

**MEDICAL FIRST RESPONDER VEHICLE
FOR CHENNAI**

MOBILITY AND VEHICLE DESIGN PROJECT III

MVD III-19

BY

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GUIDE

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Medical First Responder vehicle for Chennai

Design Project 3

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APPROVAL SHEET

This vehicle design project report entitled "MEDICAL FIRST RESPONDER VEHICLE FOR CHENNAI", by Harish Kumar P is approved in partial fulfillment of the requirements for Master of Design degree in Mobility and Vehicle Design.

Project Guide:



Chair Person:



Internal Examiner:



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Date: June 18, 2014

DECLARATION

I declare that this written submission represents my idea in my own words, and where others ideas or words have been included, I have adequately cited and referenced 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/sources in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also invoke penal action from the sources from which proper permission has not been taken, or improperly cited.

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Harish Kumar P

Date :

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1 [Abstract]

First responder vehicles are specialized vehicles which are made to respond for any emergency purposes. They are usually used for fire breakouts, rescue missions, medical emergency, or even for emergency police patrol cases. Their main purpose is to reach the destination faster to take control of the situation even before the actual task force arrives.

The project deals with medical first responder vehicles. These vehicles can reach the patient or victim even before the ambulance can reach the spot. This vehicle got to be fast and small enough to cut through traffic and reach the patient to give first aid. In medical terms, they call it the golden minute treatment, in which the patient is given immediate medical response. This immediate response is very

critical in cases like Cardiac arrests, airway problems, insects or snake bites, accidents occurring on roads, at home or at workplaces. Paramedics treat the patients on the spot before the ambulance arrives. Mahindra Reva E20 was selected as the base vehicle and the main focus was on the interiors.

The Design process starts with investigating the need and scope of the project by doing research on the existing projects and actual use of this vehicle in Indian context. The project is divided into three stages. The first stage concentrates on the need of such a vehicle: Research on the existing products, the users of the vehicle, equipment to be carried during in that vehicle. The vehicle that is going to be used as a base vehicle will also be looked into in this stage. A

quick look into the scenarios, the city Chennai which is the target location of the vehicle, will also be touched upon in this stage. The stage ends with generation of inferences out of the user study and a design brief which states the requirements, the technical details and other must have points in that vehicle. Stage 2 starts with quick ideations on how the concepts might be. Quick renderings are also made in this stage. Then package exploration is made to understand how the equipment and the paramedics will be placed inside. Mockups of the equipment simulating the size and weight were made and the package was evaluated on an actual car. Using the selected package, various concepts were made and they were evaluated based on criteria's like quick accessibility, securing the

equipment. The selected concept is refined further and a 1:5 scale interior model was made.

Stage 1

- Existing products study
- Study on the equipments to be carried
- User study
- Insights & Design Brief

Stage 2

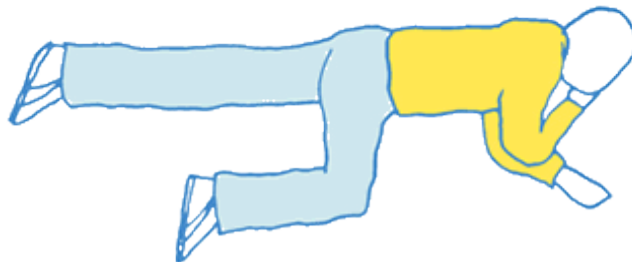
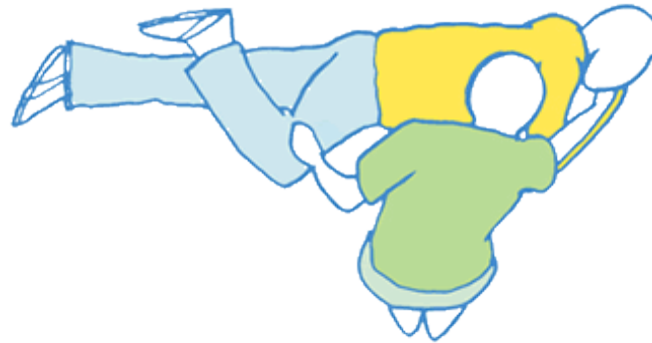
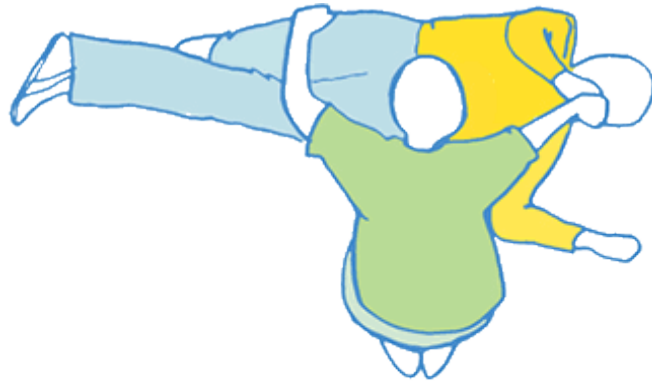
- package Exploration
- Shortlisting package concepts
- Mock ups and Rigs
- Final Concept Renderings

Stage 3

- Refining Final Concept
- 1:5 scale clay model

2 [Research]

2 [Research]



FIRST AID

The first aid is the initial care given to any kind of injury or illness. They are given so as to avoid the condition worsening. There are cases where the first aid is the actual live saving treatment. First aid is usually done by paramedics or trained people. One need not be a doctor to give first aid. Talking about the first aid, the techniques and strategy vary according to the geographic location, the patient, the one who gives first aid and few more secondary scenarios. The techniques are usually simple and straightforward. They involve less equipment and manpower. Certain illness or injury will not need any further treatment also, only the first aid will be sufficient to save the person. The types of cases which need first aid are usually heart attacks, Accidents

in the home, Road Accidents, Burns, Drowning, Electricity, and Poisoning. According to statistics, the maximum numbers of cases are heart attacks and Cardiac arrests.

The following steps are done in case of emergencies. These are not followed all the time; it may vary based on the situation and the equipment available. But these are recommended in a general scenario.

Recovery position

When someone is unconscious, make sure they lie down sideways with one leg and one arm extended to their side so that they don't swallow their tongue that will block their airway. It also make sure that vomit or any fluid doesn't block the airway.

Even after that the person is not breathing properly then the 'ABC' resuscitation procedure must be followed.

Airway

In this step the victim's chin is lifted with one hand and head is tilted back with another hand. The airway will be open in this position, check for the symptoms of breathing, that is chest movement or breathing sound. [image for airway]

Breathing

If the person is not breathing, then do the following steps

- Lift the chin up and push the head down to open airway
- Close the nostril and place your mouth over the victim's mouth, looking at the chest
- Slowly blow into the person's mouth and see if the chest

- rises
- Repeat the step until breathing aid arrives

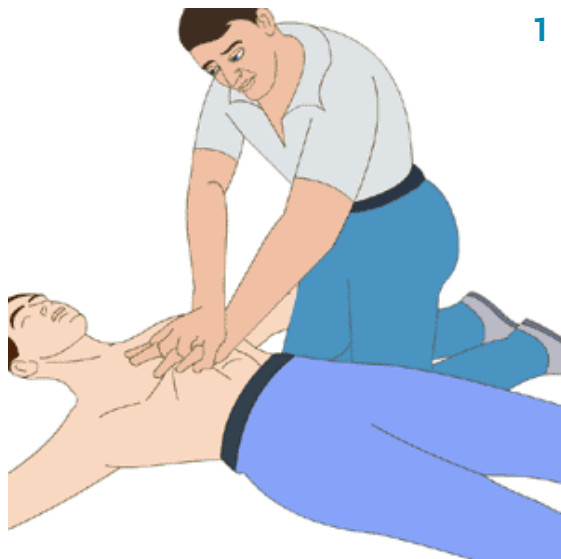
Circulation

If there are no signs of life at all after the breathing step, then do the following

- Locate the breastbone, that is the point where the rib cage divides
- Place your hands in the middle of the person's chest, just above the breast bone
- Interlock the fingers and press quickly to about 2 inches, while keeping your elbows straight
- Rate of compression is like two compressions every second.
- 30 compressions and then two breaths should be given and repeat the steps.

Similarly for other types of





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accidents or illness there are other types of recovery mechanisms. But it is very important to give first aid to these patients. For example, if a person is suffering from burns proper dressing at right time can prevent further damage occurring to the patient.

First Aid Equipment

The first aid equipment aids the person who gives first aid (usually paramedic) faster. The equipment needs special training to use them properly. They are carried to the spot using ambulances or first responder vehicles. There is countless number of equipment for first aid, but the following few are the most essential ones.

Defibrillator

The Defibrillator is a device which is used in treating for

life threatening conditions like cardiac dysrhythmias, ventricular fibrillation and pulseless ventricular tachycardia. The device produces therapeutic electrical energy which is used to restore the heart to its normal beat cycle. The charges target the critical heart muscles and stops the dysrhythmia and makes normal sinus rhythm to restore the natural body pacemakers status. The device is used in many ways. It can be planted inside the body like a pacemaker or it can be external. In external also there are several types. They are manual, semi and Automatic External Defibrillators.

The devices need some experience, since it needs the paramedic to judge the correct placement of electrodes and reading the patient's heart signal. Paramedics must know how much electrical discharge must

be given to the patient and when it should be given. If given in a wrong way, it might lead to even death. The surrounding area around the patient must be cleared before giving electric charge as the patient starts conducting electrical charge. There are different kinds of defibrillators. They are find their use based on the patient.

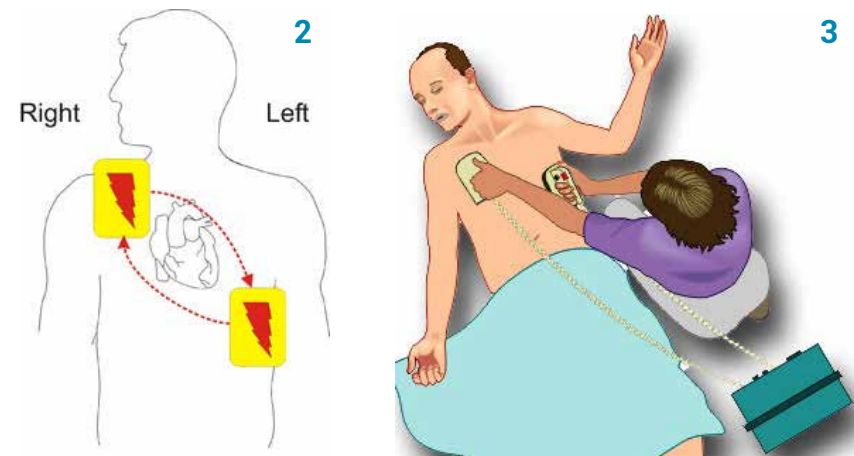
Manual External Defibrillator

These are handled by highly trained paramedics who could read the patients vital signs and Electro Cardiogram (ECG) signals. When the paramedic finds any abnormality in the patients ECG reading he gives a proper dosage of current to the patient. That value of current can be decided by the paramedic based on the patients all vital stats. The equipment consists of screen to display the ECG

readings, two leads to pick up the heart signals and then two pads where the electric current is given to the patient.

Automatic External Defibrillator

Many cases the paramedics wont be available to calculate the current and timing , so it is of paramount importance that the current must not be given in a wrong way so that the patient is not killed. Automated External Defibrillators (AEDs) are invented to solve this problem. The AEDs are programmed defibrillators which could calculate the patients cardio signals and generate current based on that. These devices are known to be more accurate than the manual ones. They can be used by any layman. It usually has voice commands which guides the person to fix the leads properly and give current signals when needed. It also





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helps the person to carry out the CPR routine which is necessary after every electric shock.

Suction Apparatus

This usually refers to a portable suction apparatus used in wards and theatres for aspirating fluids and vomit from the mouth and airways, and from operation sites by sucking the material through a catheter into a bottle. The term could also apply to devices which operate from piped vacuum supplies or bottle gas cylinders but is more commonly used to mean electric suction units which contain a vacuum pump (piston, diaphragm, or rotary vane), bacterial filter, vacuum gauge, trap for moisture (or any debris accidentally drawn into the mechanism), a reservoir for the

aspirated material, and a suction catheter or nozzle. They may be intended to provide high or low vacuum, and high and low flow rates. Low vacuum is used for post-operative wound drainage.

