the skid plate features CVT heavy, final drive, on-the-fly two-wheel- or four-wheel-drive engagement. The vehicle features extremely low center of gravity which maximizes safety, stability and performance, while also allowing the vehicle to cut through sharp corners and handle extreme side-slopes.

State of the art ATV's round the globe



VANDERHALL BRAWLEY



STORM MPV



ATLAS ATV



VENTURA ANTARTICA


MAD NOMAD ATV


EZ RAIDER


FEROX AZARIS


TINGER TRACK


CFMOTO ZFORCE 950 H.O. Sport


LEXUS ROV CONCEPT

Design Brief

To design a light weight and powerful electric border patrolling mobility vehicle (ATV) that assists the border security force operating in the Thar Desert region of Rajasthan, so that it mitigates the problems in usage slow and tiring ways to patrol (on foot and camels).

The primary focus is to design a vehicle which could help them move and patrol effectively with all the necessary equipment and have following basic requirements.

Function must be to

- Provide fast movement of the personnel responsible for patrolling.
- Reduce the response time in case of any emergency situation on the fencing.
- Ensures the maintenance cost is low with ladder on frame chassis and must be easy to repair
- Provide adequate space to accommodate 2 people with necessary storage space to keep 10-12 liter water, required artillery, radio transmission system etc.

Being part of the system which have following characteristics

- Withstand heavy sand storms and high temperature upto 60 degrees as well as low temperature upto -10 degree.
- Different types of terrain ranges. Must provide high ground clearance, smooth and long suspension travel for going up and down the sand dunes that may be as steep as 45 degrees.
- War sensitive zone readiness.

Sub System

Mid Drive Motor

V/s

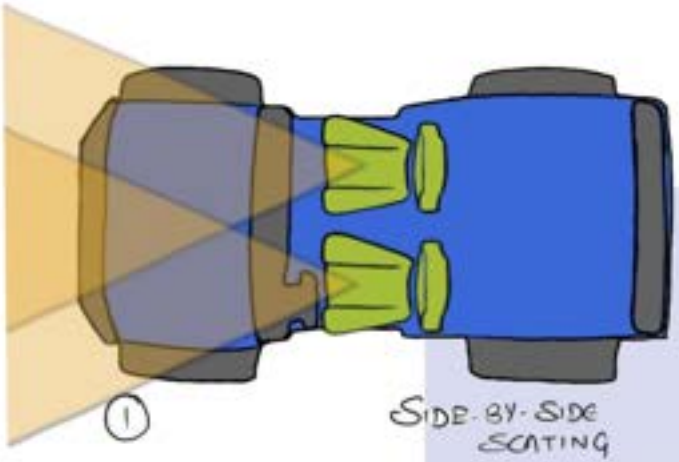
Hub Motor

Mid-drive motors are known for higher performance and torque when compared to a similarly powered traditional hub motor. One key reason why is that the mid-drive motor drives the crank, instead of the wheel itself, multiplying its power.

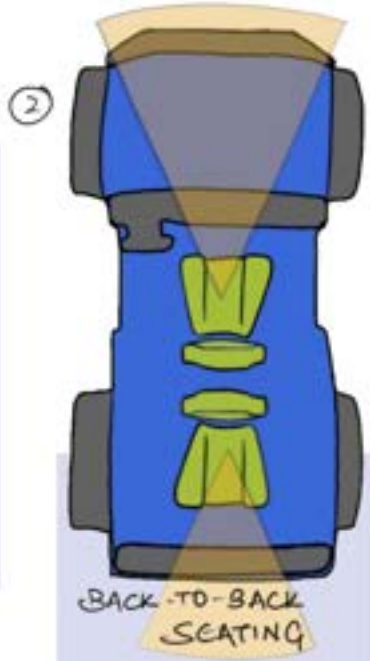
Mid-drive motor is designed to make maintenance and service extremely easy. You can remove and replace the entire motor assembly by simply taking out two special bolts – without affecting any other aspect of the Vehicle. Thus, Mid- Drive Motor was chosen for this vehicle.

Seating Arrangement

Priorities: Maximum awareness Compactness Dominance on the area



- Conventional
- More space for Cargo
- Less Visibility for both the driver and Gunner



- Can cause nausea
- Less space for Cargo
- Less flexibility for the Gunner
- Unconventional

- 360 degree Attention
- More range of motion for the Gunner
- Better Visibility for both the driver and Gunner

- Less space for Cargo
- Less Visibility for the Gunner
- Extra space to move around

- Fully Autonomous
- Negligible space for Cargo
- Limited Accessibility

Platform

- Dimensions - 4010mm x 1540mm x 1875mm
- Wheelbase - 2375mm
- Ground Clearance- 11"
- Wheel Size- 26"

- Dimensions - 3508mm x 1524mm x 1821mm
- Wheelbase - 2705mm
- Ground Clearance- 15"
- Wheel Size- 27"

- Dimensions - 3100mm x 1500mm x 1980mm
- Wheelbase - 2090mm
- Ground Clearance- 16"
- Wheel Size- 29"

- Dimensions - 3680mm x 1520mm x 1930mm
- Wheelbase - 2743mm
- Ground Clearance- 14"
- Wheel Size- 26"

- Dimensions - 3050mm x 1580mm x 1980mm
- Wheelbase - 2060mm
- Ground Clearance- 14"
- Wheel Size- 29"

- Dimensions - 3250mm x 1880mm x 1890mm
- Wheelbase - 2440mm
- Ground Clearance- 16"
- Wheel Size- 32"

The platform used for this vehicle would use **space frame architecture** with protective cage design.
The powertrain will be **electric with swappable batteries** that can be charged with a solar setup at the base.
The elimination of IC engine will clear out lot of space at the rear which can be used for the motor and storage.

Ergonomic Package

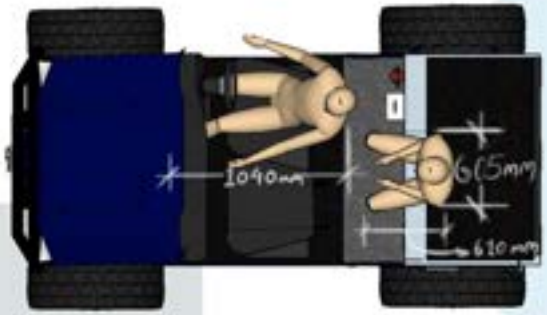
Anthropometric data for 95th Percentile Male

Stature	Sitting height	Shoulder Height	Lower leg Length	Hip Breadth	Elbow Height	Buttock-Popliteal Length	Buttock knee Length	Thigh Clearance	Eye Height, Sitting	Shoulder Breadth	Knee Height	Body Mass (kg)
1810	880	620	487	380	245	520	610	185	780	462	570	91.5

95th Percentile male in sitting and standing position

INITIAL ERGONOMICS STUDY

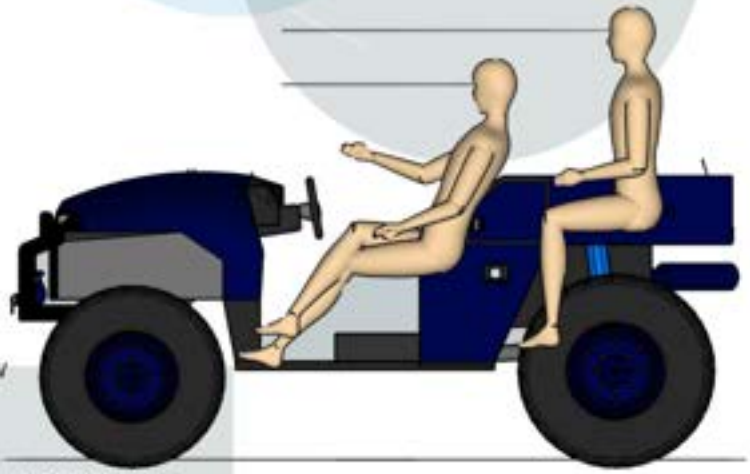
This Study provides a understanding of available space in the following platform's dimensions. Although with precise CAD models it was concluded that this package wastes a lot of space hence, packaging was done parallelly with the concept ideation



TOP VIEW

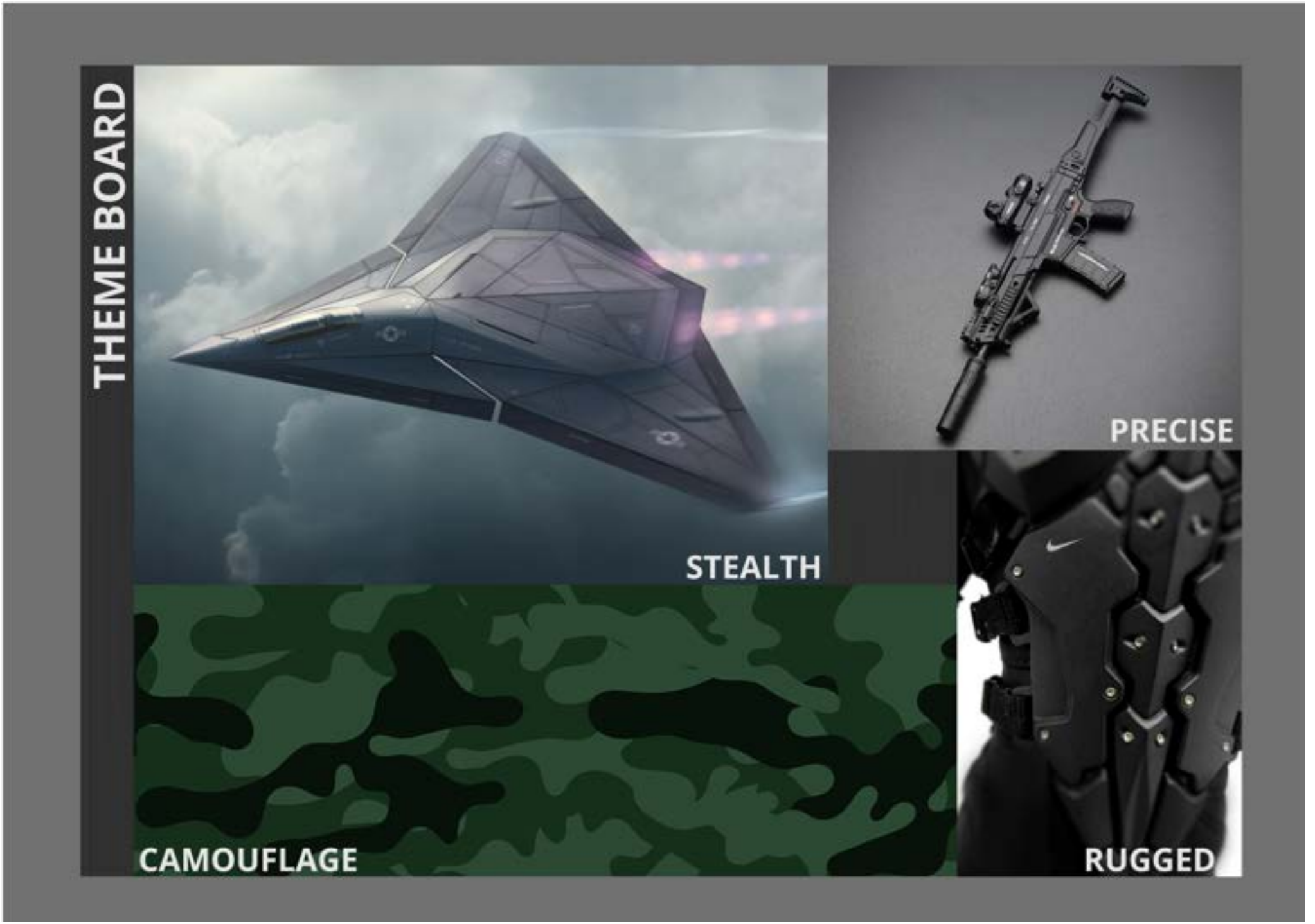
The driver sits in a conventional position where as the gunner is in the center so his view is not hindered.

The observer sits a bit higher and upright so his field of view as well as range of motion is not hampered.



SIDE VIEW

MOOD BOARD


THEME BOARD
STEALTH
PRECISE
CAMOUFLAGE
RUGGED

REFERENCE BOARD

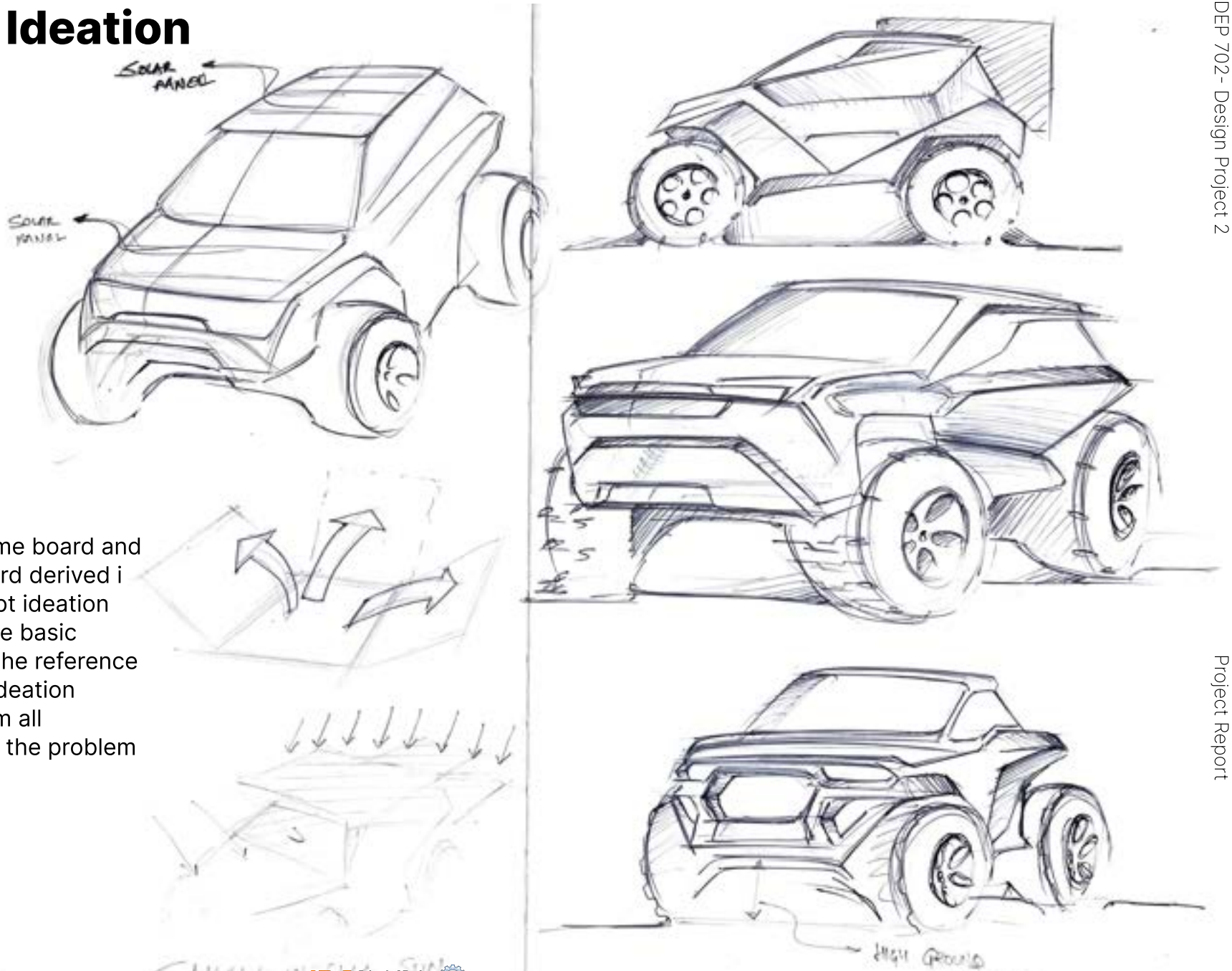
STRONG & LIGHT FRAME

OVERALL GOOD LOOKING

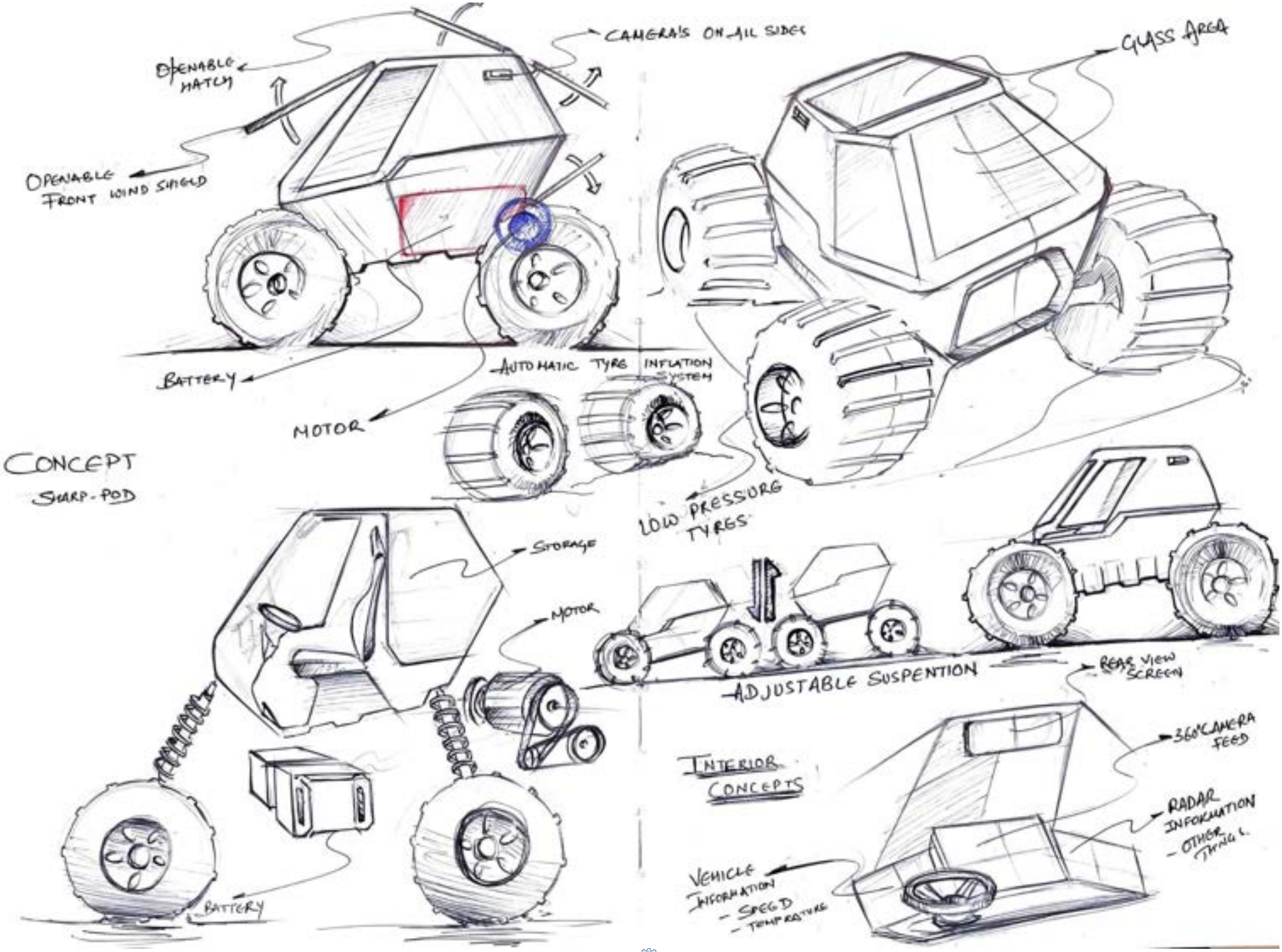
PURPOSE BUILT
BULLET PROOF

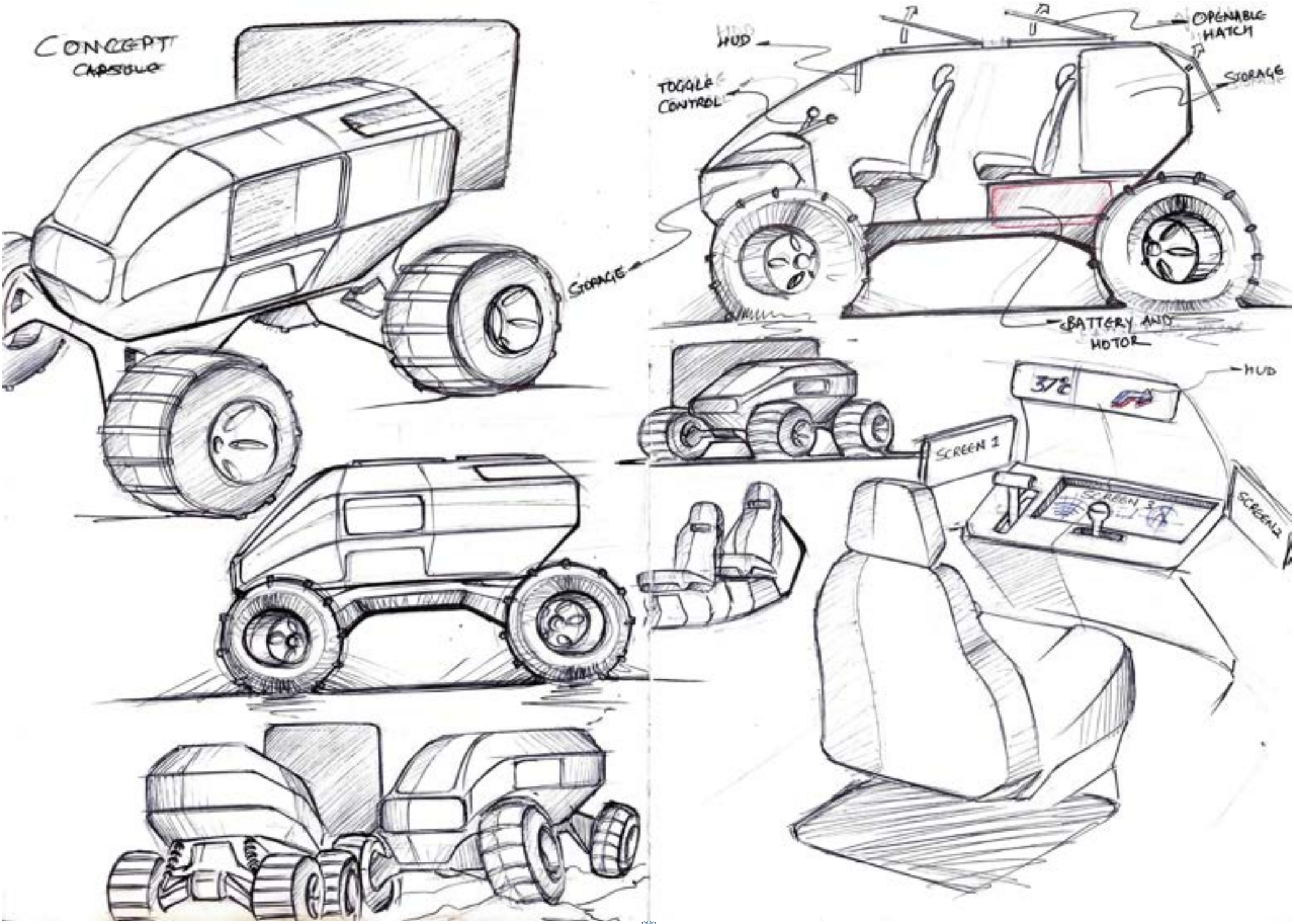
MULTI UTILITY & LIGHT WEIGHT

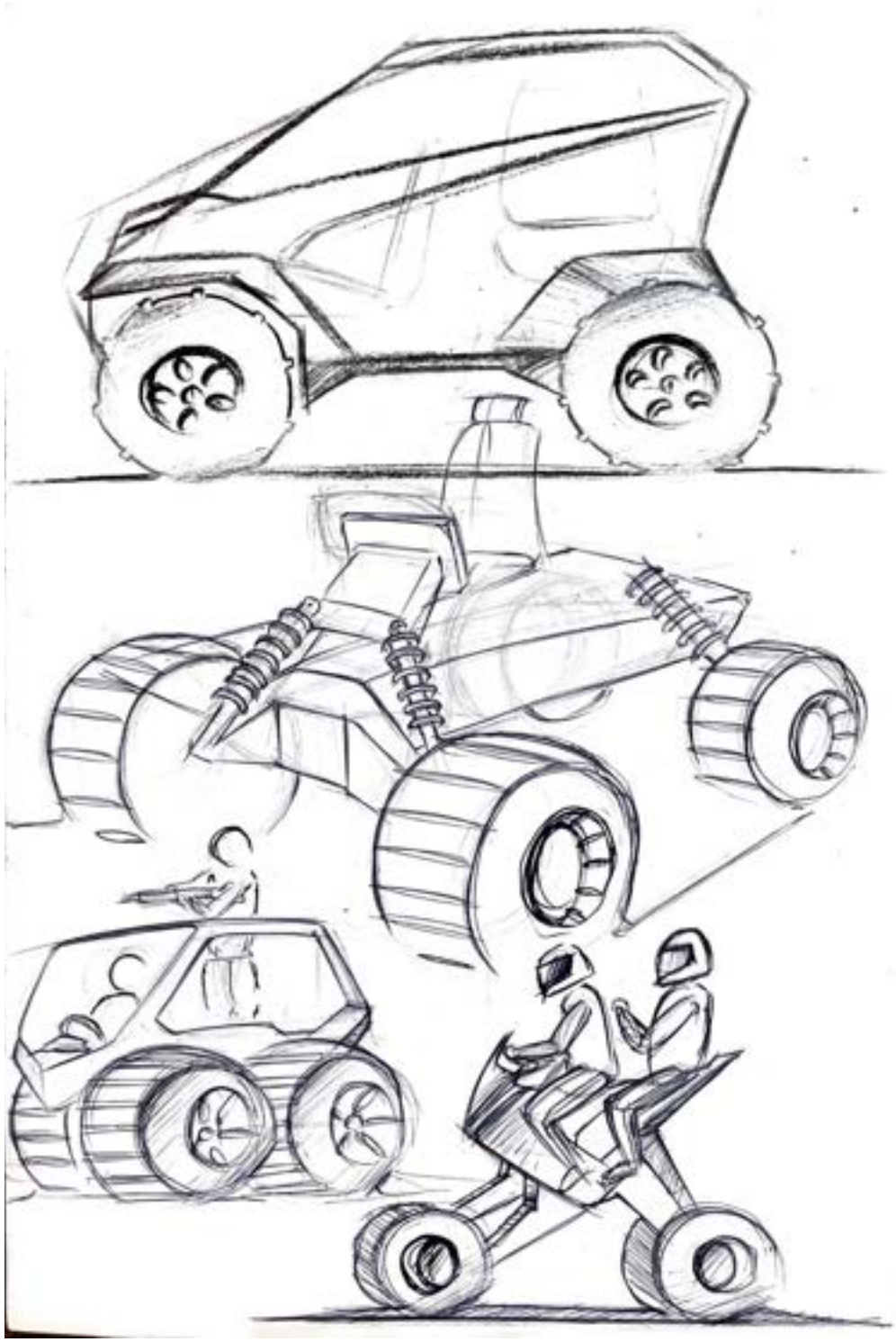
Concept Ideation

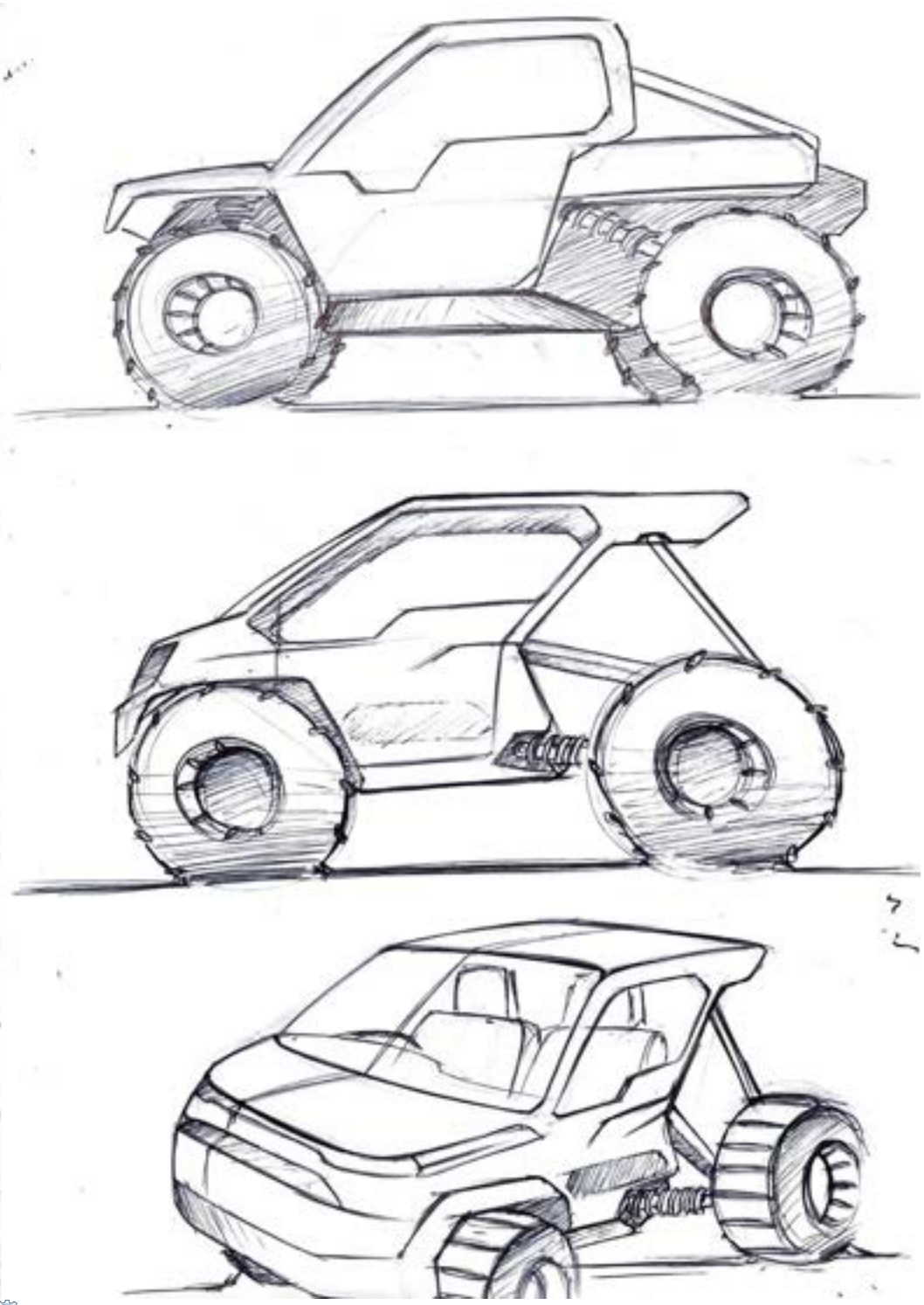


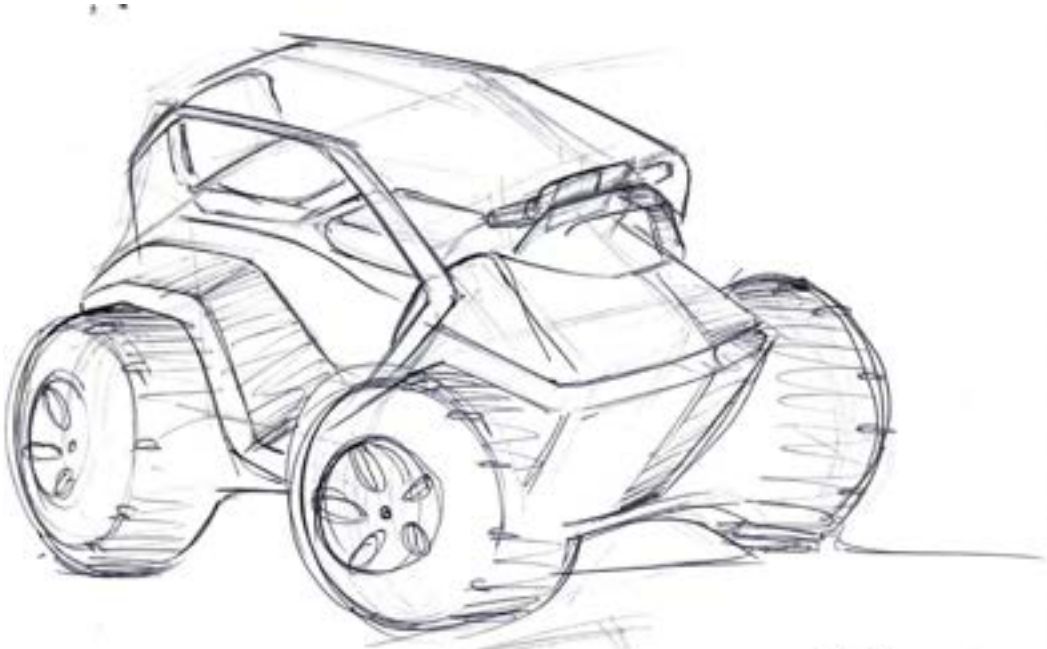
Based on the Theme board and the Reference board derived i started the concept ideation keeping in mind the basic prerequisite from the reference board. The Initial ideation includes ideas from all directions to solve the problem in hand.