The main reservoir is usually a glass bottle with volume marks up the side and sometimes this has a float valve so that the vacuum is cut off before the bottle becomes full enough to allow the contents to be drawn into the pipework of the pumping mechanism. However, frothing of the contents can sometimes defeat the float valve mechanism.

They may sometimes be described as high-grade or low-grade suction machines, which relates to the degree of vacuum achieved. High-grade suction



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¹ <http://srxn.files.wordpress.com> Retrieved 26-2-2014.

² <http://www.made-in-china.com/> Retrieved 26-2-2014.

machines are used for rapid aspiration of fluids and debris (such as vomit), whereas low-grade machines are used for post-operative wound drainage.

Immobilization Equipment

Spinal Immobilization is a very critical pre hospital care that ought to be executed if the person is suffering from penetrative trauma which has reached the spine. In this case the patient cannot be moved so that the spine movement happens. Spine is a collection of bones and discs which could flex in almost all directions. The vertebral column consists of important nerves which contribute to the motor functions of human body.

If the spine is injured, the victim generally goes into an unconscious state. To prevent

the victim from going to an unconscious state, he or she must not be moved, so that the spine is not affected. The cervical and head immobilization is also an important factor as any injury to these parts will also result in a similar kind of reaction.

The spinal immobilization will give positive outcome when it is done properly. Again properly trained professionals are needed for this execution. If executed in a wrong way, it might lead to some major neurological problems. There are equipment's like spine board, scoop boards which aid the victim to stay in place. Scoop board helps in lifting a patient without disturbing the spine arrangement.



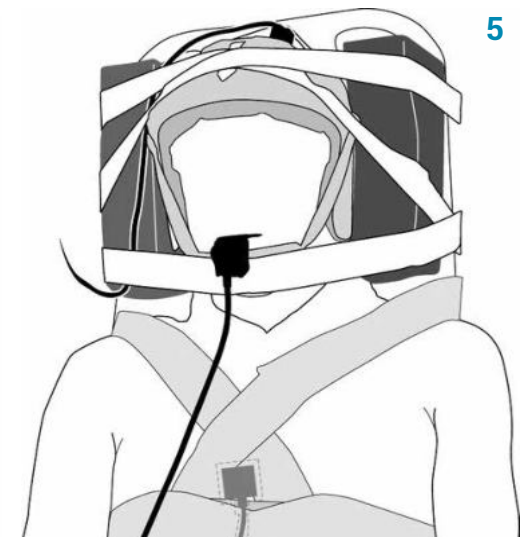
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3 <http://tjskl.org.cn> Retrieved 27-2-2014.

4 <http://dekage.hr> Retrieved 27-2-2014.

5 <http://bmsi.ru> Retrieved 28-2-2014.

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Breathing Apparatus

Many times the patient will not breathe and the paramedic needs to do a manual resuscitation process. The paramedic will bend the patient's head back, open the mouth and blow air into the mouth to initiate the breathing cycle again. This can be done only by trained paramedics. But blowing into patient's mouth every time is not so easy and comfortable. An Artificial Manual Breathing Unit (AMBU) bag is a pouch which when pressed, forces air out of a small tube which can be redirected to the patient's mouth. This process is also called as "Bagging" the patient. It is useful when the patient is suffering from respiratory failure or respiratory arrest.

The air which is forced inside the

patient's lungs will inflate them under pressure and then provide positive pressure ventilation.

This AMBU bag is found in almost all hospitals and ambulances. This is very vital, even if the victim is a child. There are different sizes available.

The tube can be inserted directly inside the patient's mouth or it can be used with a pocket mask which is used with an oxygen cylinder.

Bandages and Splints

A splint is nothing but a bandage which is used to secure any broken bone. This could be only bandages or it could be compounded with sticks or



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1 <http://store.medicaltactics.com/> Retrieved 28-2-2014.

2 <http://cmeeducation.com/> Retrieved 28-2-2014.

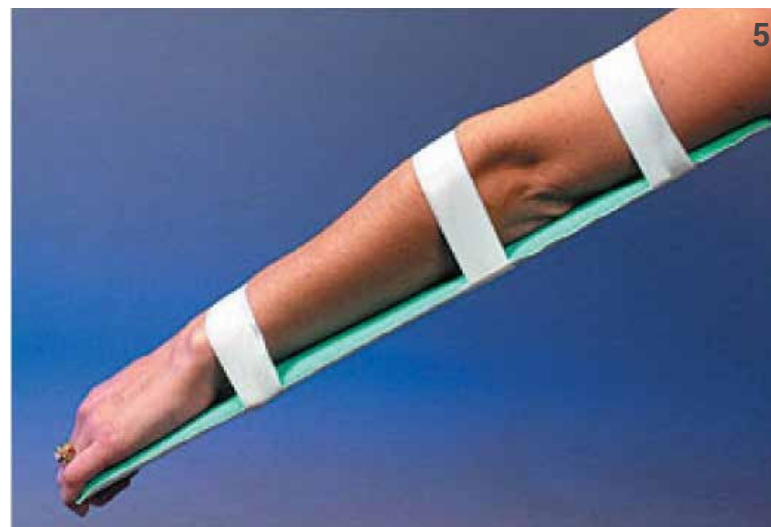
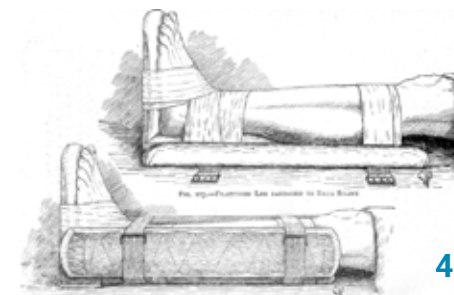
boards. There are two types of broken bones, Simple fracture and compound fracture.

Simple fracture is when a bone is broken into two parts. The bones are beneath the skin and don't come out. They could slice through the tissues and blood vessels which are underneath the skin, hence more care is needed. Compound fracture is when there are many smaller pieces of broken bone and they stick out of the skin. In this case, there are more chances of infection to happen. The bone should not be pushed beneath the skin, it cannot be treated like a normal puncture wound. Treating a compound wound, the same procedure of dressing and applying bandage is done.

The broken bones needs special attention, it cannot be treated like a normal wound. The bones need to be fixed in place and then some

rigid material like plaster of paris is applied over the bandage to prevent any movement. Different types of knots and splints are available to make them stay in a place.

In an ambulance all different types of splints and bandages are available. The paramedic needs to analyze what kind of fracture has taken place and must immobilize the broken part without any further movement. Padding between the rigid material and the body is needed to comfort the victim.



3 <http://www.allkids.org/> Retrieved 28-2-2014.

4 <http://www.allkids.org/> Retrieved 1-3-2014.

5 <http://www.schoolhealth.com/> Retrieved 1-3-2014.



1

Drugs

Drugs are very important in any first aid process. This helps the patient to cure quicker. The drugs for emergency cases are used for cases like cardiac arrests/arrhythmias, strokes, seizures, allergic reactions, overdose, and traumatic injuries. These are common drugs which will be available in all the first aid boxes. The drugs just initiate the chemical action and bring back the vital signs of the patient. Drugs like activated charcoal will be helpful for cases like poisoning. The drugs can be carried in any box, usually no need of any extra refrigeration. Rucksacs are available which can hold almost all important medicines, bandages and gauze strips.



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FIRST RESPONDER VEHICLE

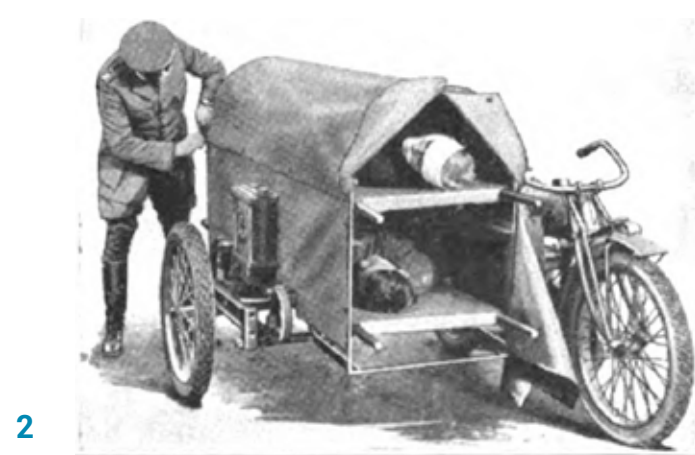
These are the Vehicles that can carry all necessary equipment and paramedics to reach the destination as quickly as possible and give pre-medical care for medical emergencies. Emergency response vehicles can be used to reach a scene more quickly than a standard ambulance, as they may be able to move through traffic with greater ease, or travel at greater speed, to bring additional or more skilled resource to a scene, or to simply to avoid sending too much resource to medical problems that do not require it. The vehicle may be a production car (often a station wagon or SUV as they have greater carrying capacity) which is provided and manned by an emergency medical service

organization in order to provide transport to their staff. The fly-car enables the crew (often a lone responder) to bring their equipment quickly to the scene of an emergency, and may carry most of the same equipment as a full size ambulance, although it is likely to be limited in its capacity to transport patients. The purpose of this vehicle is ,emergency response vehicle can help emergency medical organizations use their resources more efficiently, sending this smaller vehicle to the scene of an emergency call, where they can **assess an incident's severity** (especially where there is reason to suspect the injury or illness is not serious) and call in additional help if required. A QRV is smaller



3 <http://commons.wikimedia.org/> Retrieved 1-3-2014.

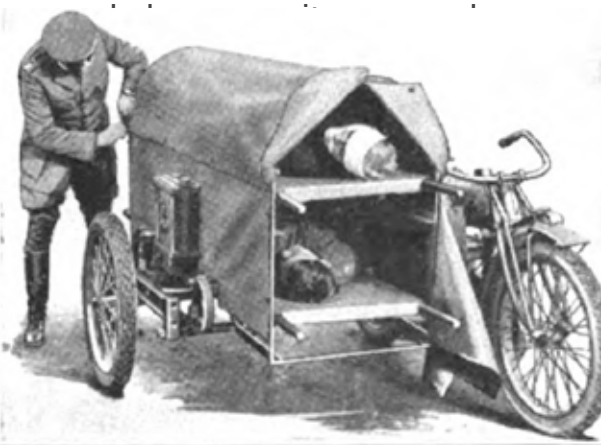
4 <http://www.ambulancevisibility.com/> Retrieved 1-3-2014.



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This can represent a **resource saving** on several levels, with most fly-cars costing much less than full size ambulances, and because they can often be staffed by a single person (ambulances require a minimum of two crew members: a driver and an attendant).

Fly-cars can also be used to **improve response times**. This especially applies in areas such



, where the smaller
ble to move through
than a full size
Some fly-cars may
f-road capabilities,
ccess to areas that
mbulances cannot

or fly cars include
supervisor" vehicle
icer or supervisor
various calls but

does not ride on the ambulance
to the hospital. This principle
especially applies where the fly-
car is crewed by a paramedic,
who can assist lower qualified
staff, such as emergency medical
technicians on an ambulance,
meaning fewer people at the
higher qualification level are
required. However, dependent
on the jurisdiction and needs of
the individual service, any level

1 <http://sidecarworld.blogspot.com/> Retrieved 2-3-2014.

2 <http://commons.wikimedia.org/> Retrieved 2-3-2014.

of emergency medical provider from first responder to doctor can be found on fly-cars.

Motorcycle ambulance

Motorcycle ambulances are a type of emergency vehicle which either carries a solo paramedic or first responder to a patient; or is used with a trailer or sidecar for transporting patients. A motorcycle ambulance is able to respond to a medical emergency much faster than a car or van in heavy traffic, which can increase survival rates for patients suffering cardiac arrest. Motorcycle ambulances were used during World War I by the British, French and Americans. At the time the advantages of light weight, speed, and mobility over

larger vehicles was cited as the motive for the use of sidedcar rigs in this role. The US version had two stretchers arranged one on top of the other. The French ambulance used a sidecar that held a single patient, who could either lie down or sit up.