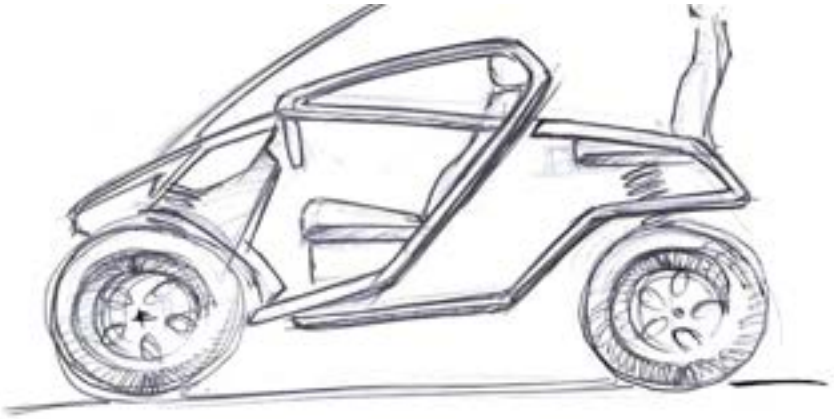

OPENABLE HATCH
OPENABLE FRONT WIND SHIELD
CAMERA'S ON ALL SIDES
GLASS AREA
BATTERY
MOTOR
AUTOMATIC TYRE INFLATION SYSTEM
LOW PRESSURE TYRES
CONCEPT
SHARP-POD
STORAGE
MOTOR
ADJUSTABLE SUSPENTION
REAR VIEW SCREEN
BATTERY
INTERIOR CONCEPTS
360° CAMERA FEED
RADAR INFORMATION
- OTHER THINGS
VEHICLE INFORMATION
- SPEED
- TEMPERATURE

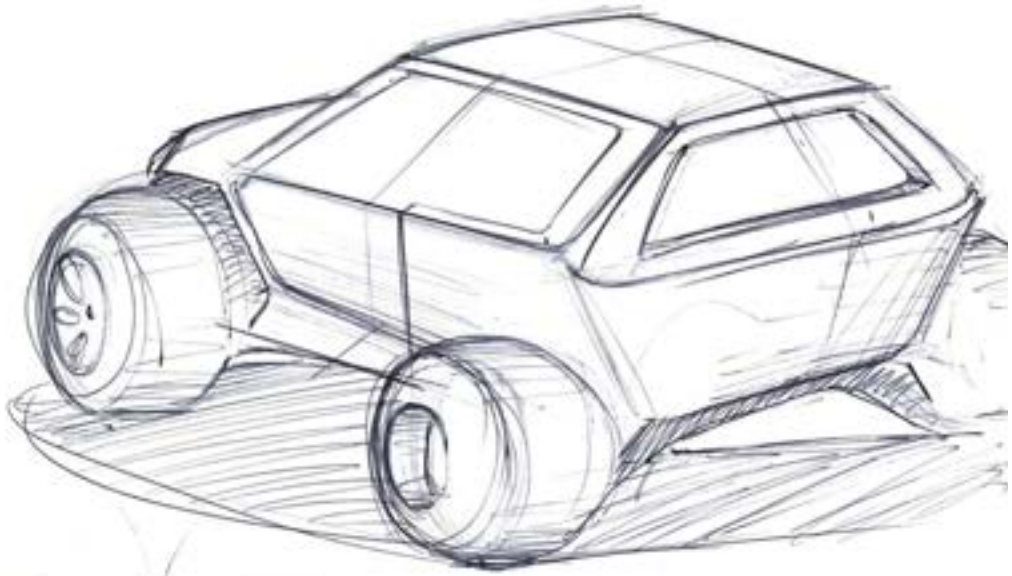

CONCEPT
CAPSULE
STORAGE
HUD
TOGGLE CONTROL
OPENABLE HATCH
STORAGE
BATTERY AND MOTOR
HUD
SCREEN 1
SCREEN 3
SCREEN 2

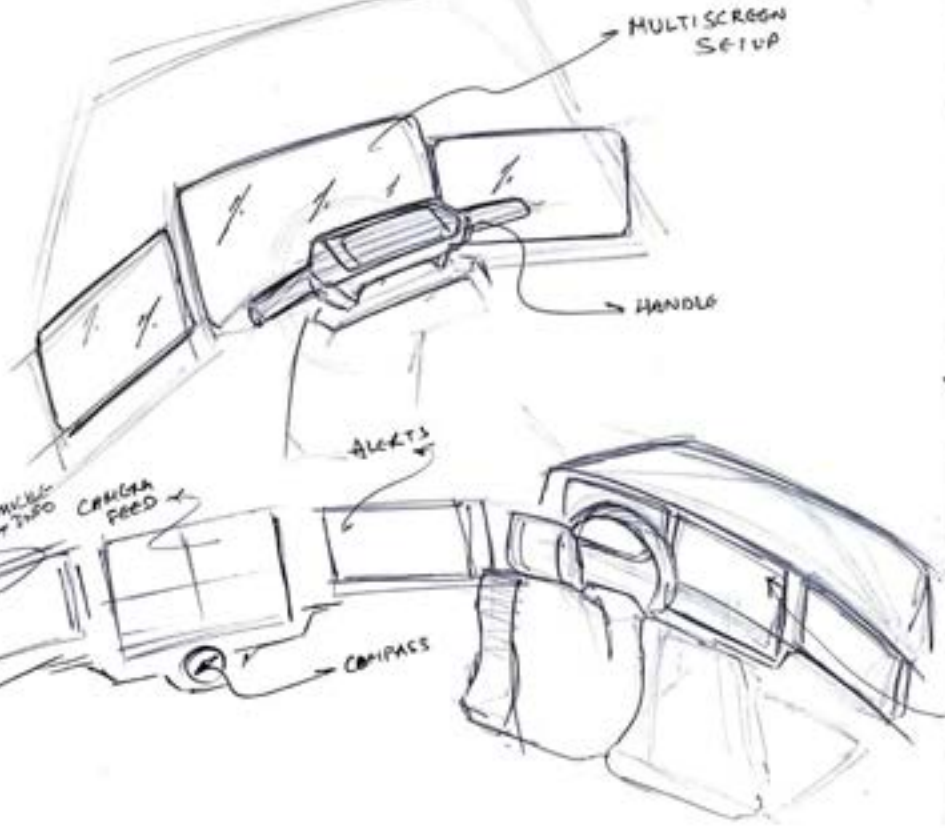


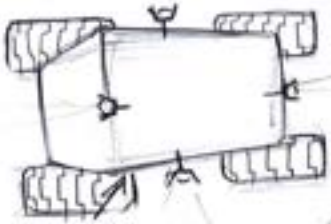


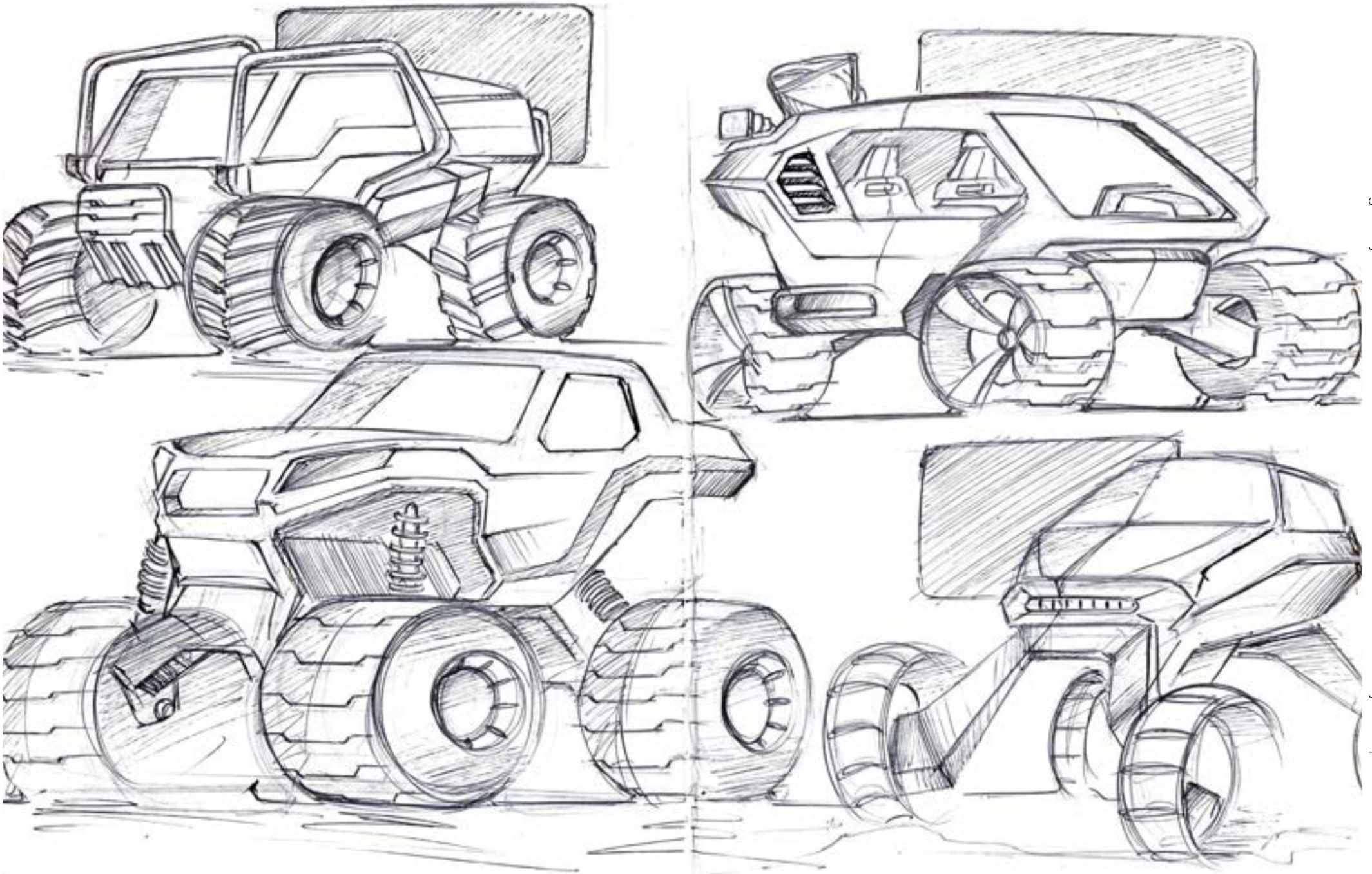


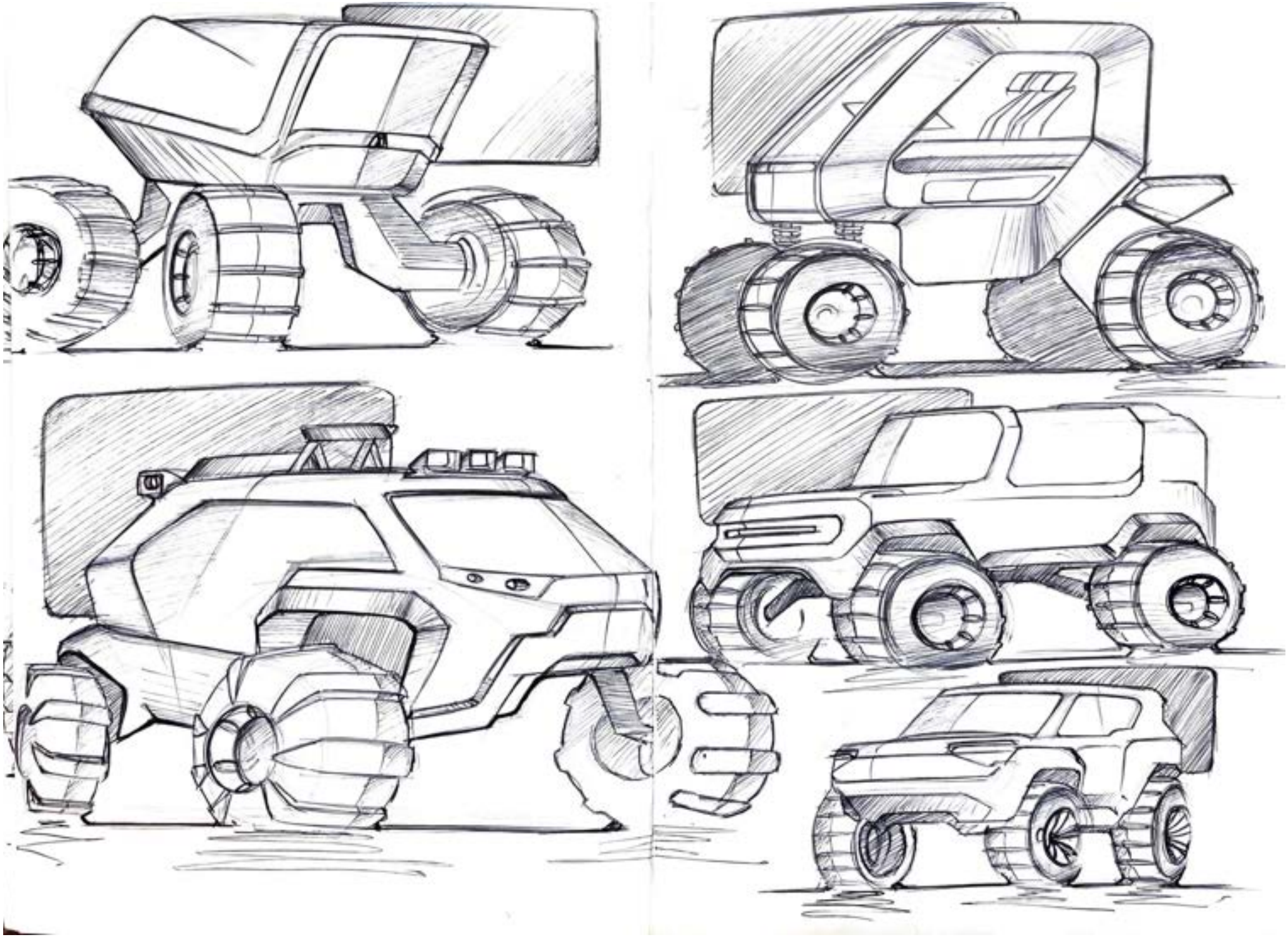


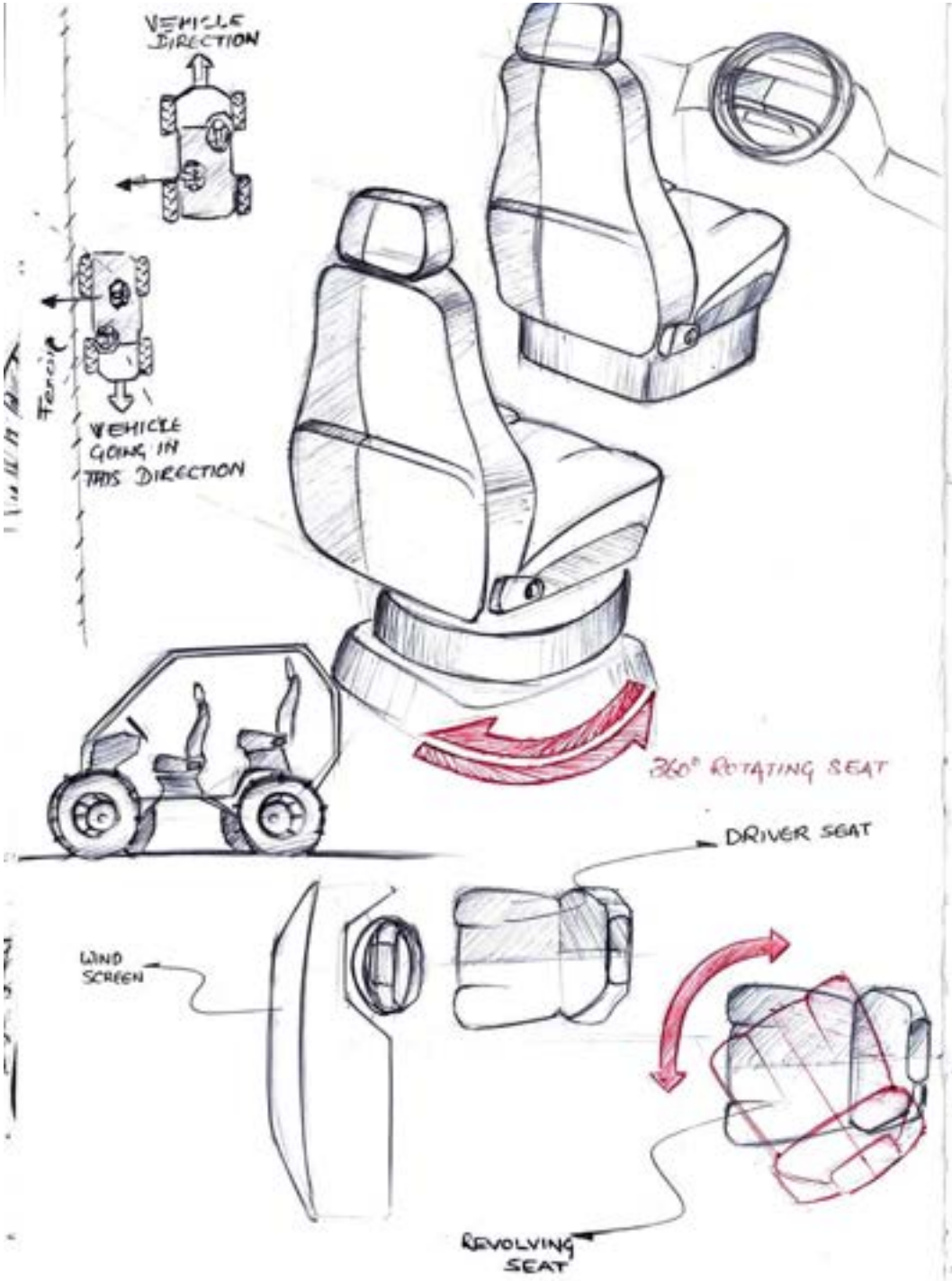


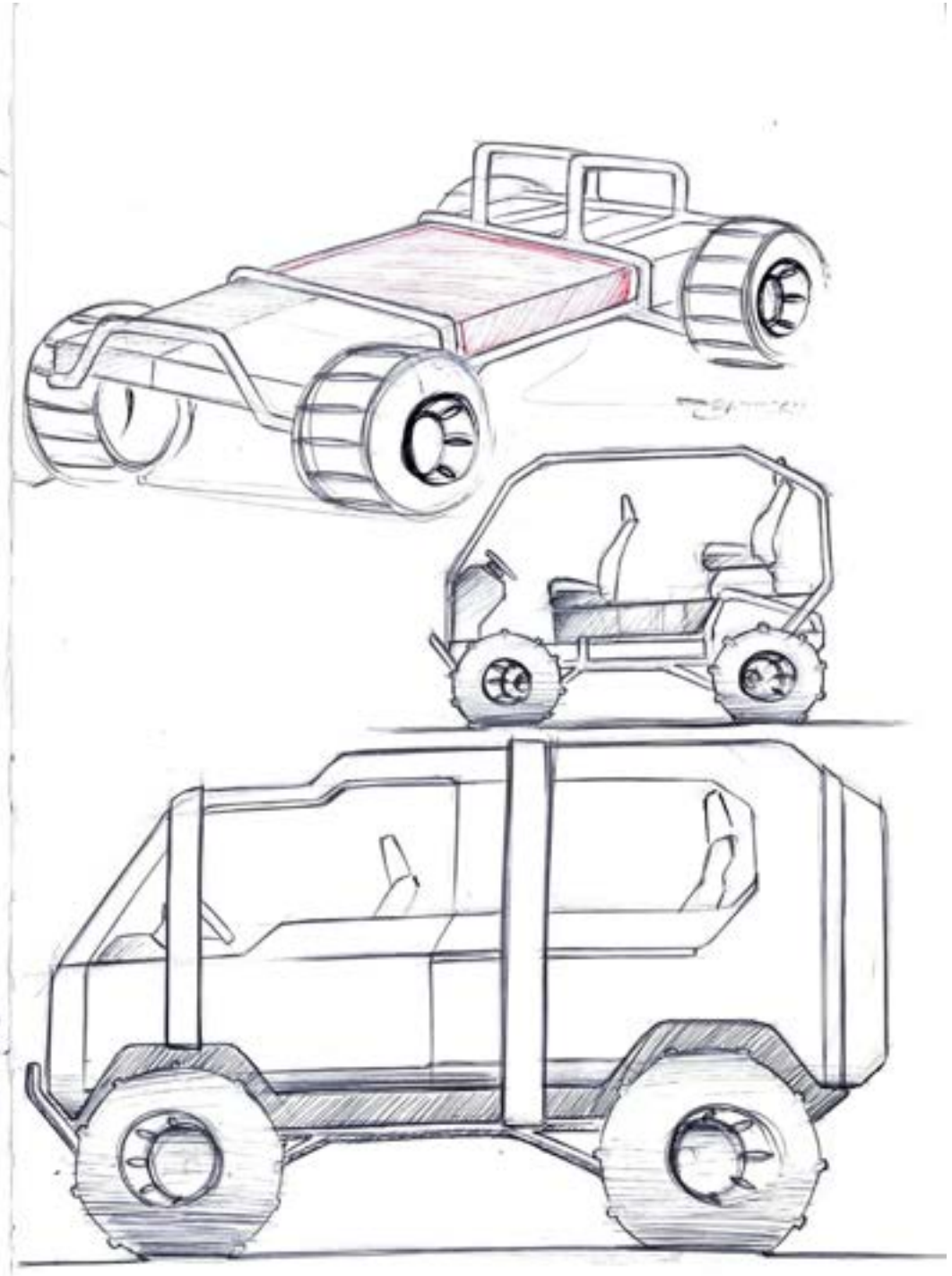

MULTI SCREEN SETUP
HANDLE
ALERTS
VEHICLE INFO
CAMERA FEED
COMPASS

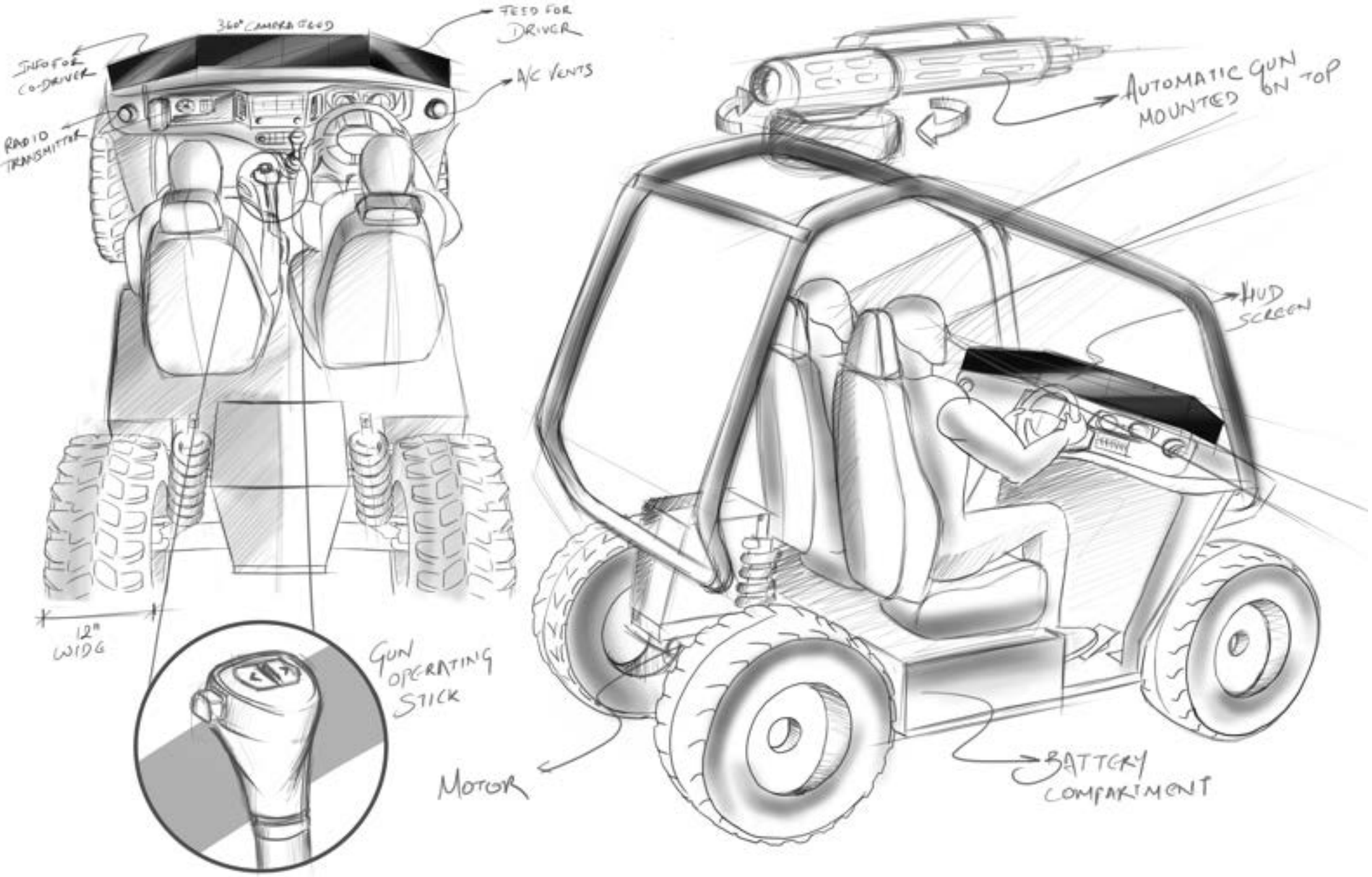

360 CAMERA VIEW






VEHICLE DIRECTION
Terrain
VEHICLE GOING IN THIS DIRECTION
360° ROTATING SEAT
DRIVER SEAT
WIND SCREEN
REVOLVING SEAT

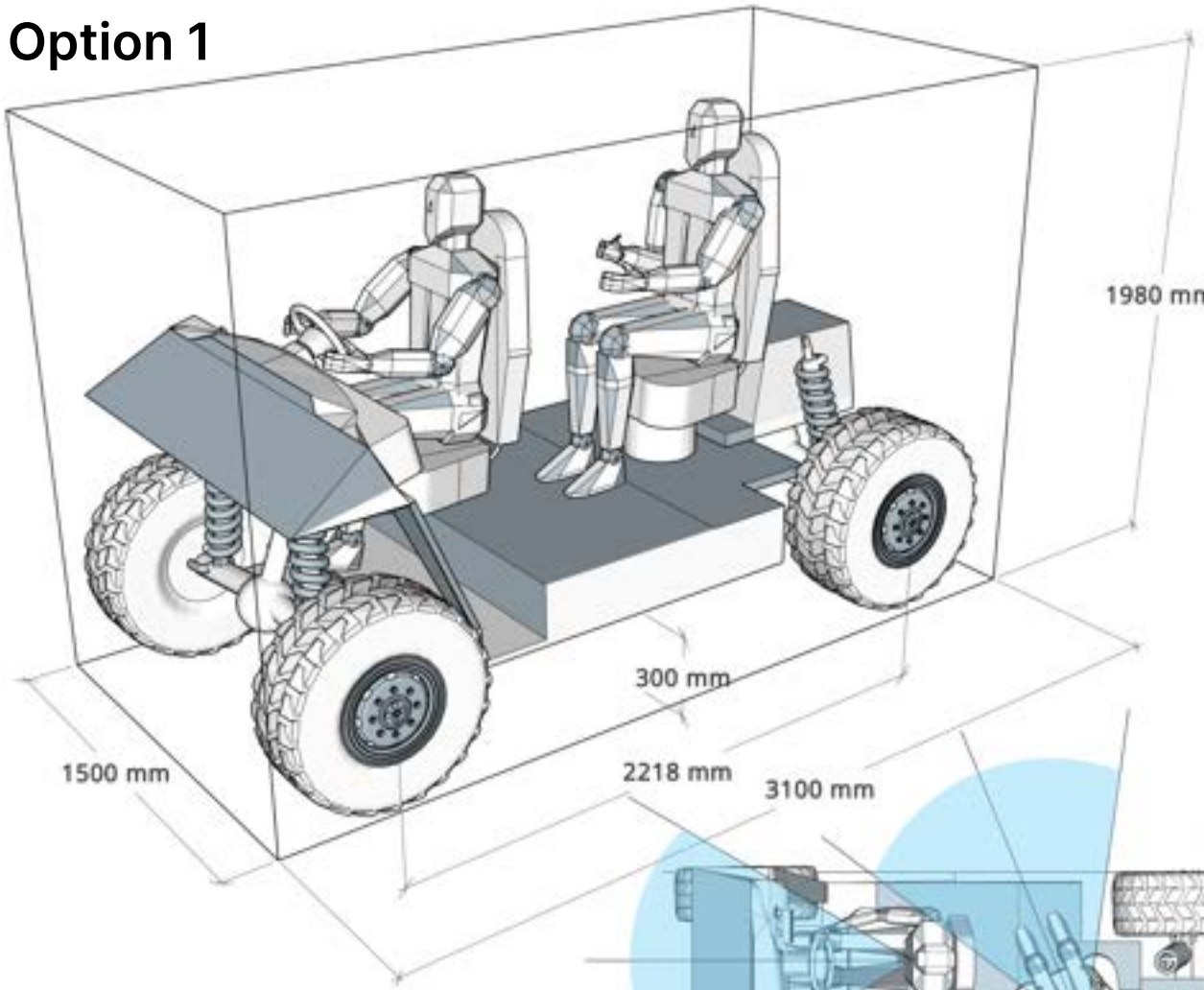


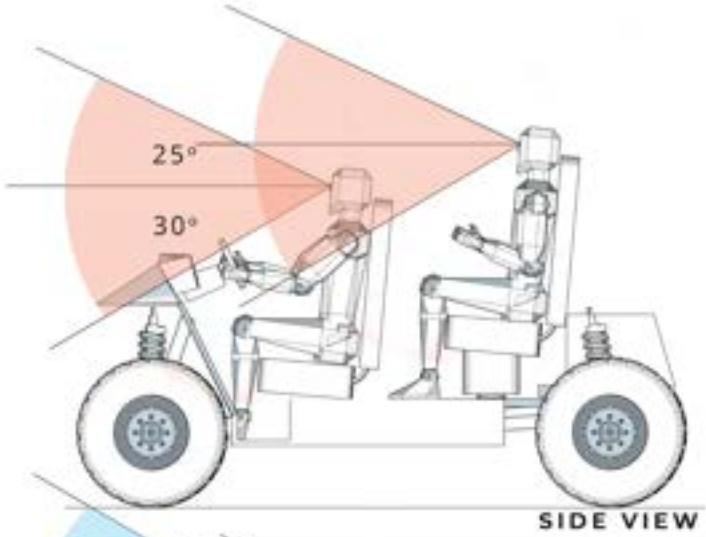

360° CAMERA FEED
FEED FOR DRIVER
INFO FOR CO-DRIVER
A/C VENTS
RADIO TRANSMITTER
12" WIDE
GUN OPERATING STICK
AUTOMATIC GUN MOUNTED ON TOP
HUD SCREEN
MOTOR
BATTERY COMPARTMENT