Modern First Responders

Nowadays the first responder vehicles are becoming more narrower and smaller to tackle the traffic conditions. below are a few example cases which shows compactness is given importance.

Renault Twizy

The Renault Twizy is a battery-powered two-seated electric vehicle, legally classified in Europe as a heavy quadracycle.



3 www.almchh.org.hk/ Retrieved 2-3-2014.

4 <http://commons.wikimedia.org> Retrieved 2-3-2014.



1 <http://bos-fahrzeuge.info/> Retrieved 5-3-2014.

The Vehicle is so narrow(only 1.2 meters) and has a turning radius of 6.6 meters, it is one of the best compact four wheeled first responder vehicle that exists.They have this rack on the back that can carry additional life saving equipment. One can ride the vehicle, and one can accompany on the back. The paramedic at the back wont feel so comfortable because of space constraints. It doesnt have any windows,so rain protection might not be so efficient. The speed of the vehicle is not an issue. Even though it has all this problems it is one of the promising concepts made. This vehicle can be made as a standard vehicle in many countries where the traffic is low, but the road must be good enough

as the ground clearance is very low, and it is an electric vehicle, so it needs proper infrastructure.

Indian Scenario

The Indian first responder vehicles are still in a very conceptual stage. A few attempts have been done, but most of them failed. To understand the scenario better, i visited Apollo Emergency hospital at Chennai, which is known to be best emergency ambulance service provider in Chennai city. I Spoke to Mr. Ramadoss who is the ambulance coordinator of Apollo group of hospitals in Chennai. When the word first responder vehicle was uttered, he became excited and said that even Apollo is interested



Mr. Ramadoss
Ambulance Coordinator, Apollo Hospitals, Chennai



in such a project. He then mentioned about the project they made in 2005 which was a first responder vehicle for Chennai city. They launched India's first fully-equipped two-wheeler ambulance service called 'Apollo First'. It used a TVS Centra motorcycle with all the basic life support equipment boarded on it. Two paramedics were on it to reach the spot on time and treat the patient. Apollo Chairman, PC Reddy said, "Irrespective of all that we do with the siren, still there is a lot of time that is being wasted because of traffic block. So, for that we have created this two-wheeler ambulance 'Apollo First', so that two-wheeler can negotiate itself and go to patient care almost immediately and attend to his urgent need. The ambulance will follow if it is

necessary for him to be shifted to the hospital. So the two-wheeler ambulance to beat the traffic and to reach the patient at the earliest is the first. We are launching it across the country".

The project even though was a bold and sensible move in Chennai, it failed within few months time. The reasons stated were,

- People are not accepting a first responder vehicle, they need proper ambulance to be available. They were not cooperating enough with these paramedics.
- The paramedics were not very skillful to ride the vehicle with all the equipment on board. It does not make sense to use a very entry level commuter motorcycle to carry these expensive equipment.

¹ <http://www.hindu.com/> Retrieved 2-3-2014.

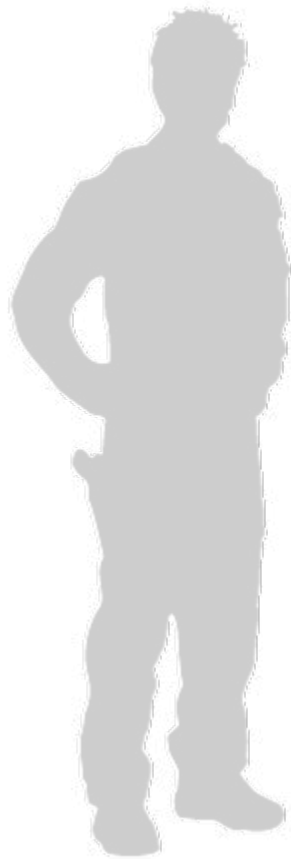
² www.indiatraveltimes.com/ Retrieved 2-3-2014.

To understand better, i went and spoke to the chief male nurse, Mr. Sudhakar who is trains all the male nurses at Apollo hospitals. The first and the foremost information was that in Chennai there are no paramedics available, only male nurses are available to give first aid. Only male nurses can respond to these situations as they need to lift heavy weights and travel in rough and tough scenarios. He also added to the case that they had done before, the two wheeler first responder that the male nurses did not feel good to ride the motorcycle in chennai weather. They used to travel in air conditioned ambulances, but in that two wheeler project, they need to travel in hot chennai sun.

Then he gave information about the types of ambulance and the curriculum they follow for these male nurses, who are considered as paramedics in Chennai. There is no proper curriculum set for these training, they are still working on the scope to improve the quality and meet international standars.



Mr. Sudhakar
Sr. Nursing Officer, Apollo Hospitals



User Defined

- Male Nurses travel usually two in numbers. They always act in a team and they know their roles very well.
- These guys are of age 20s to mid 40s, they are physically strong and can handle harsh conditions.
- Trained in Basic Life Support and have good field experience.
- Knows to drive well, they pick people who already drives good. But it is not essential for all paramedics to drive all kinds of vehicles.
- Need to communicate before, during and after the trip.
- Records all events, vital stats of the patient. He must have a good memory to remember all the events, and will compile everything as a trip sheet. This trip sheet is very important document for the doctors to know what happened during and before the patient is shifted to the hospital.
- Works fast and knows to use all Basic life support equipment.



In Chennai, '108' most used for road accident cases

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On an average, 108 caters to 3,500 emergencies a month in the city. The number of cases has increased from last year — Photo: M. Vedhan

The city may well be the road accident capital of the country going by the emergency calls made to the 108 ambulance service.

The city's utilisation of 108 has been increasing but emergency care managers say the ambulances were mostly sought for accident cases as against pregnancies and other emergencies like chest pain.

On an average, 108 caters to 3,500 emergencies a month in the city. The number of cases has increased from last year — in April 2012, 108 handled 2,299 cases, whereas, this July, the number of cases stood at 3,776.

"When we look at the State figures for utilisation of 108 ambulances in the city, nearly 26 per cent of cases are pregnancy-related emergencies followed by road traffic accidents at 24 per cent. In Chennai, 25 per cent cases comprise accidents and just 10 per cent are pregnancies. Other emergencies

such as chest pain and acute abdominal pain are single digit contributors to the overall utilisation percentage," said B. Prabhudoss, regional manager of GVK-Emergency Management and Research Institute (EMRI).

People should understand they can use 108 for any kind of trauma and medical emergency including respiratory problems, oral poisoning, and insect, snake and animal bites, he said.

The Tamil Nadu Health Systems Project is the nodal agency that sponsors the 108 emergency response service along with GVK-EMRI, which is a private partner. There are 629 ambulances in the State, of which 35 operate in the city. "The ambulances are

fully equipped with medicines, equipment and oxygen. It is available free of cost to patients. They can choose the hospital they want to go to. In an emergency situation, it should be the nearest medical facility," he said.

V. Kanagasabai, dean of Government General Hospital, said more than 60 per cent of cases brought to the GH were of trauma. "Two-wheeler accidents constitute a

TOPICS
Tamil Nadu
Chennai

disaster and
accident
road safety

transport accident
road accident

108 Ambulance service

Initially, Tamil Nadu Health Systems Project had partnered with selected NGOs in 15 districts to provide ambulance services. Due to various difficulties faced in running the operations, it was decided to partner with an experienced organization. The 108 Emergency Ambulance Service is a 24x7 service, which anyone can avail by dialling the number 108 on their phone during the case of any emergency.

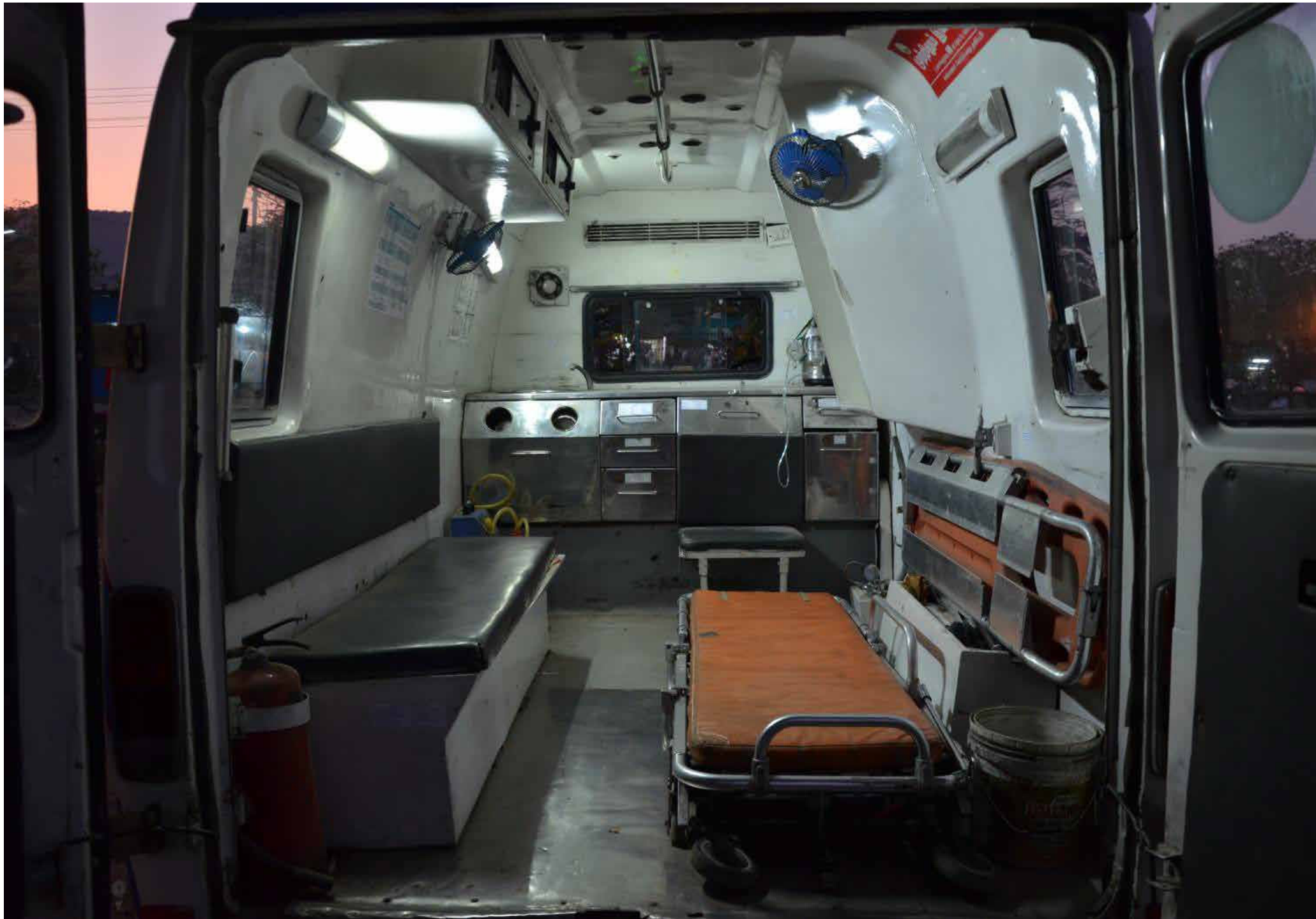
It could be either a medical emergency, a fire emergency, or a crime being committed. The number 108 is a toll-free number and can be dialed from any phone, be it a mobile phone or a landline, at the time of an emergency, without any prefix or suffix.

Help reaches the person within 20 minutes.

Initially, the person who receives

the call at Emergency Response Centre (ERC) takes down the nature of emergency and the location of the caller. Depending on the nature of the call, either an ambulance, a fire engine, or a police assistance is sent. This is done through the Emergency Response Centre.