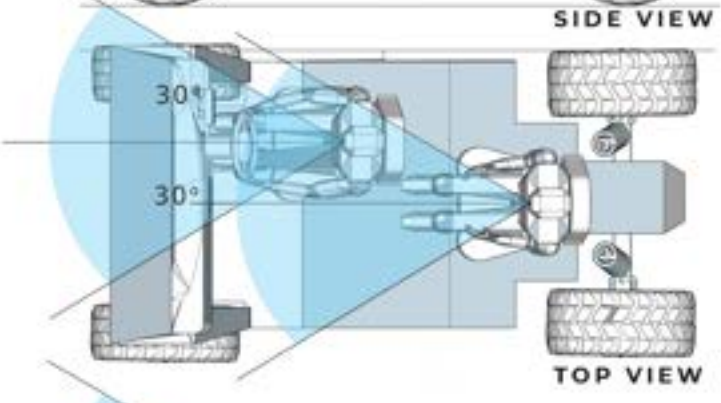
Detailed Packaging Iteration

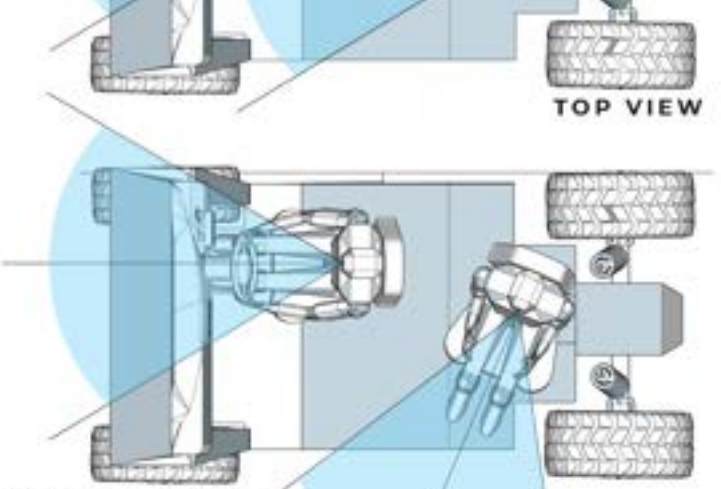
Based on concept ideation and packaging done till this point we went ahead in detain to see the most effective possible package that can include all nessesary and advanced equipment required for patrolling and came up with three different iterations for the final packaging, understood their pros and cons, based on which the final package was selected.
The idea was to make vehicle as compact as possible and also fitted with the most advanced and connected tech for the BSF, that would assist in the task at hand.

Option 1

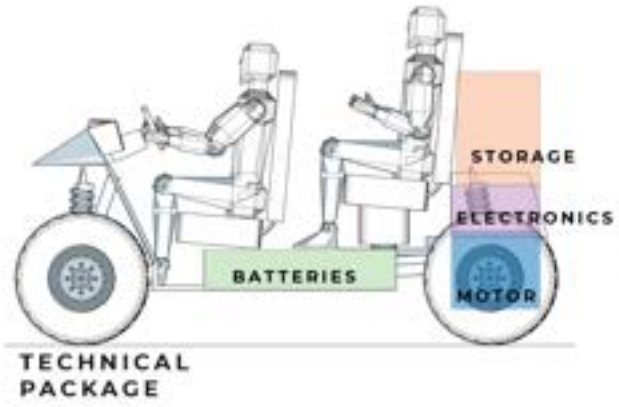








The observer can turn his seat and look in the direction of the fencing.



TECHNICAL PACKAGE

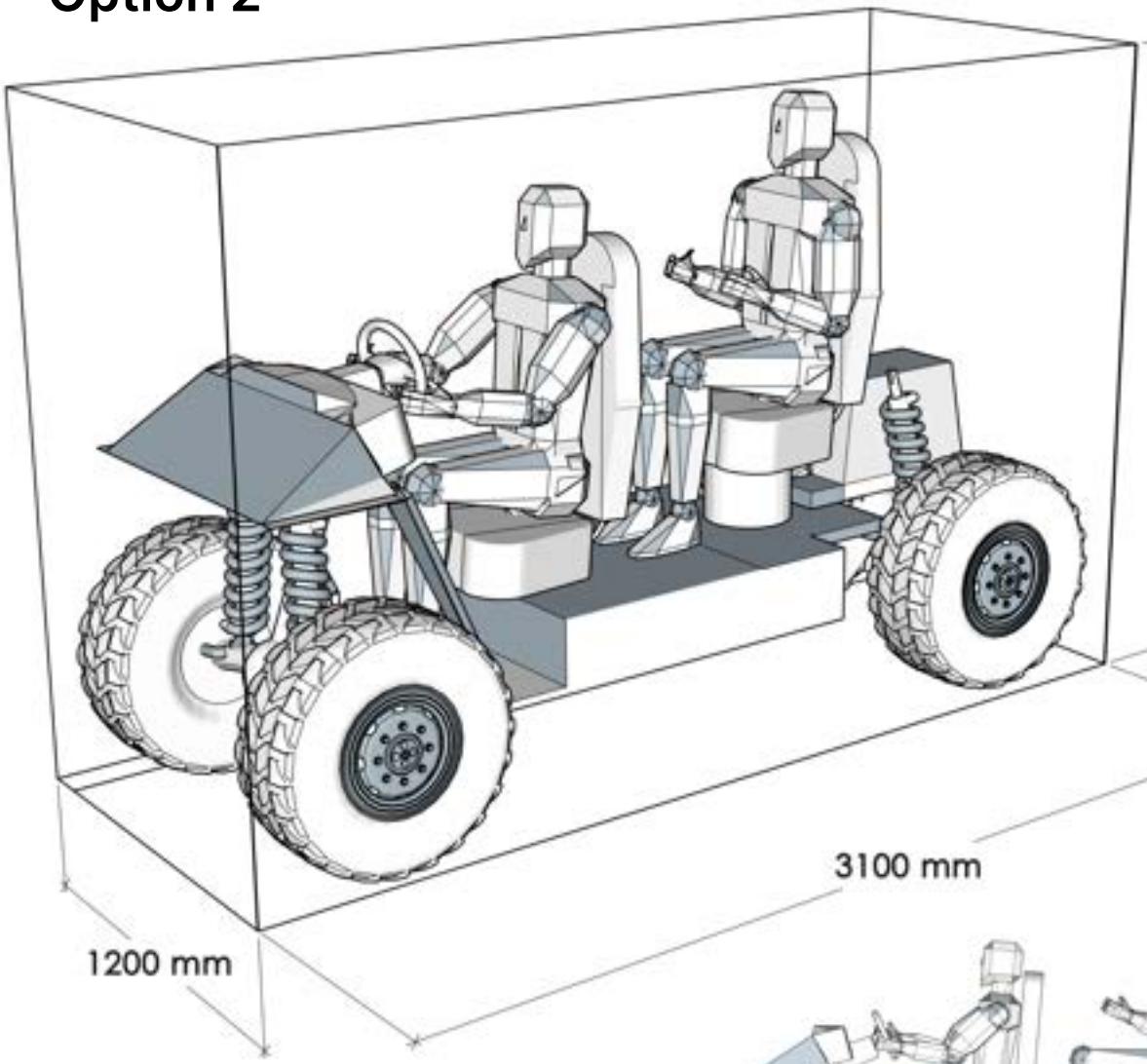
PRO's

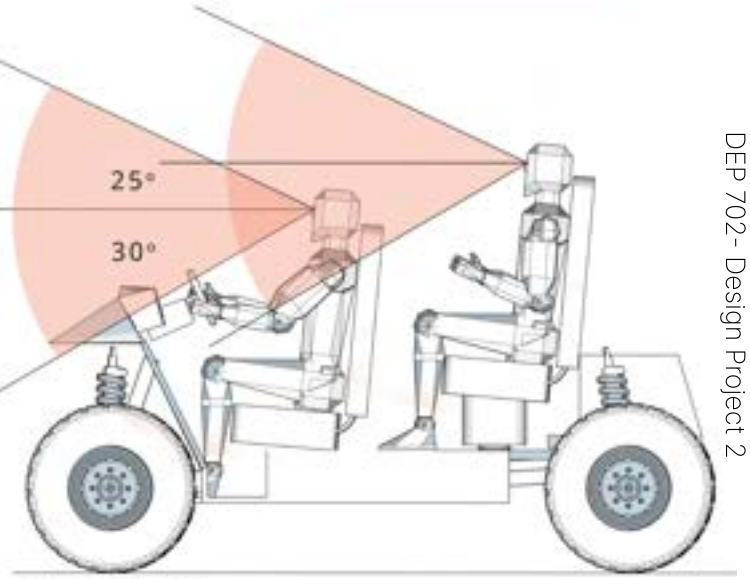
1. Better visibility for the observer
2. Space to move in a 230° angle
3. Dedicated spot for a gun mounted on top.

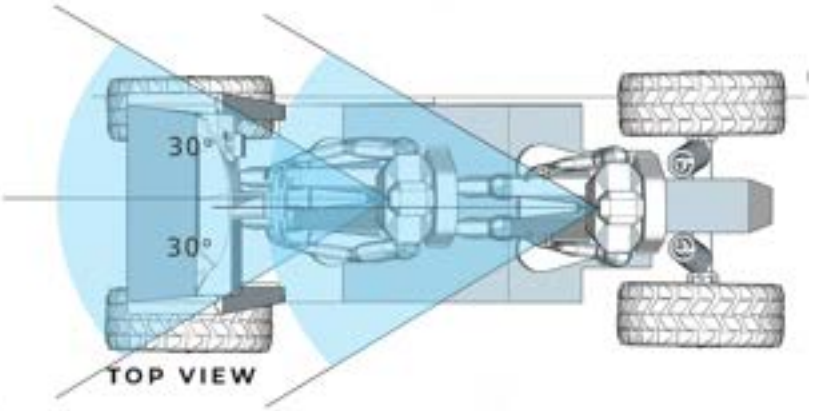
CON's

1. Unused space in the front
2. Field of vision remains same for the driver

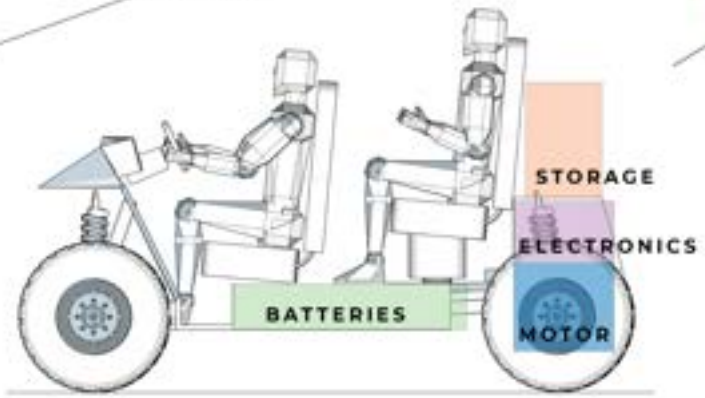
Option 2







The platform is a tandom seating one where the observer/gunner sits above a bit higher then the driver for better visibility. the driver is provided with 360 degree camera feed on the dashboard.



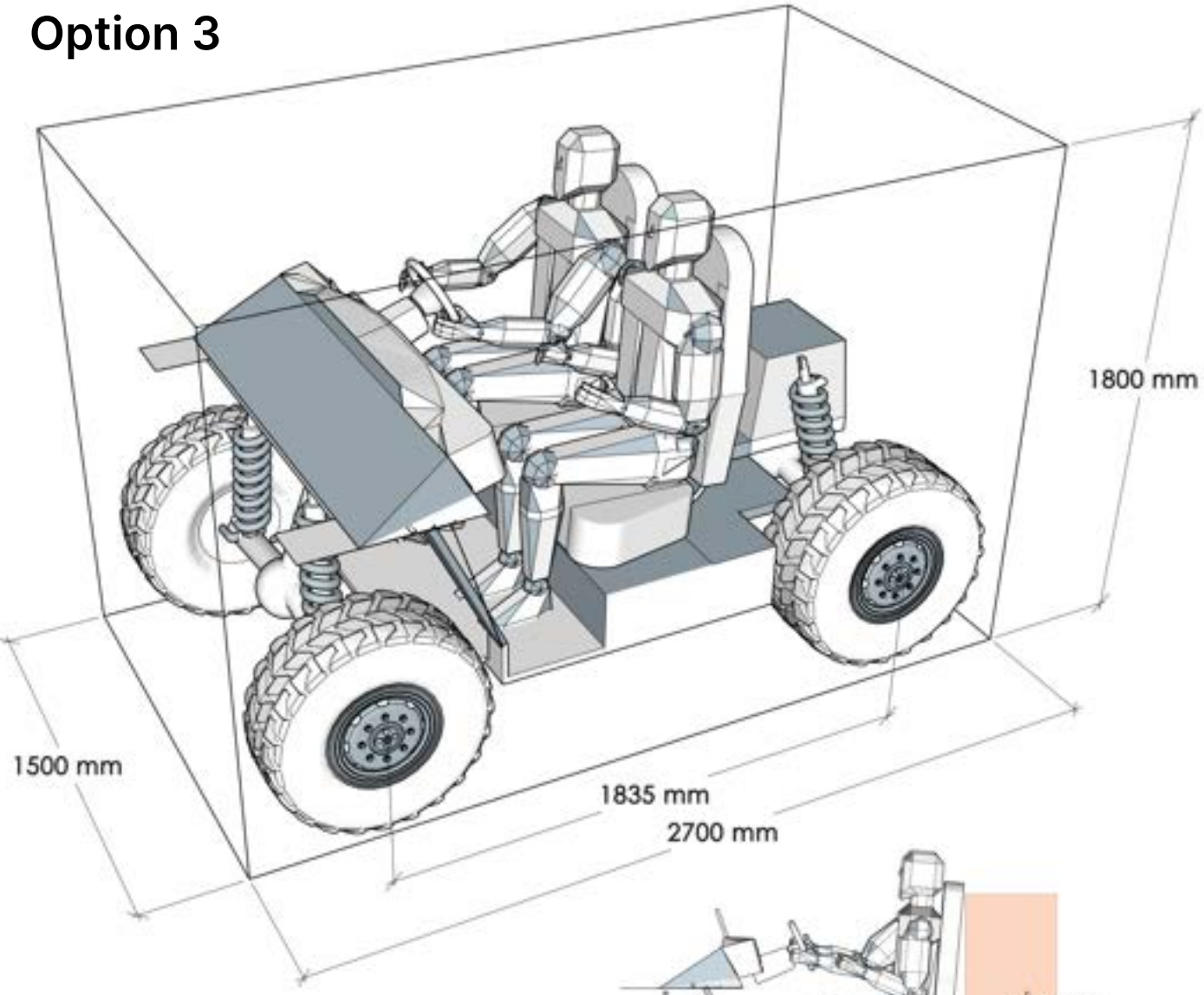
PRO's

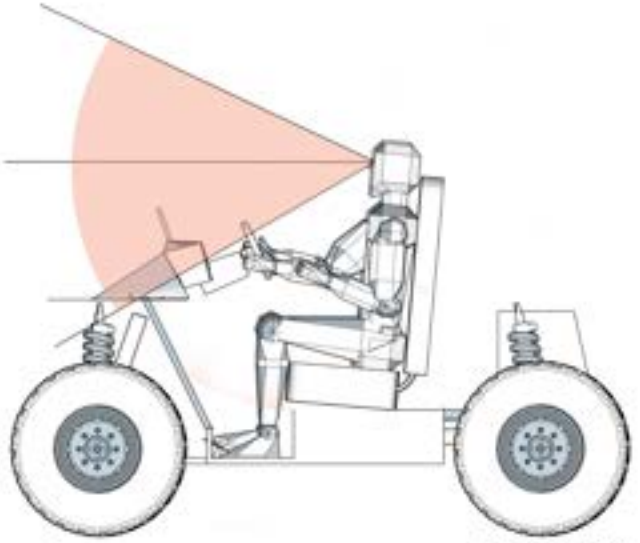
1. Better visibility for the observer
2. Less track width of 1200mm
3. Dedicated spot for a gun mounted on top.