The centralized Emergency Response Centre helps coordinate between the Despatch Officer, Emergency Response Centre Physician and the Emergency Medical Technician (EMT) for getting guidance during transit. Coordination with police and fire department is also facilitated through the Emergency Response Centre. The entire service is free for any citizen.



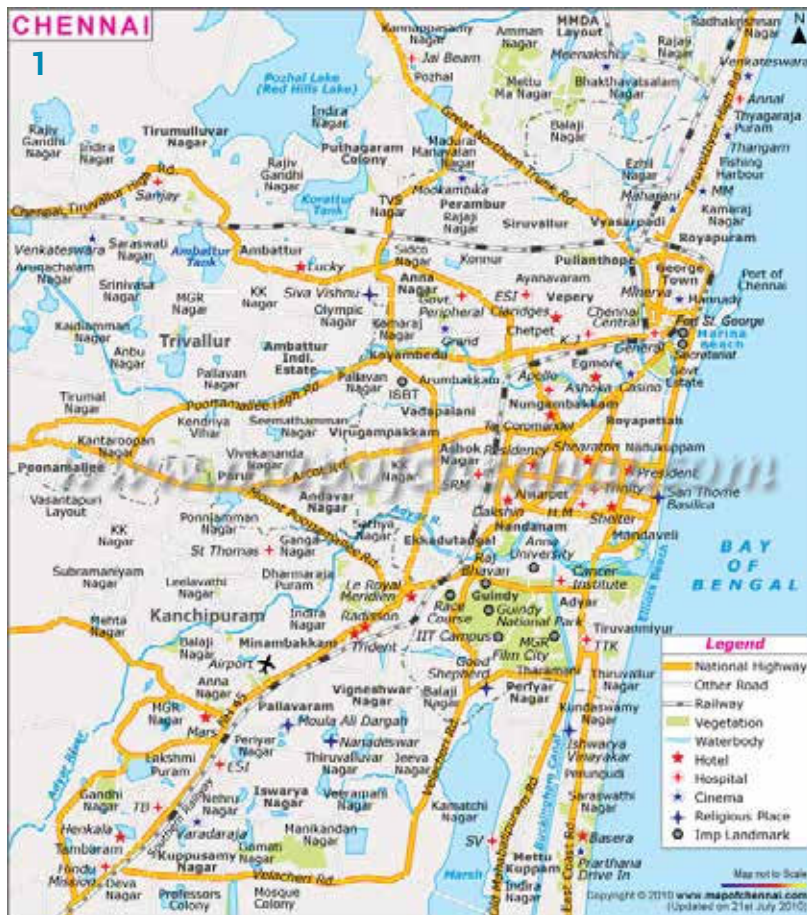


Observations from the 108 ambulance

- The ambulance is not kept clean first of all. There are blood stains all over the place.
- The garbage is not cleaned at all and the lids are defective.
- Non ergonomic seat for the paramedic.
- The racks are not organised properly.
- The reach of the racks are not very well planned.
- The cabin is well lit, fans are provided for the paramedics.
- Apparatus are not maintained in a very good condition.
- hangin tubes and equipment blocking the pathway.



Mr. Rajan
Paramedic, 108 Ambulance



Why Chennai?

Chennai is one of the four metropolitan cities in India. It is known for the rush and the chaos on roads during peak traffic hours. The traffic can be divided into three different types, they are solid, liquid and gaseous state. The solid ones are straight and not moving, liquid is when they are moving but a but faster. Gaseous is when they randomly move in all directions, Chennai has a gaseous type of traffic. It is very hard to control. People tend to break traffic rules and two wheeler concentration is also high in this place. The images shown on the next page the road condition on most of the part of the year. The condition worsens when it rains. Chennai roads are tar roads, unlike mumbai which has cement roads. tar roads need frequent replacement and

repairs. The problem of dust and slow paced road works worsen the condition. Even pedestrians are aggressive on the road. They usually dont use foot path and walk on roads.

Hot and humid conditions are the other trouble makers. Chennai faces warm and hot conditions most of the months in a year. The temperature reaches 40 degree Celsius and more during April to June period. This makes the tar road really hot and radiate heat. There are many cases where the tires bust just because of heat in Chennai. The temperature can cause huge problem to the accident victim lying on the road. This radiating heat will definitely worsen the condition of the victim. It is also a problem to the paramedics who come to treat the patient on that spot. They need

to keep all the equipment on the hot ground, which might affect the performance. Water clogging, flooded roads when it rains, lack of proper drainage system is also a trouble maker. That needs to be taken into consideration. This will need the relocation of the patient to a dry place. Many streets are not properly illuminated. In such cases some kind of light source will be needed while treating the patient.

There are around 33 general hospitals, 12 government hospitals, and more than 150 private hospitals in Chennai. This makes sure that every couple of kilometres inside the city would have some kind of emergency medical care, that could be government or private hospital. The frequency of hospitals varies when we go off the centre of the city. Chennai has all the facilities;

it is just that the paramedics could not reach due to all the above said reasons. Another driving factor to choose Chennai is the number of road accidents that happen here are more than other parts of India. If this project works in Chennai, it can be taken to any part of India.

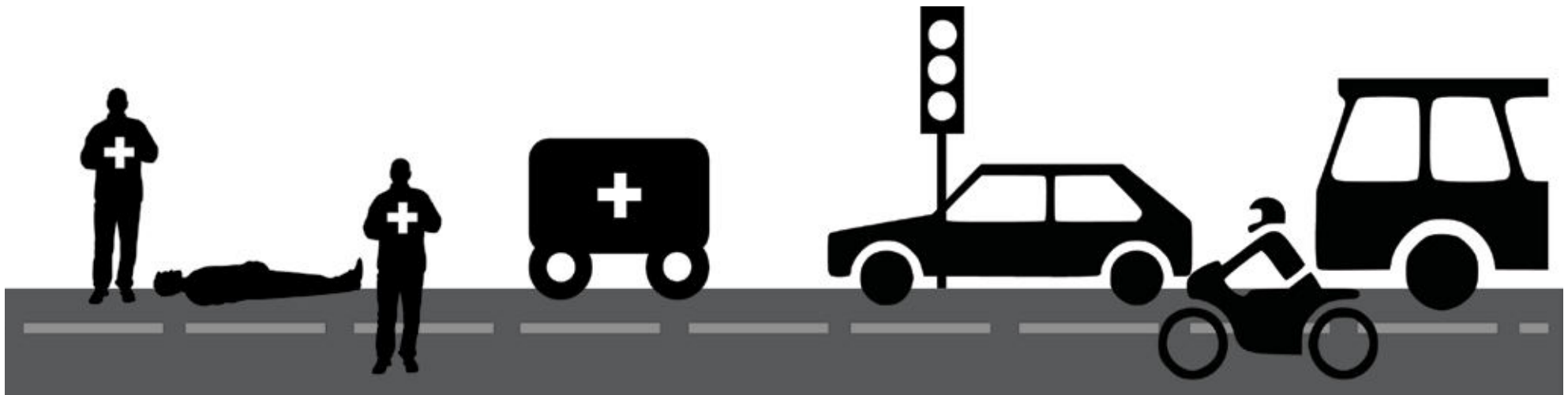


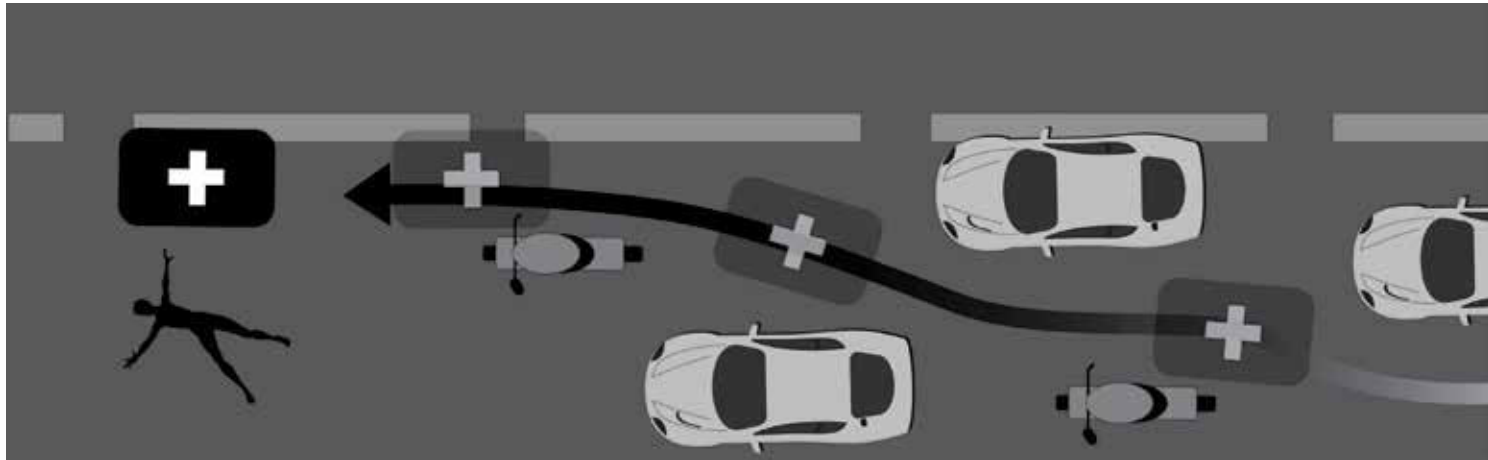
2 <http://chennaiplus.net/> Retrieved 10-3-2014.
3 <http://www.livechennai.com/> Retrieved 10-3-2014.
4 <http://www.thehindu.com/> Retrieved 10-3-2014.
5 <http://www.thehindu.com/> Retrieved 10-3-2014.

Scenarios

Shown below are the few scenarios that the first responder vehicle might need to face.

On Road





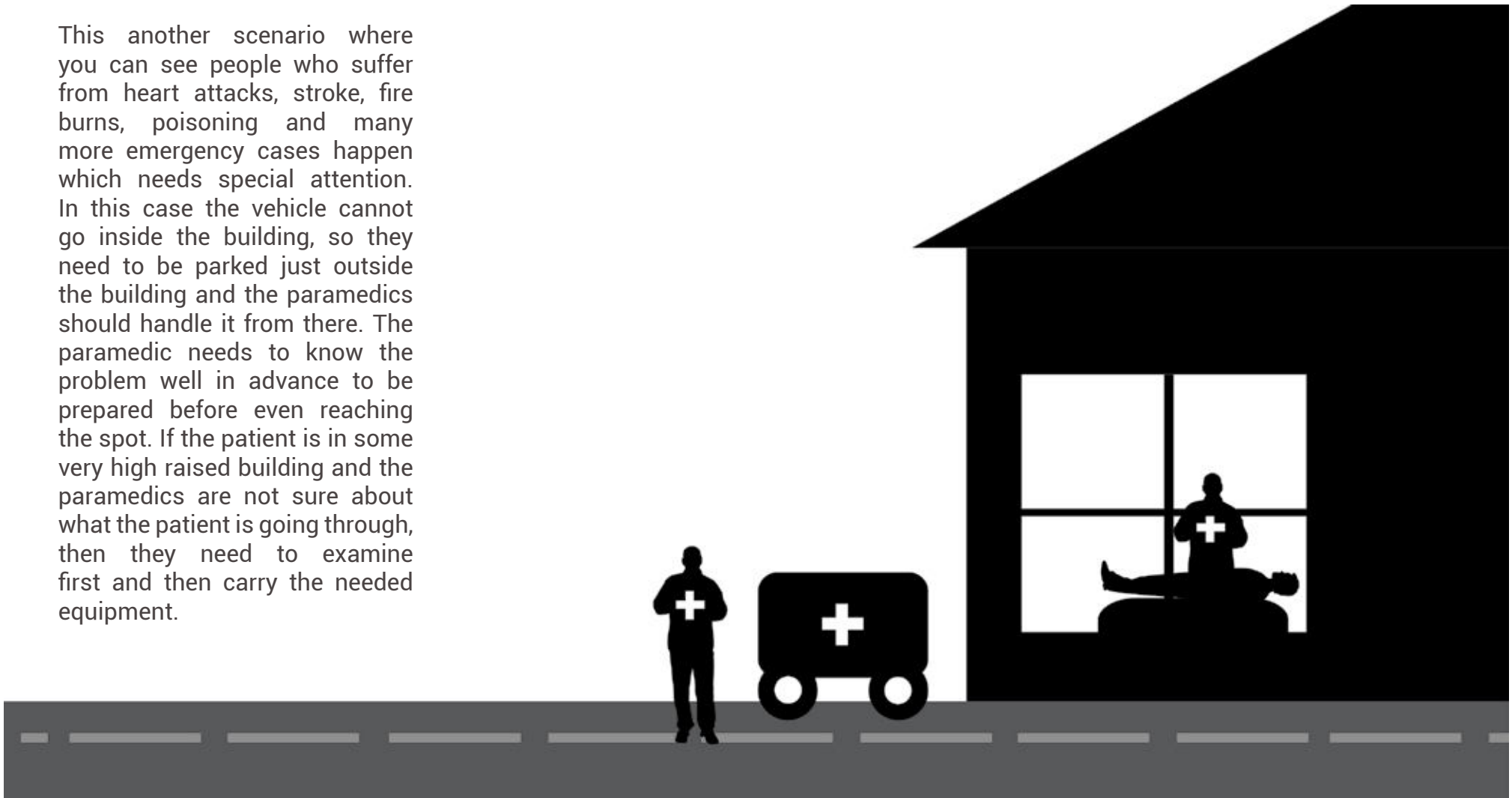
Accidents happening on road because of vehicles is the first scenario. The maximum number of patients who need immediate first aid comes under this scenario. The road accidents are the major cause. Vehicular collisions, pedestrian accidents while crossing, road side workers getting injured while working, riot based injuries are some of the cases which lead to this scenario. The roads could be either inner city roads or highways. The inner city roads include all the main