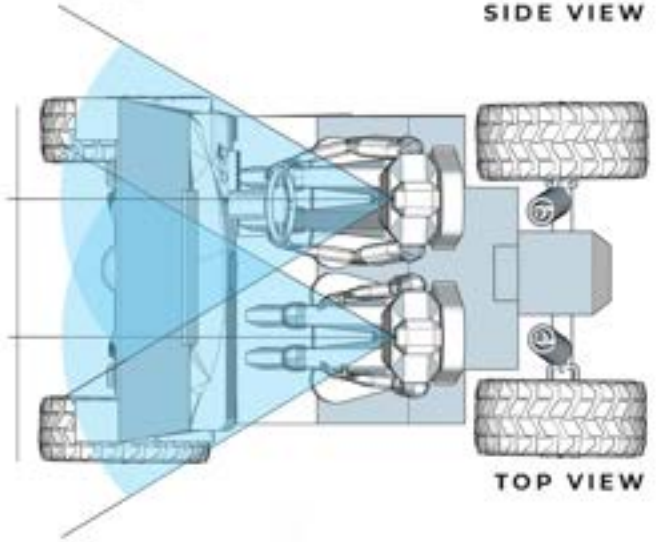
CON's

1. Less space to move around
2. Less storage space.
3. Field of vision remains same for both the occupants

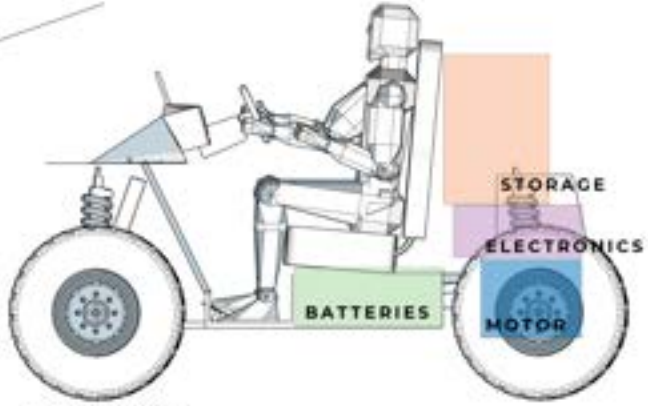
Option 3







The platform is a side-by-side seating. The driver and the observer is provided with 360 degree camera feed along with GPS information on the dashboard in form of a head's up display.



TECHNICAL PACKAGE

PRO's

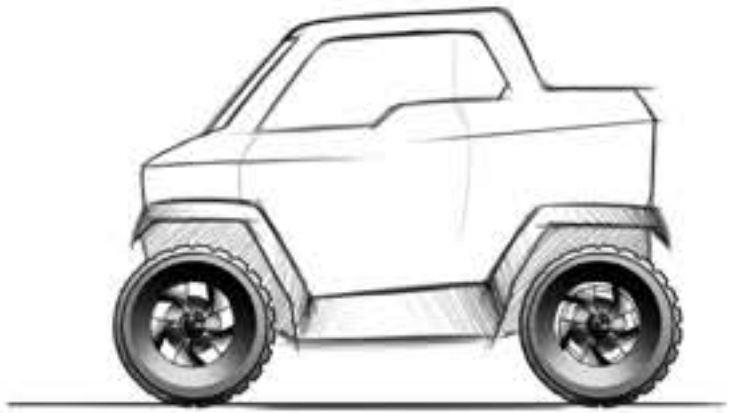
1. Better field of vision
2. Smaller footprint of 2700x1500mm
3. Gun operation can be done from inside.

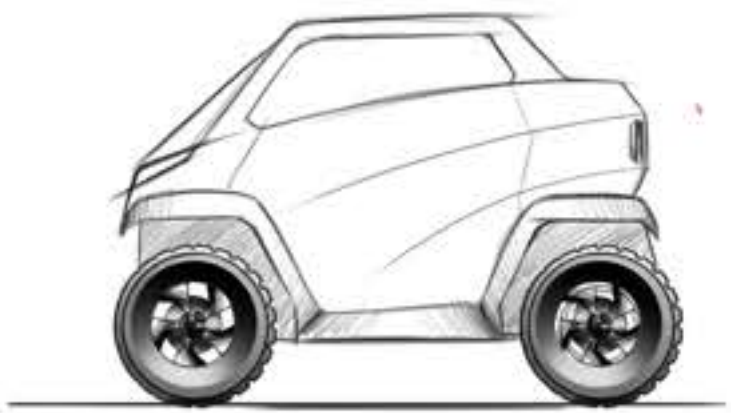
CON's

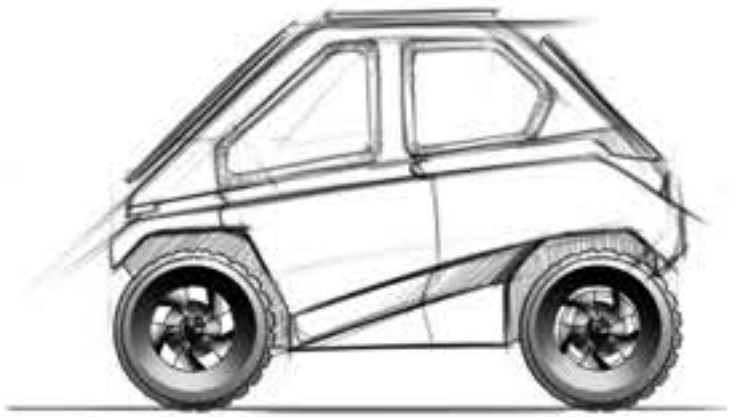
1. Less space to move around
2. Less space for batteries
3. Conventional style

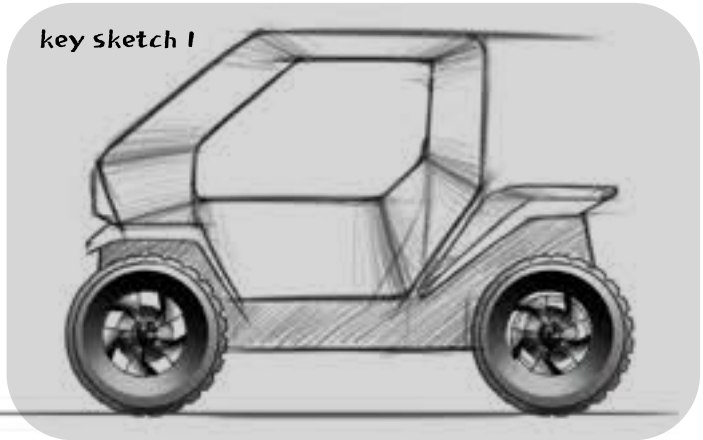
Form Ideation

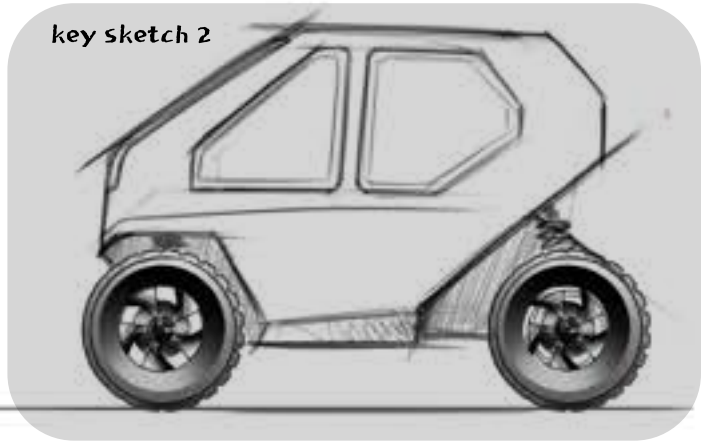
From indepth analysis, we arrived at the conclusion that option 3 provides the smallest footprint as well as will be the most effective package for the purpose. taking it as the base drawing i went ahead and made mutiple ideations keeping in mind the moodboard and the themeboard.

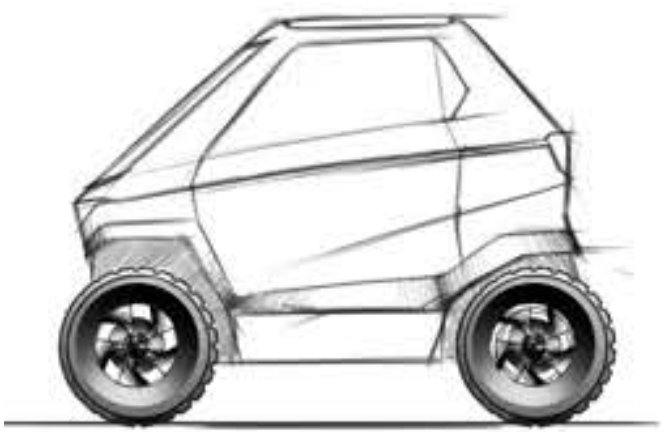


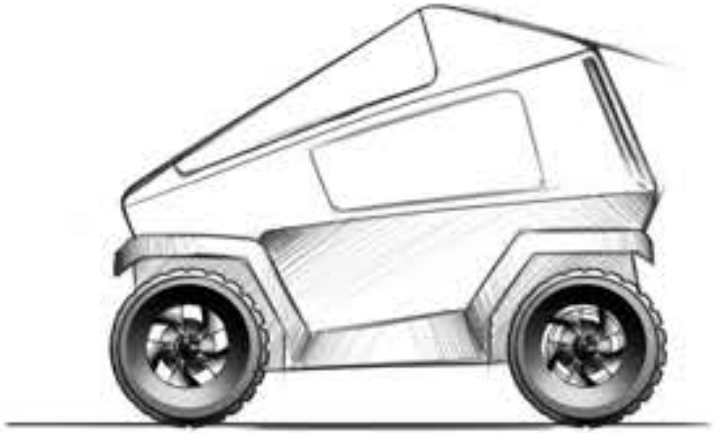


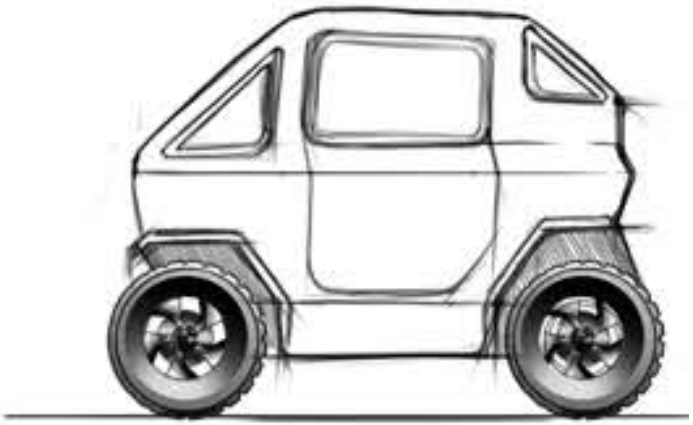


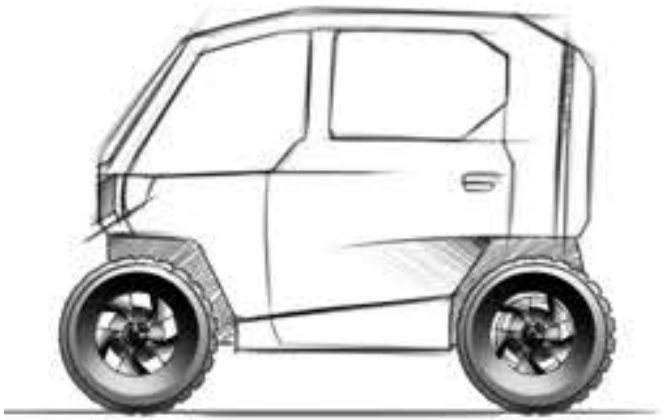


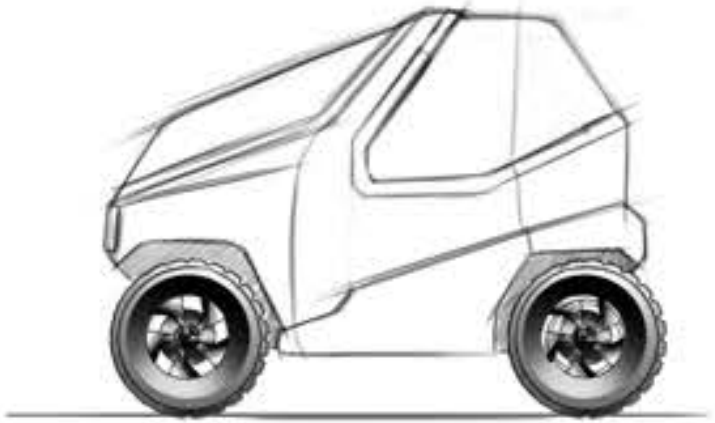


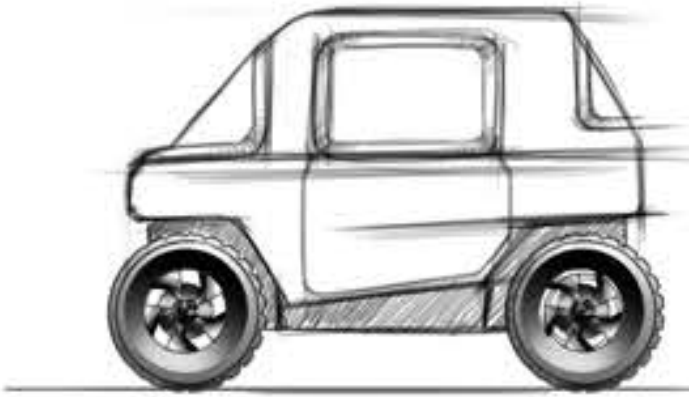


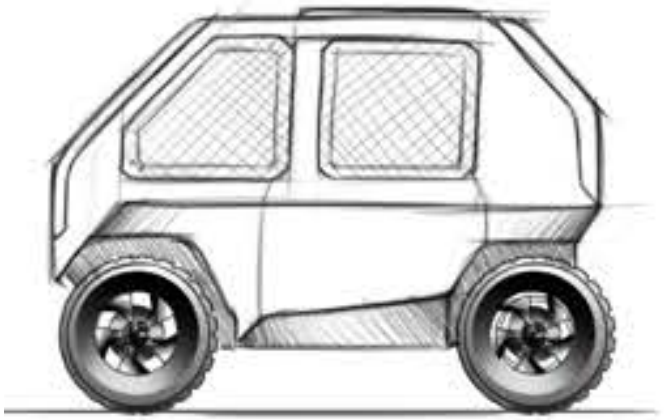


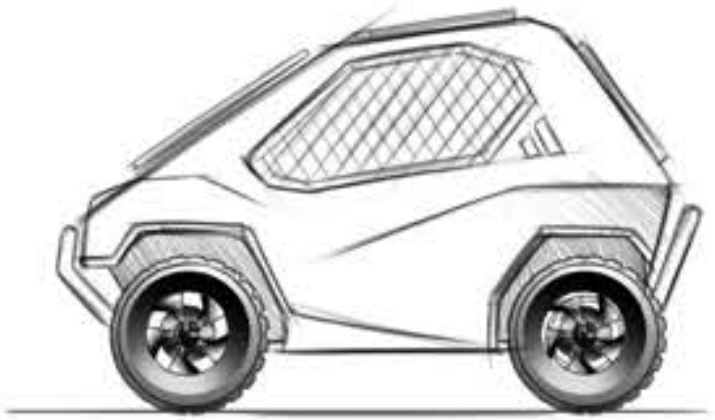




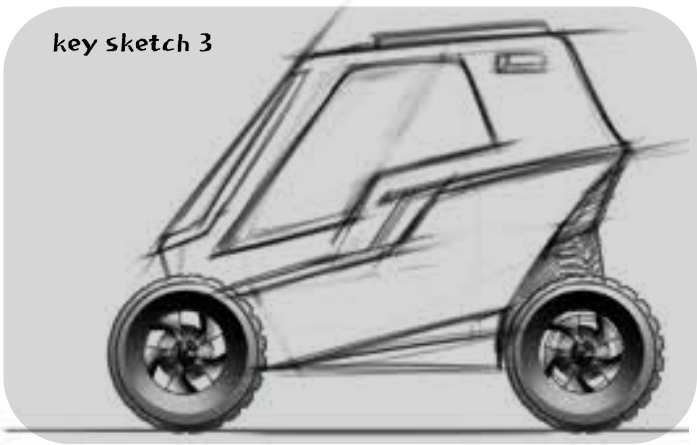






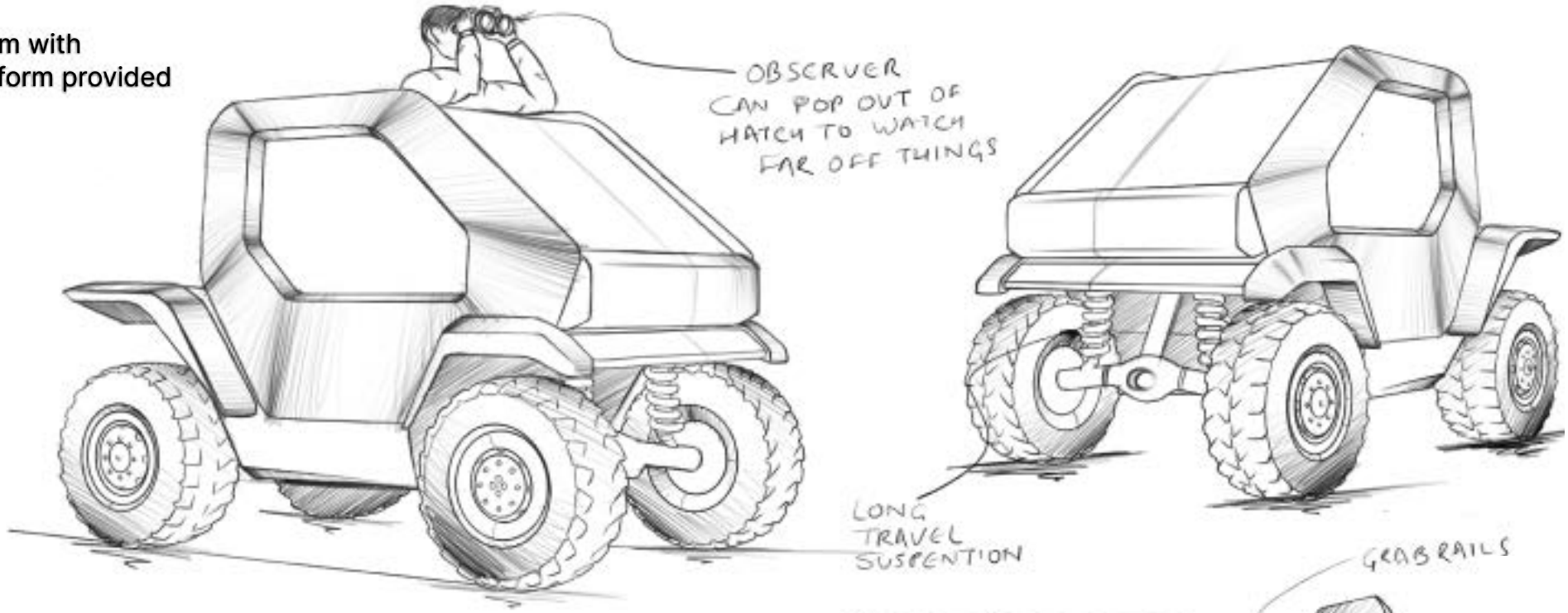


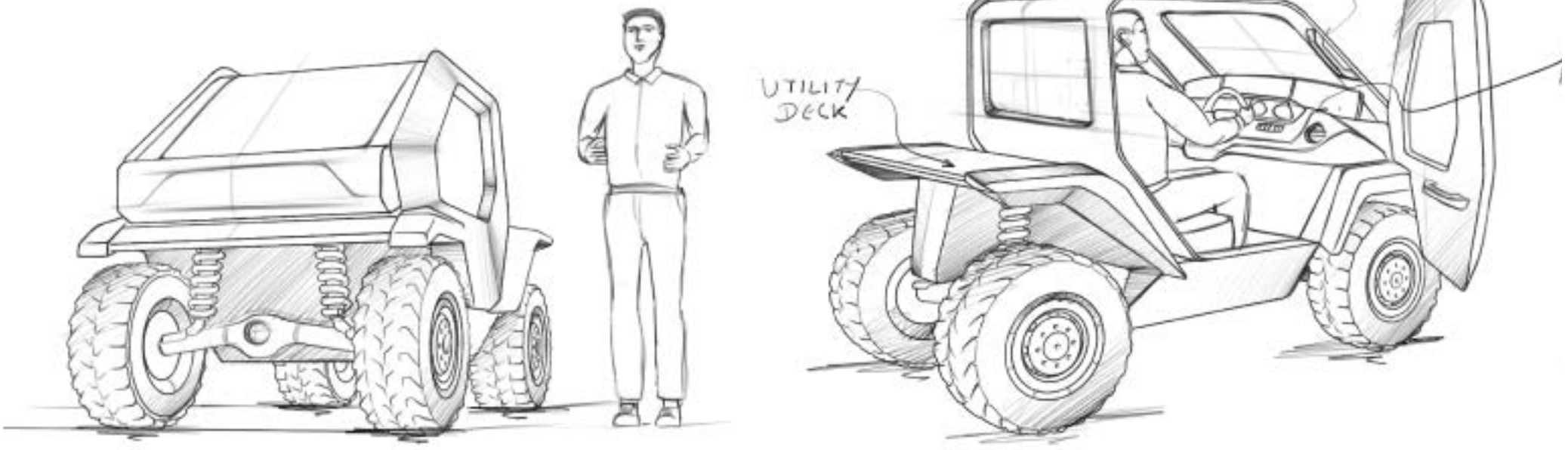
key sketch 3



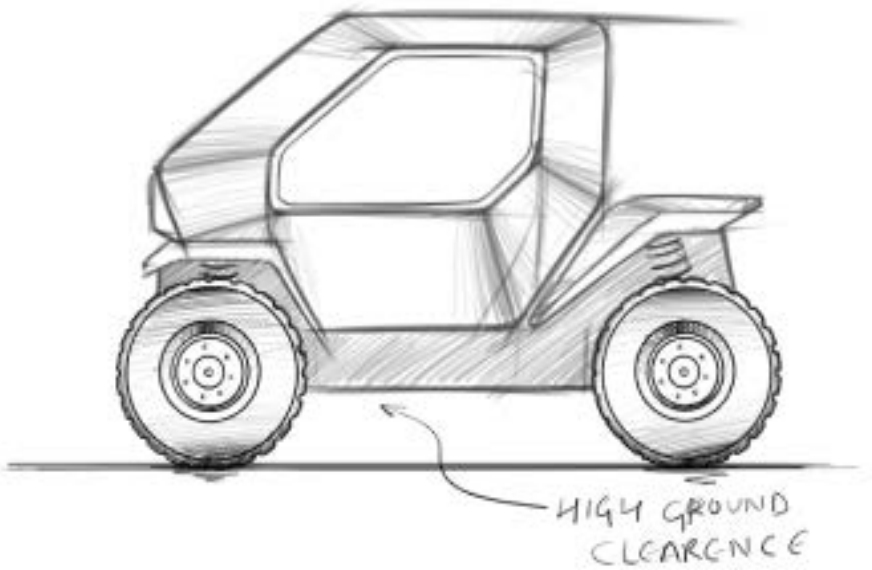
Direction 1

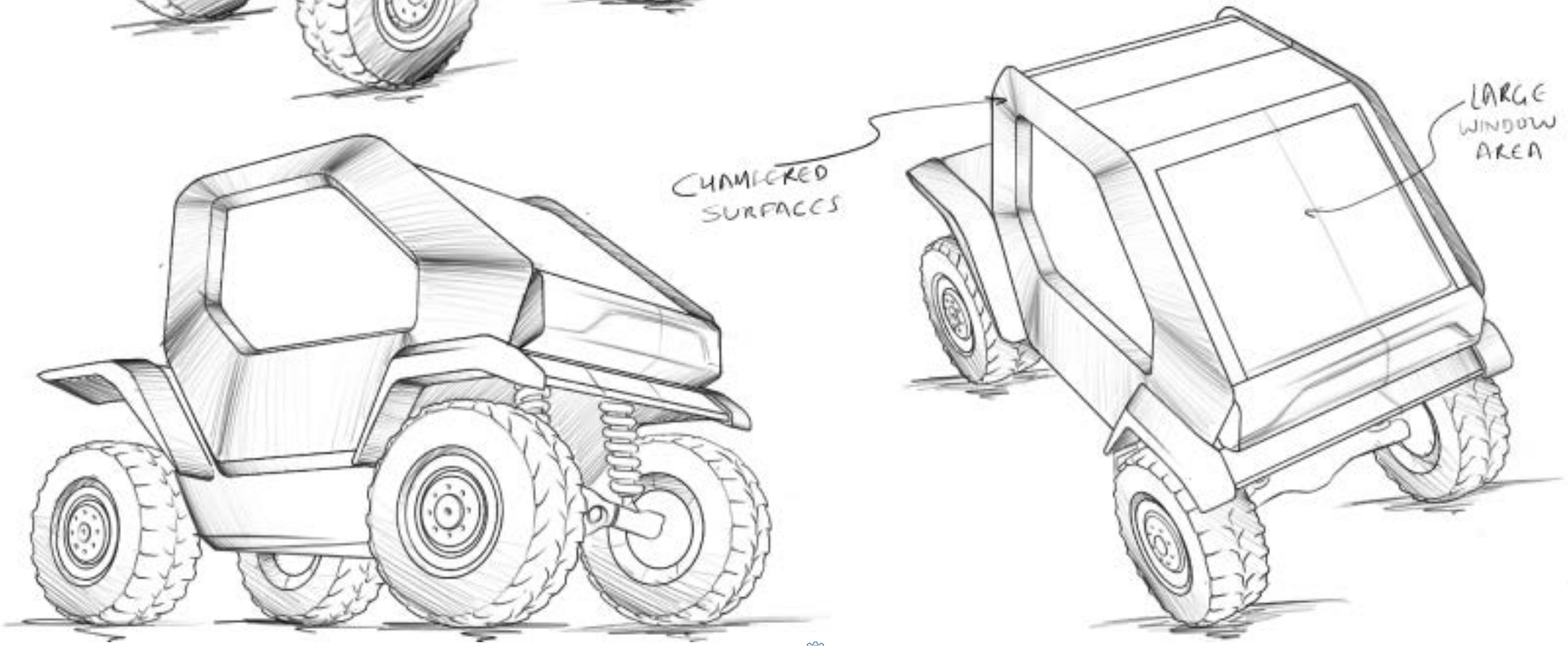
A futuristic form with additional platform provided at the back .