roads and street which branch into other streets. The streets could be hard to access since most of them are narrow and the routes are confusing. On the other hand, the roads can also be hard to access because of the traffic which moves very slowly. This is a major concern of the vehicle, which should cut through the traffic. Vehicular congestion will be a major problem for the first responder vehicle. It could be because of heavy vehicular flow rate or simply because of problem

created by few individuals on the road. The first case can be controlled using proper traffic signals, but the second case needs the intervention of traffic police to take care of the situation. This is what happens when an emergency vehicle passes by on the road, the traffic police will get alerted either by the siren sound or by visually seeing the flashing lights of the vehicle and he slows down the other vehicles making way for the emergency vehicle to pass by.

Inside a Building

This another scenario where you can see people who suffer from heart attacks, stroke, fire burns, poisoning and many more emergency cases happen which needs special attention. In this case the vehicle cannot go inside the building, so they need to be parked just outside the building and the paramedics should handle it from there. The paramedic needs to know the problem well in advance to be prepared before even reaching the spot. If the patient is in some very high raised building and the paramedics are not sure about what the patient is going through, then they need to examine first and then carry the needed equipment.



Off Road

The vehicle might need to do some off-roading too. There are places inside the city where there are almost no roads to access. For example places like railway tracks, local parks, playgrounds, and more, where the vehicle might need to handle rough

terrains which will need a good ground clearance and good tires. Most of the time the ambulances cannot reach these spots since it is designed only for the roads.



Which scenario to work upon?

Given all three scenarios (On road, Off Road and inside building), the challenge will be how to address all these three scenarios. If we see all the three scenarios, the task is to go as close to the patient as possible and then treat them. The off road and inside building scenarios will be hard to take the vehicle close to the patient. The paramedics needs to get down and then go to the patient, the vehicles role is not fully utilized in these two scenarios. If the vehicle goes near the patient, the vehicle can be used as an object for aiding the treatment. Since the number of road accidents is more in Chennai and the vehicle can be put to the maximum use, if the patient is near the vehicle, the on road scenario will be the

best to choose. Said these, the road scenario will need more than just transportation of the paramedics and the equipment. It must protect both the paramedic and the patient while treating. It should be able to judge where the patient is lying down on the ground, hence better visibility is very important. The appearance of the vehicle and proper colour schemes should be used to alert the other vehicles that this is a special purpose vehicle. All roads are not well lit, hence there should be some way to illuminate the place they work. Garbage disposal will also a concern on the roads. In addition to these, there must be good alerting techniques like flashing lights or sirens that would alert while cutting through

traffic. Communication between the vehicle and the hospital should also be taken care of. The patient could be in any orientation or any level on the road, so all the cases must be considered before finalizing the design.

INFERENCES

- Male nurses are looking for comfort as they work for 12 hours a day.
- Ambulances take more than 20 minutes response time.
- Chennai traffic is not controllable.
- Hot sun in Chennai is a big problem, both for the male nurse and the patient.
- The male nurse must remember all the events happening during the trip.
- Two wheelers are not a good option in Chennai.
- people look for the image that will make them feel confident that the first response will be effective.
- There is no communication happening between the ambulance and the hospital or the doctor during the trip. It is happening only after the trip.
- Sanitation is a big issue.
- Sirens are not helping in a big way.
- The male nurses are not feeling comfortable with the current facilities provided to them.
- There is no assurance that the male nurses will be safe on roads when they are giving the first aid.

Essential equipment to be carried

As we have seen there are many equipment's which are used to give first aid and save the victim. But when it comes to road scenario, which is finalized in the previous section, there are certain equipment's which ought to be carried. When the paramedics see a patient lying down on the road, they will first go and check his vital signs, for that they use the ABC's of life saving, in addition to that they use the defibrillators too. These defibrillators, especially the semiautomatic portable ones can read the vital signs of the patient in the form of Electro Cardio Gram (ECG) signals. It also warns if the vital signs are not in a proper condition. If we go back to the ABC's of first aid, the

patient's airway should not be blocked. Usually when a patient meets some accident or falls sick, there could be chances of oral fluids or blood might block the airway. Hence The suction apparatus and the laryngoscope to open up the patients mouth is very important.

More priority

AED

Ambu Bag

Suction Apparatus

Laryngoscope

First aid rucksack

Foldable Stretcher

Oxygen Cylinder

Less priority

Then the patient is usually wounded on the road side. They will need proper treatment on the road itself. Usually bandages, splints, cotton for cleaning blood, drugs, syringes and many other disposable wastes are produced during the treatment. That waste should also be properly disposed off. A bag containing all these bandages drugs, syringes, and other small but important

items are available. That will be having almost equal priority of the suction apparatus. Foldable stretcher is coming in the less priority category since it will be mostly used to relocate the patient to a better place or immobilize them with proper harness. The chance of that happening is very less since most of the accidents happen on the road itself, only few cases are happening outside the

road, where the vehicle cannot go. And finally oxygen cylinder will be used when the patient is breathing properly and to make sure he is getting good air until the ambulance arrives. A list of equipment which needs to be carried along with their weights and dimensions are given. The product is selected based on availability and its popularity.

Product	Dimensions	weights
Zoll X Series AED	260mmx200mmx226mm	6 Kgs
Portable Suction apparatus	450mm× 200mm× 320mm	6.2 Kgs
Rucksack for the First Aider	400mm x 300mm x 140mm	1 kg
Ambu Bag	400mm x 120mm(dia)	415 g
Foldable Stretcher	960mm x 180mm x 540mm	8 kgs
Laryngoscope	140mmx 200 mm(dia)	100 g
Oxygen Cylinder	300 X 80 mm (dia)	1.4 kgs

Factors to be considered for choosing the vehicle

The project requires a vehicle which could cut through traffic and be able to package all the equipment. Cutting through traffic means the vehicle should be as compact as possible, small turning radius, overall the footprint must be less. Overtaking is also very important, so the vehicle must have good acceleration and power to weight ratio. Being Chennai the target city, the vehicle must have good ground clearance to handle the rough roads, forgiving body panels, easy to clean vehicles. The weather condition is also a big concern. It should be covered and fully protected from heat and dust. Air conditioning should also be present as the paramedics are working for more than 12 hours a day.

Motorcycles are a good option for this purpose. But the volume of the equipment are more, it will not be able to carry everything and two paramedics in it. The accident rate of motorcycles is more compared to four or three wheelers. And the case example discussed before, the Apollo First project which used TVS Centra vehicle failed in less than four months. Four wheelers with proper chassis which ensures safety of the paramedics and which has good volume to store all the equipment are needed. The shortlisted vehicles are shown in the table given below. Considering the availability of the vehicle, the size and the cost of the vehicle, the following list

is made. The important criteria values are listed down. The evaluation is done in the next table, the weighted matrix. Score of 0 to 5 is given to every car for the corresponding criteria. For example if the turning radius value is less, the more rating it

will get, on the other hand, if the ground clearance is more, the value will be more. Accordingly the scores are given and then evaluated.

	Nano	Reva	Wagon R	Indica v2	i10 Era	Eon
Turning radius	4 m	3.9 M	4.6 m	4.9 m	4.75 m	4.6 m
width	1495 mm	1514 mm	1475mm	1,665 mm	1595mm	1550mm
length	3099 mm	3280 mm	3599mm	3,675 mm	3585mm	3495mm
Acceleration (0-60 kmph)	8 sec	11 sec	8.03 sec	7.3 sec	6 sec	6.41 sec
Ground clearance	180 mm	180 mm	165mm	170 mm	165mm	170 mm

Weighted Matrix

The six vehicles are evaluated based on the following five criteria's – Turning radius, width of the vehicle, length of the vehicle, Acceleration and the ground clearance. Based on the priority, the weightage is given. The weightage is multiplied with the individual score and the total score is calculated.

	Weights	Nano	Reva	Indica v2	Wagon R	i10 Era	Eon
Turning radius	5	4	5	2	3	3	3
width	4	5	4	2	5	3	3
length	3	5	5	2	3	3	3
Acceleration	2	4	3	4	4	5	5
Ground clearance	3	5	5	4	3	3	4
		78	77	44	61	55	58

Why Mahindra Reva E20?

Tata Nano and Mahindra Reva E20 are the top scorers from the weighted matrix seen in the previous page. Both are compact vehicles but are of a different kind. The Reva is an electric vehicle whereas Nano has an Internal Combustion engine.

1



Clearly the electric vehicle has more edge when considering the acceleration from halt and the linear torque curve. Reva has a good range and quick charging times (Just 1 hour charge gives 20

Kms). Considering the frequency of hospitals in Chennai, the range offered by Reva is more than enough for more than 5 trips. The speed and acceleration could be controlled just by tuning the Electronic Control Unit (ECU), there would not be any need to change any hardware to tweak the performance of the vehicle. Of course tuning the vehicle for better acceleration will have effect on the range, but the vehicle has got range which is more than necessary. Another major benefit with this vehicle is the turning radius. Turning radius is a critical factor for a vehicle to maneuver in traffic and take quick U turns. The battery pack in Reva provides 10 Units of power which can be used for other applications like charging the equipment, additional lights

and much more. Since there are only two passengers the vehicle will not have any problem accommodating both the paramedics and the equipment inside the car. The only disadvantage the vehicle would face is the two door configuration. The rear passenger needs to get in through the front door, but still it is not a big hindrance since only two paramedics will be travelling in the vehicle. Last but not the least, it is eco-friendly and more economical than the internal combustion engine vehicles. The vehicle has inbuilt Global Positioning System and has connectivity with Vodafone network, which will be helpful for communication purposes. This also could connect with smart phones, which again has more possibilities.

Design Brief

The vehicle Mahindra E20 is the base vehicle. The interior of the vehicle needs to be changed according to the priority of the equipment and easy accessibility. The exterior form of the vehicle will be kept intact. The paint work and graphics on the body needs to be changed. Necessary accessories may be fixed on the exterior to increase the functionality. These are the following needs the vehicle must have.

Vital Needs

- Carry all equipment
- Carry two paramedics
- Access to equipment must be easy (prioritize)
- Secure the equipment from shock

Essential

- Sun & rain protection for treatment
- Night time visibility for treatment
- Provision to discard waste after treatment
- Easy to clean
- Communication devices

Nice to have

- Additional storage for more equipment
- Better way of incoming alert

Technical Specifications

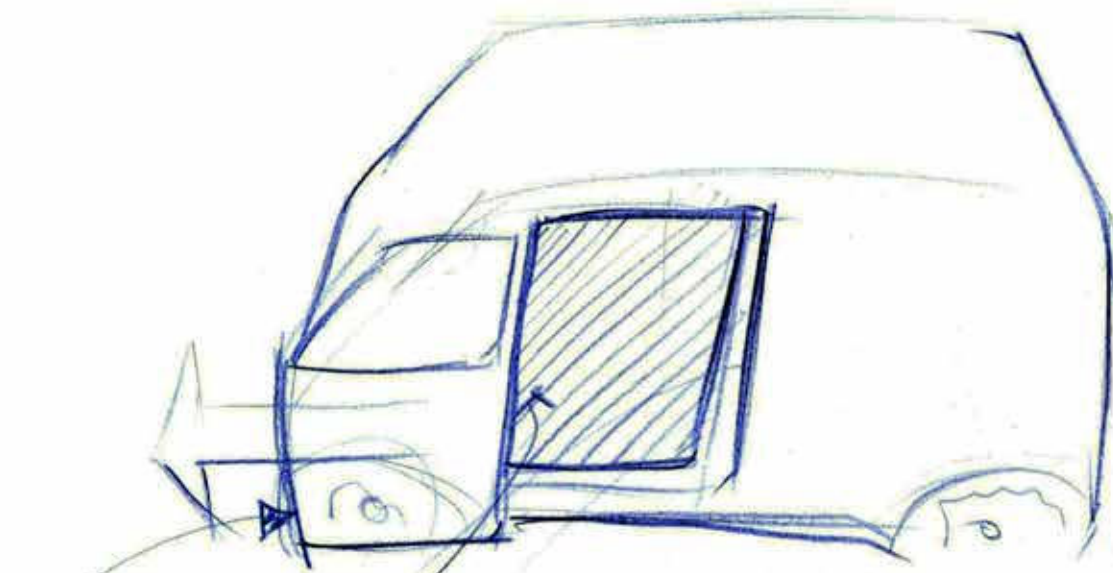
The base vehicle is Mahindra Reva E20

- wheelbase - 1958 mm
- width - 1514 mm
- Height - 1560 mm
- ground clearance - 180 mm
- Turning Radius - 3.9 m
- Transmission - automatic

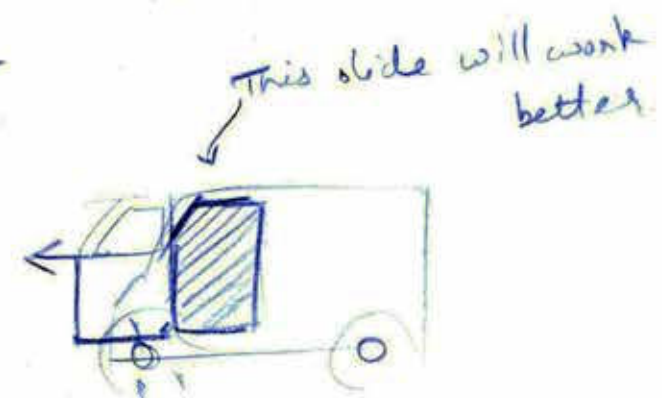
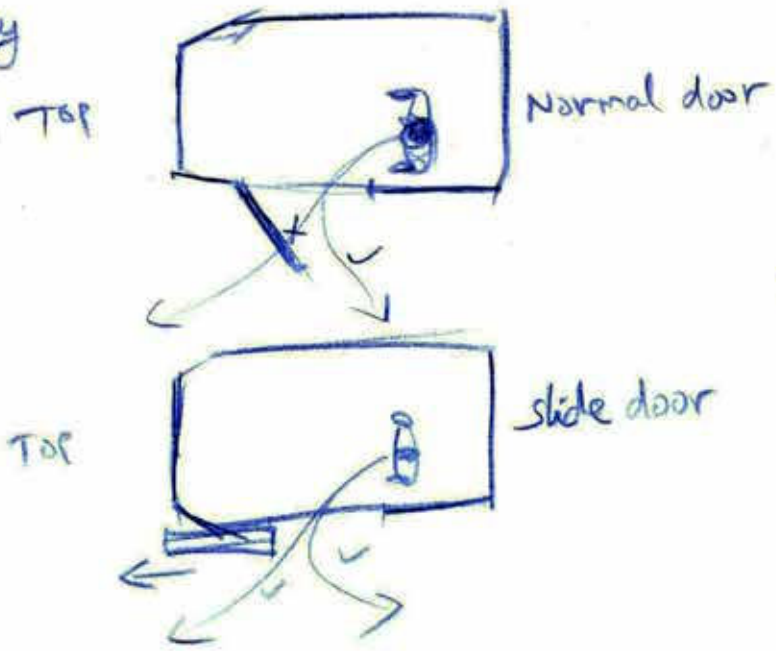
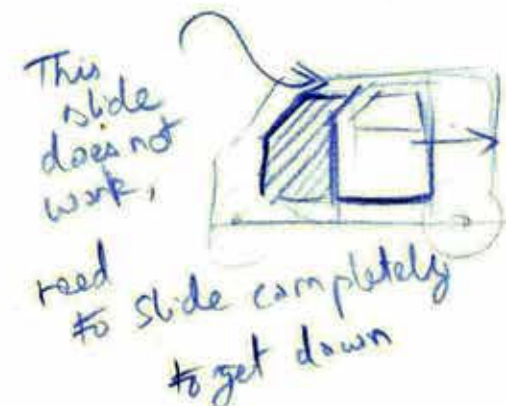
3 [Design]

Initial Explorations

The initial explorations are directed towards getting a clarity of what could the vehicle might posses. The ways of accessing the equipment, ingress & egress methods and other features that will make it as a first responder vehicle. Considering the size of the vehicle, it is very essential to plan the space ahead and utilize it to effectively access the first priority equipment. After this intial exploration, the package will be explored. Packaging will actuall give a clear idea of where goes where and how it can be retreived.



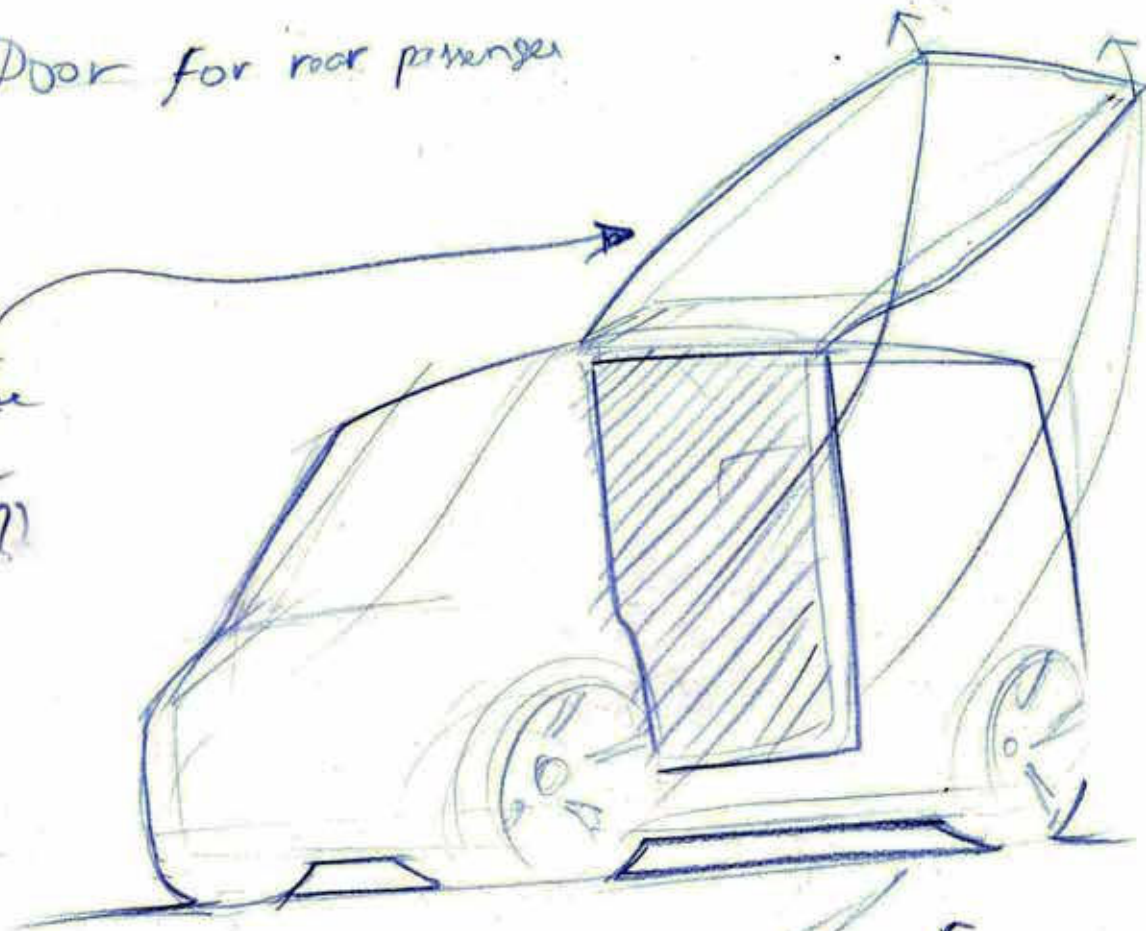
Access of Equipment will also be easy



// Might Interfere with front wheel.