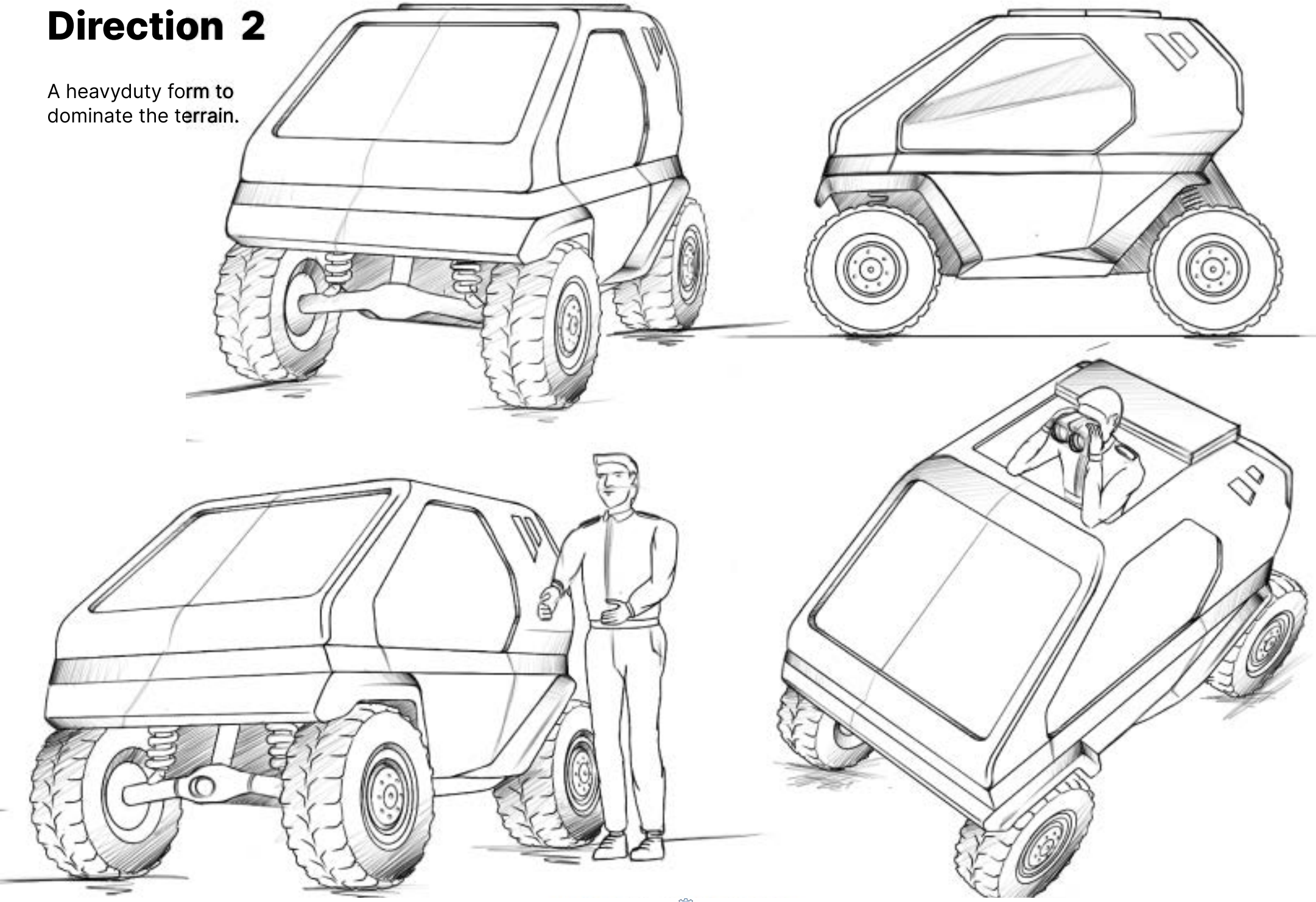

KEEPING
WATCH FROM
THE DECK

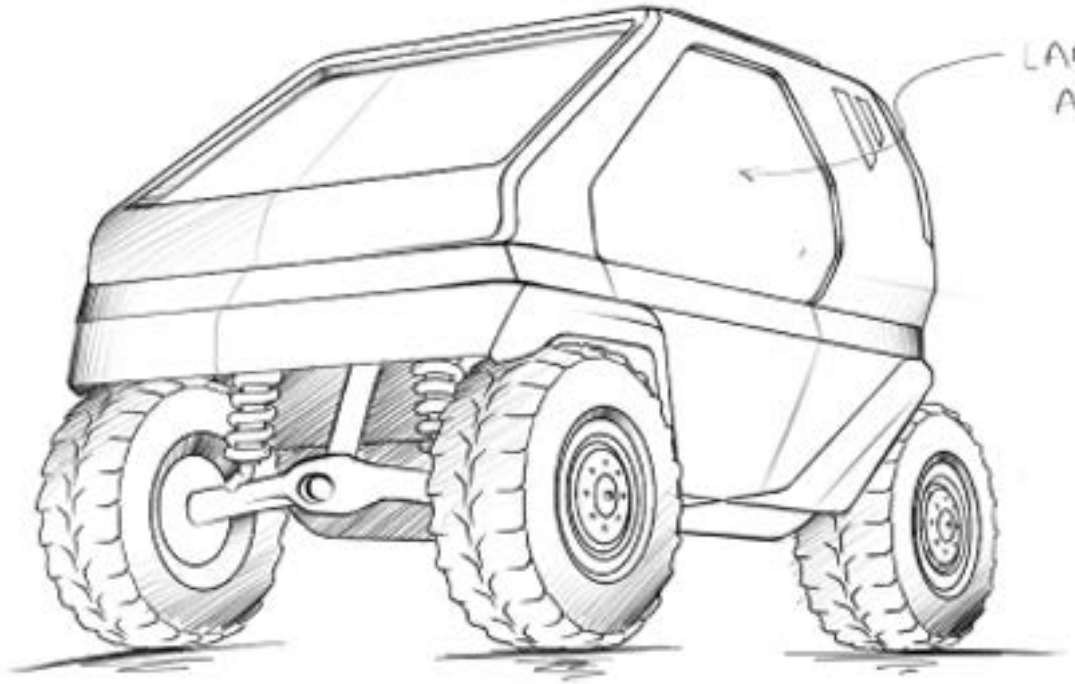

HIGH GROUND
CLEARENCE


CHAMFERED
SURFACES
LARGE
WINDOW
AREA

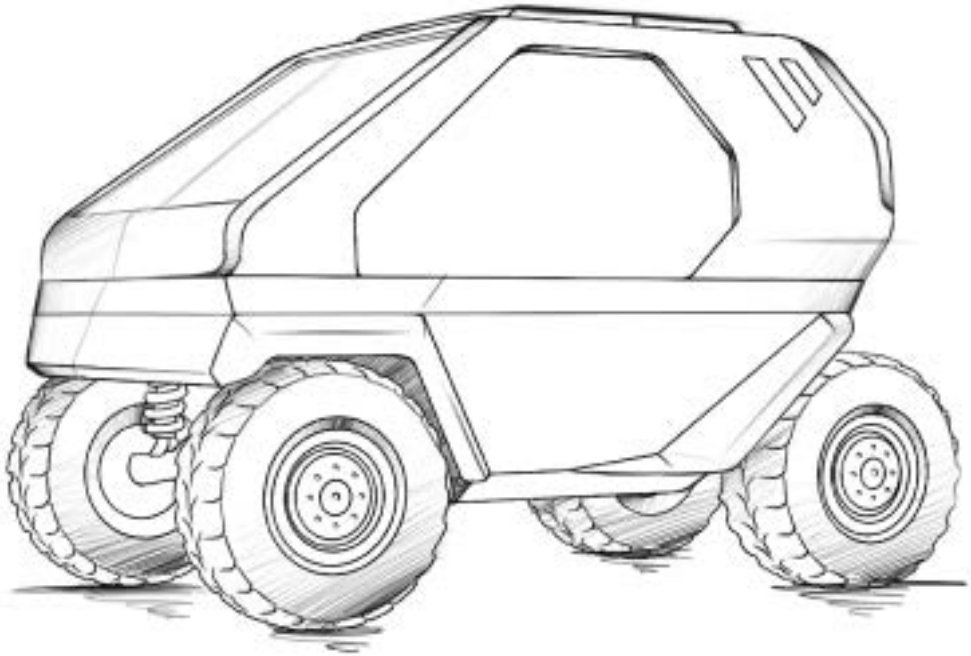
Direction 2

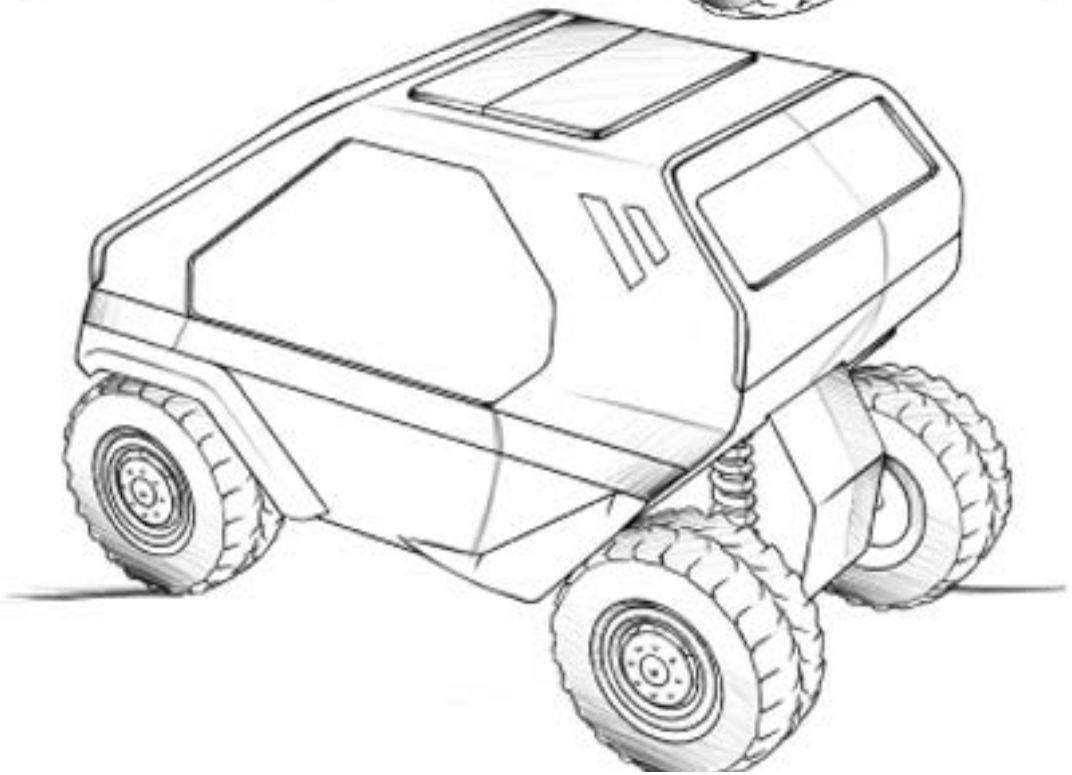
A heavyduty form to dominate the terrain.




LARGE VIEW
AREA


HATCH
TO POP
OUT-

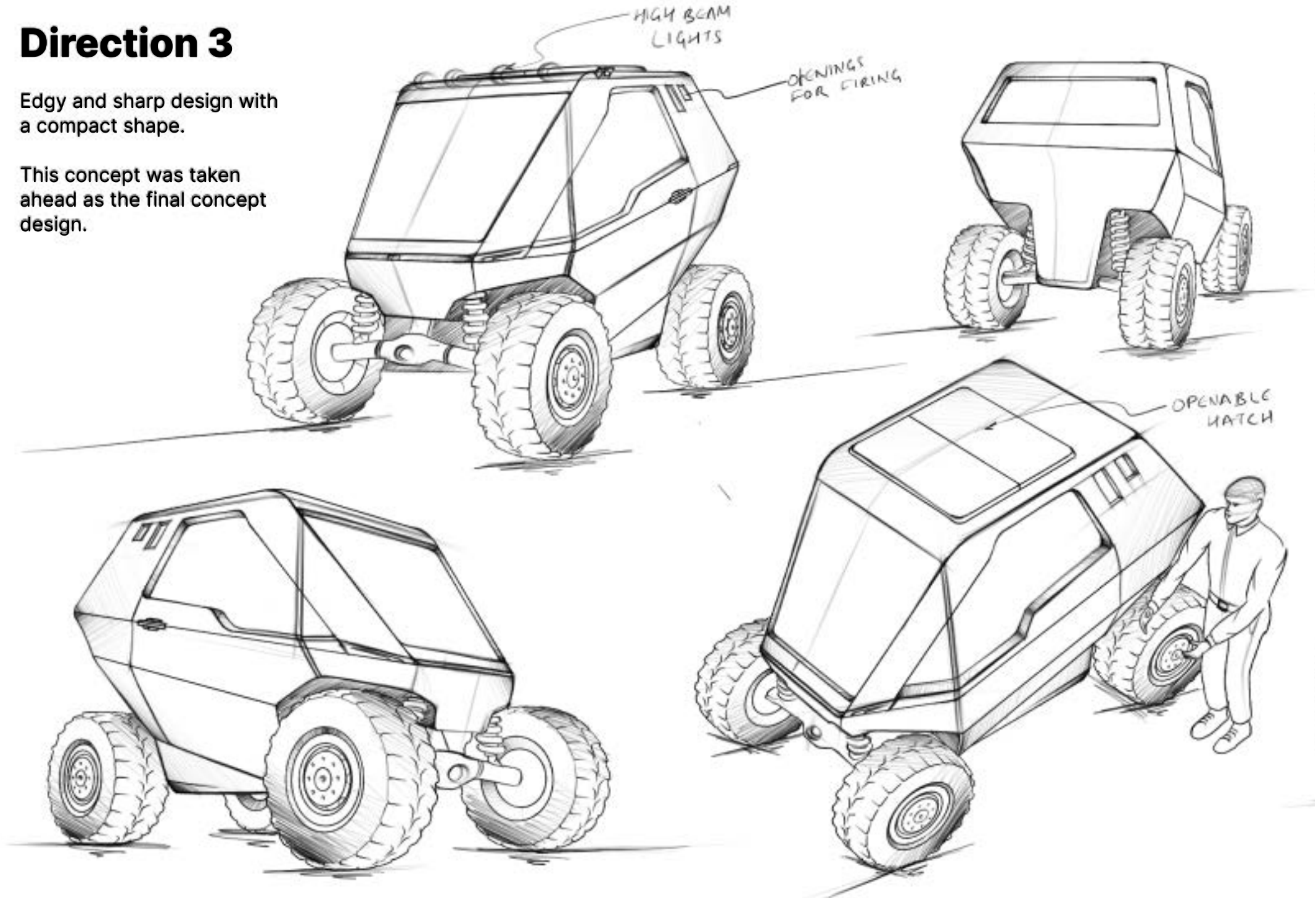




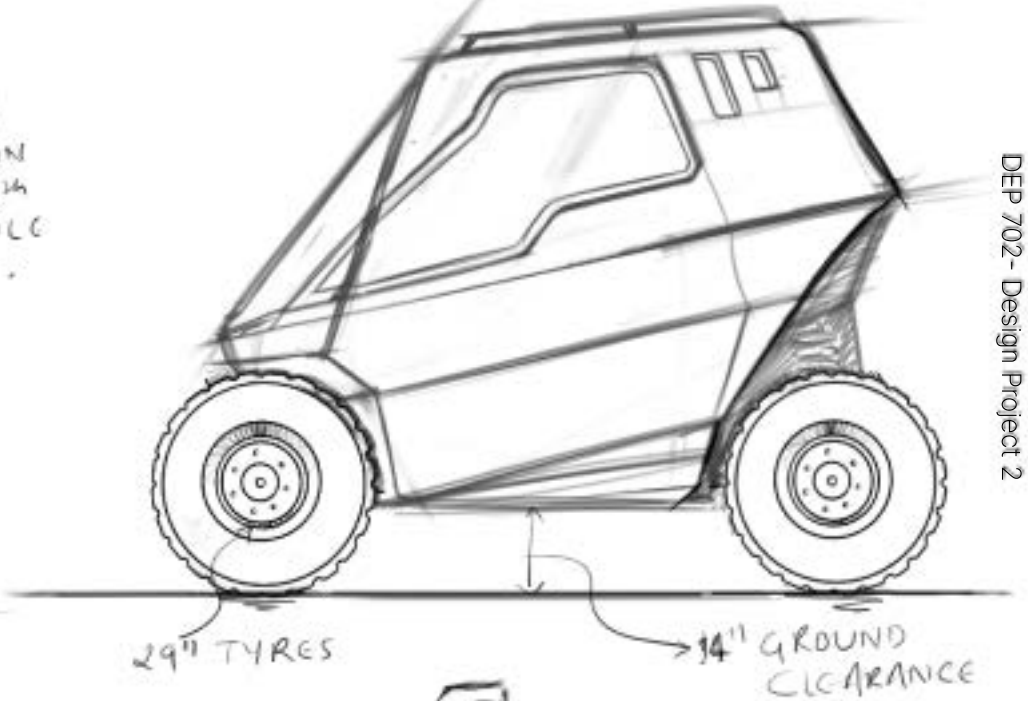
Direction 3

Edgy and sharp design with a compact shape.

This concept was taken ahead as the final concept design.




VEHICLE IN
COMPARISION
WITH 95TH
PERCENTILE
MALE.

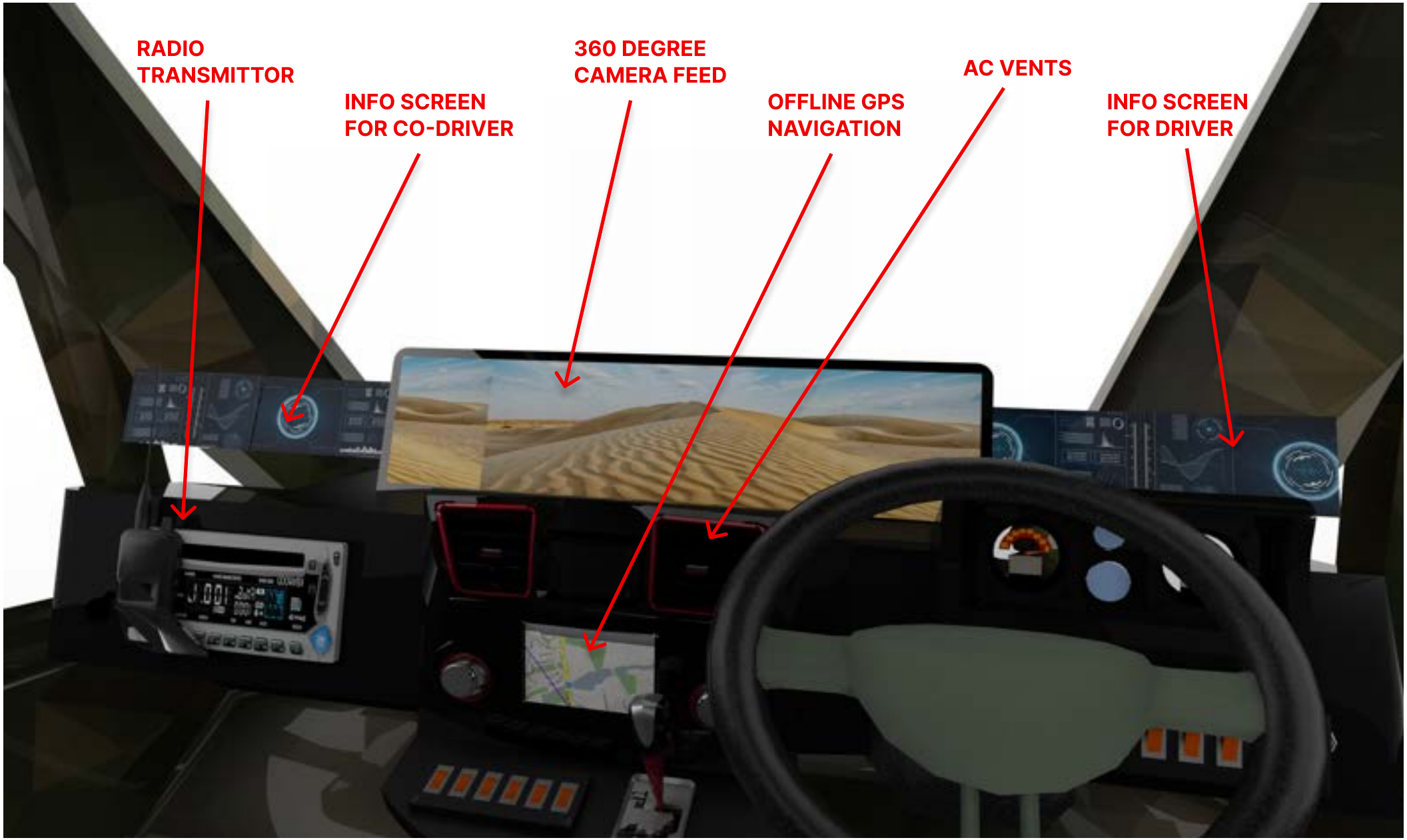

29" TYRES
14" GROUND
CLEARANCE

Final Concept Render

Final Concept Render

Final Concept Render

Interior


RADIO TRANSMITTOR
INFO SCREEN FOR CO-DRIVER
360 DEGREE CAMERA FEED
OFFLINE GPS NAVIGATION
AC VENTS
INFO SCREEN FOR DRIVER

Interior Render

Interior Render

Scenario Renders

Scenario Renders

Scenario Renders

Scale Model

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