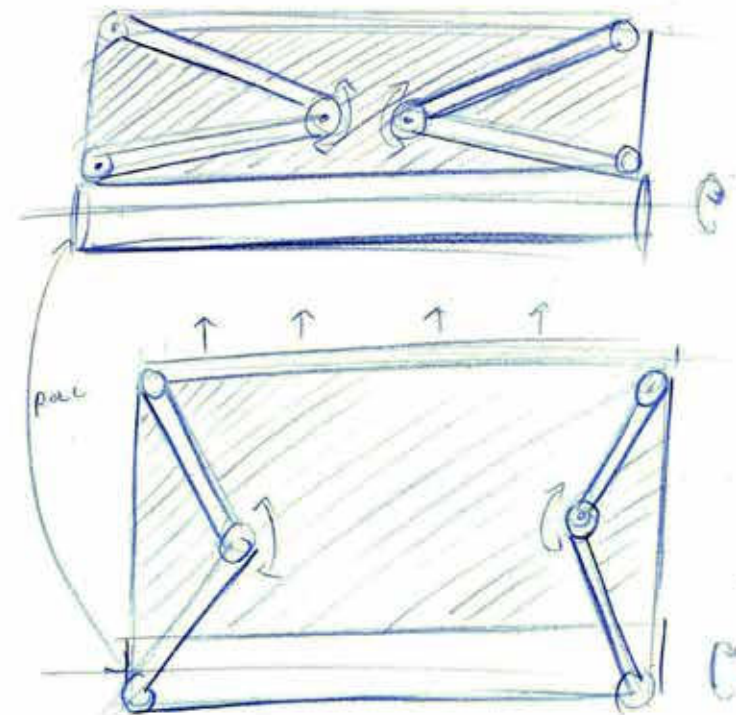
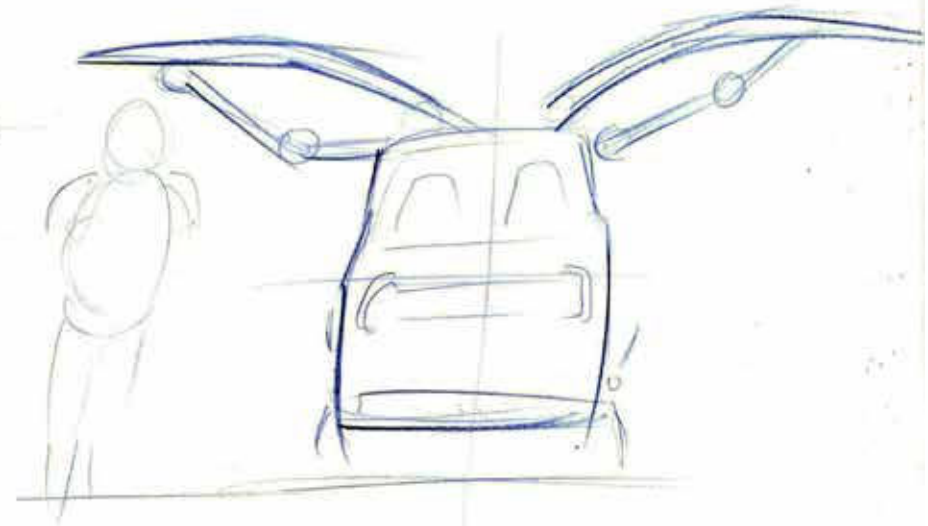
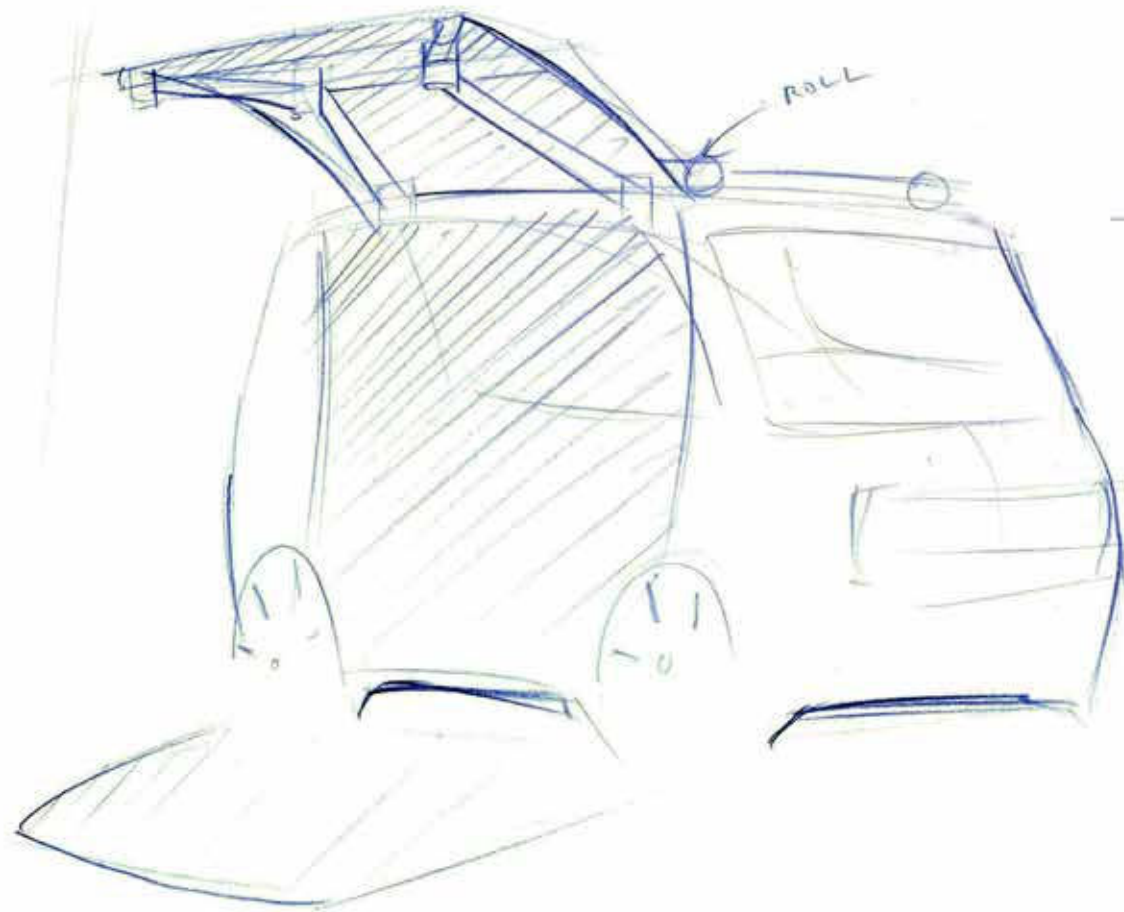
Door for rear passengers

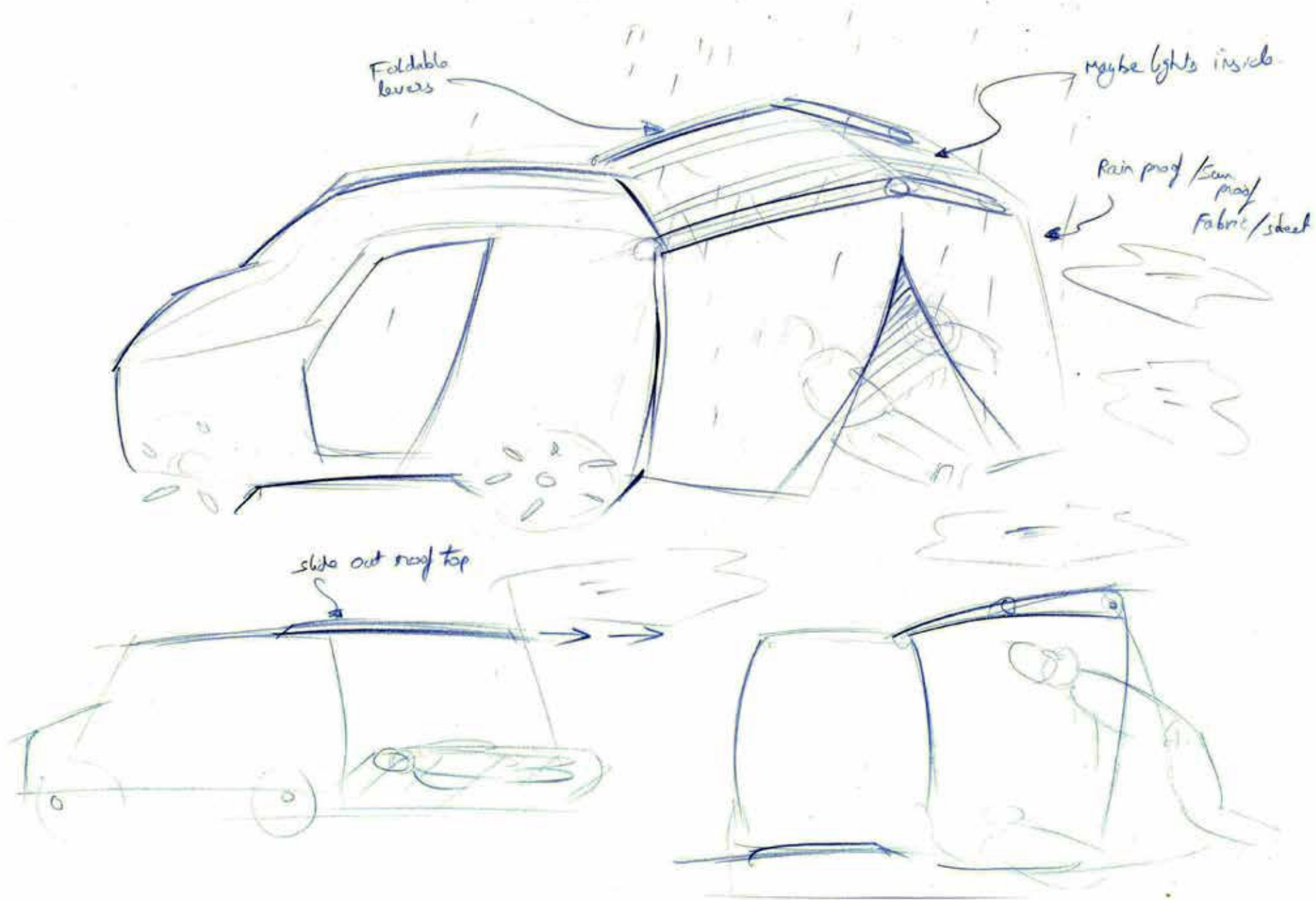
can this be
used for
shade?

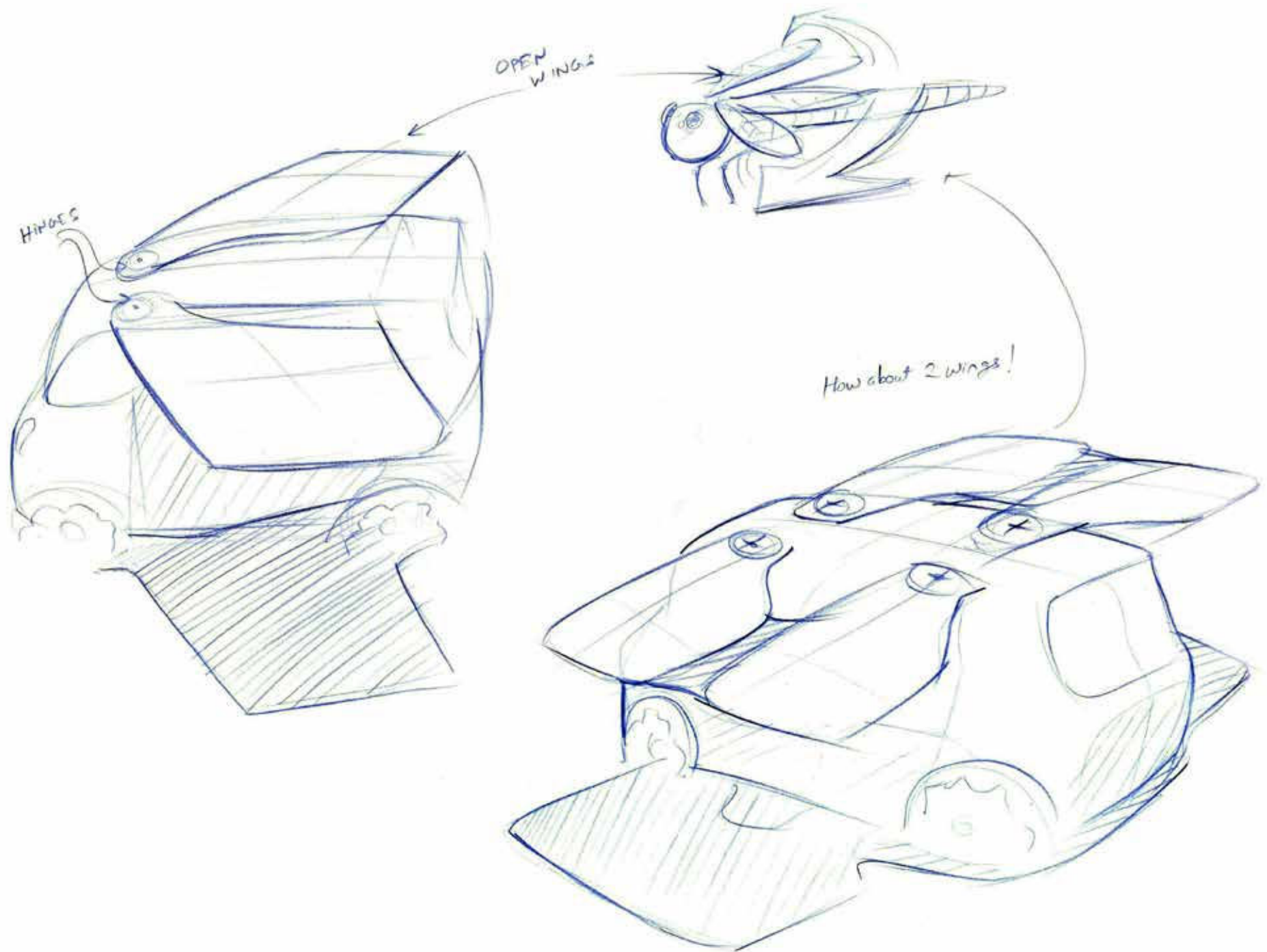


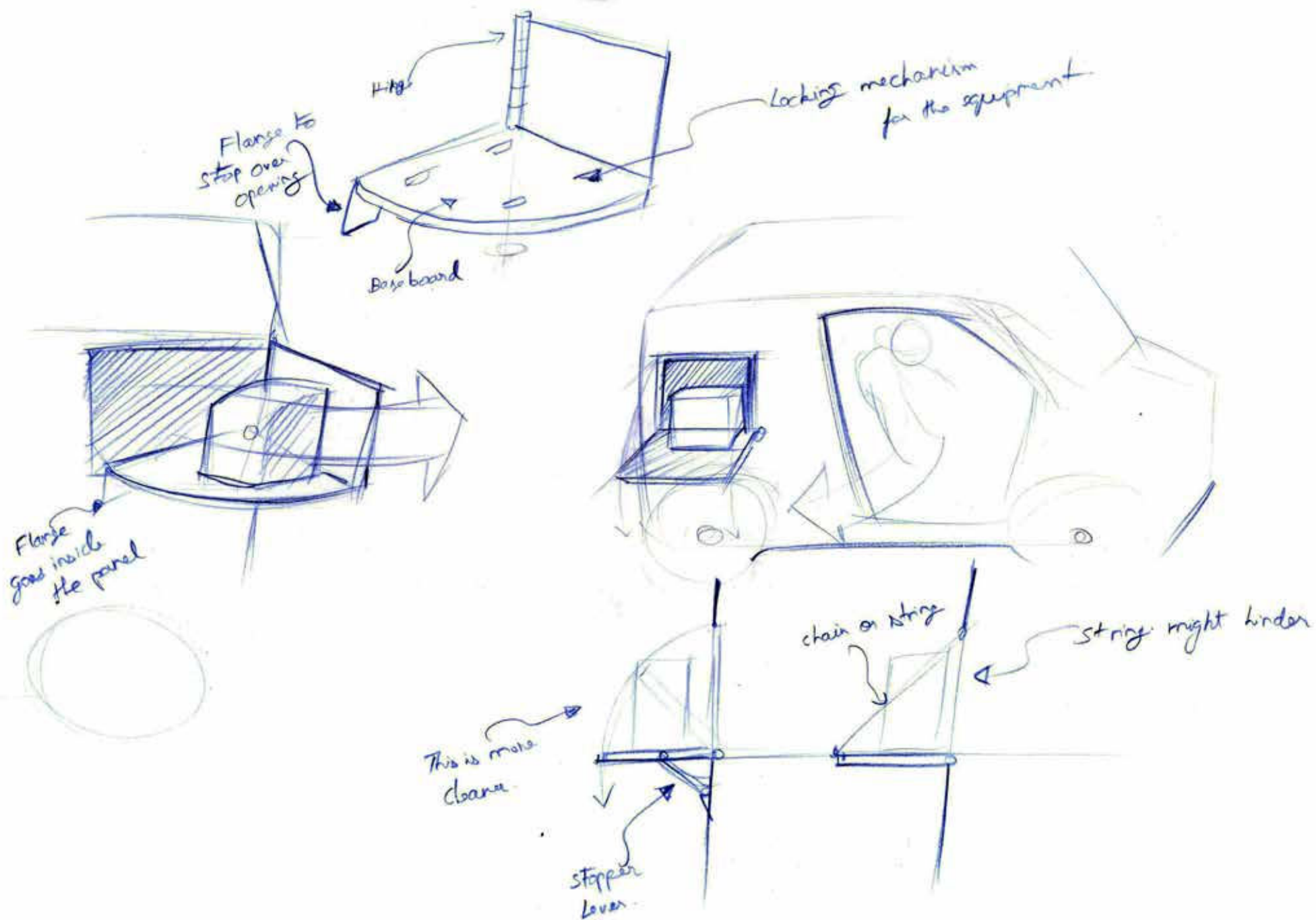
Takes up a
lot of
space

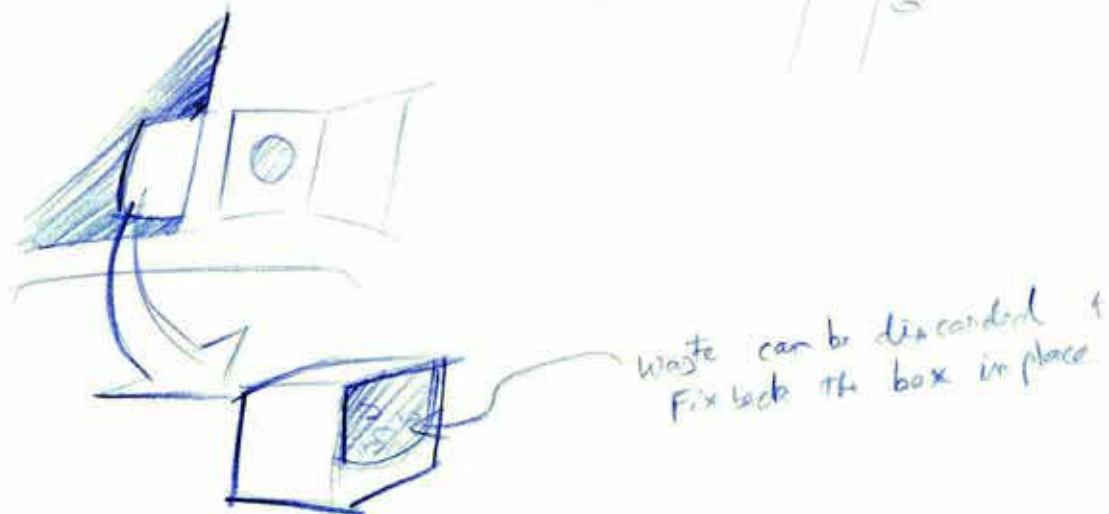
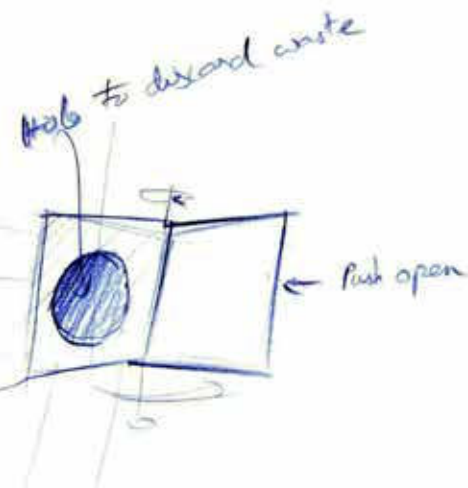
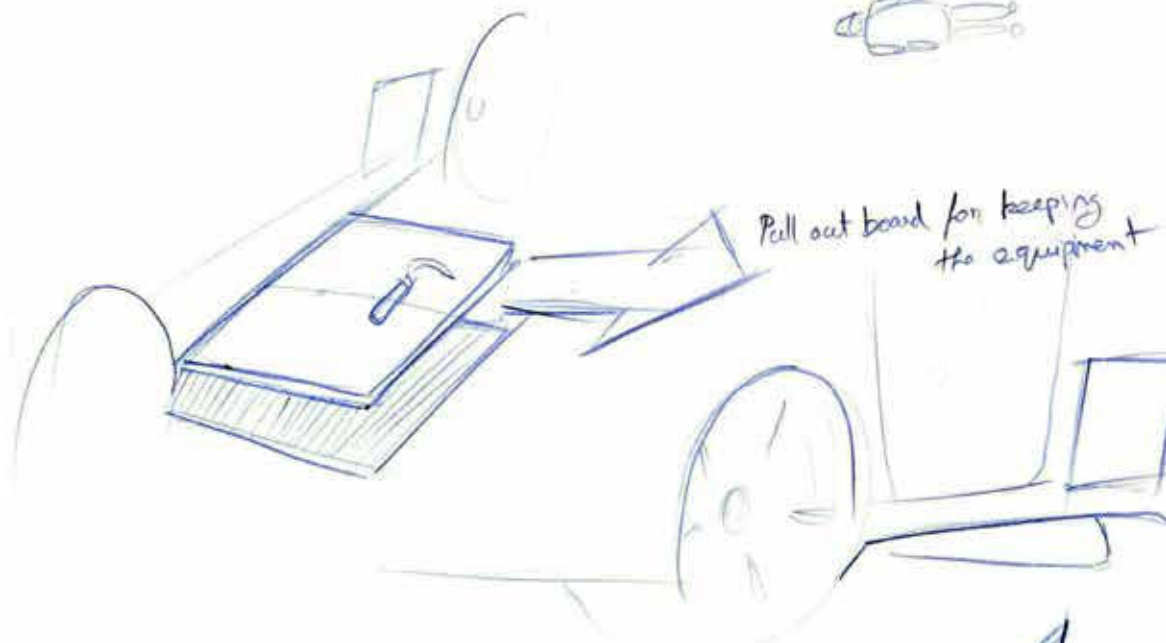
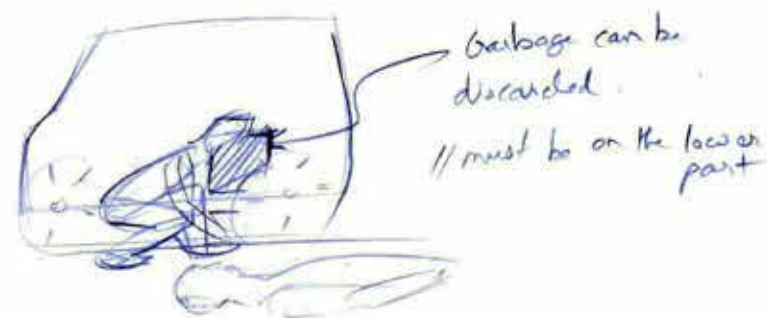
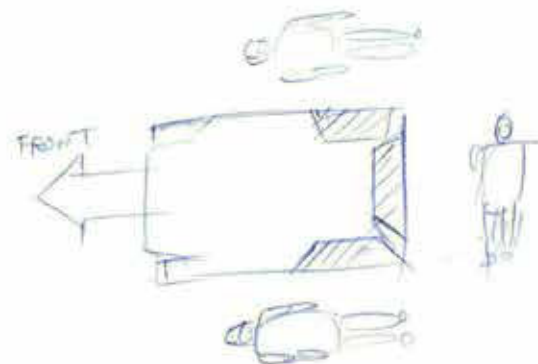
How about
LED strips
// It can be rolled

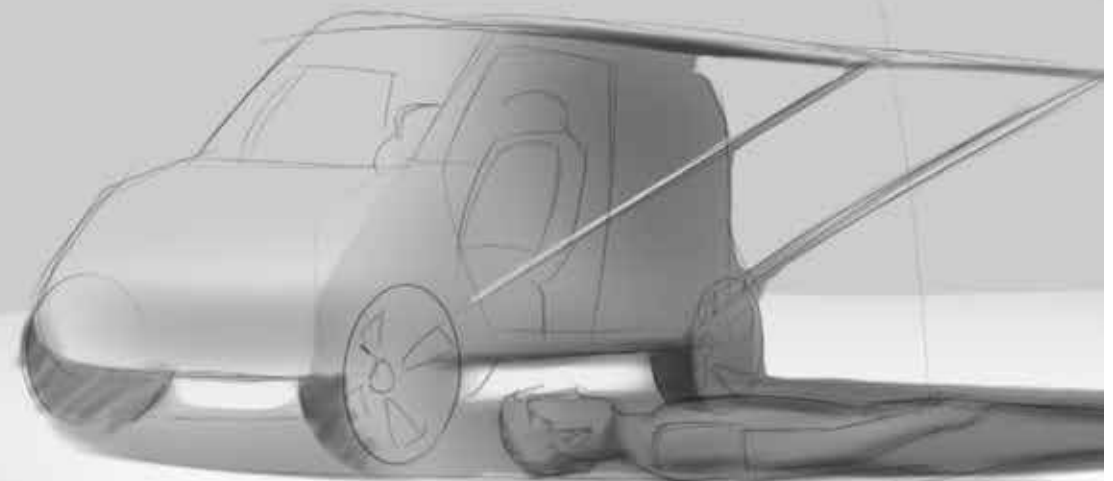
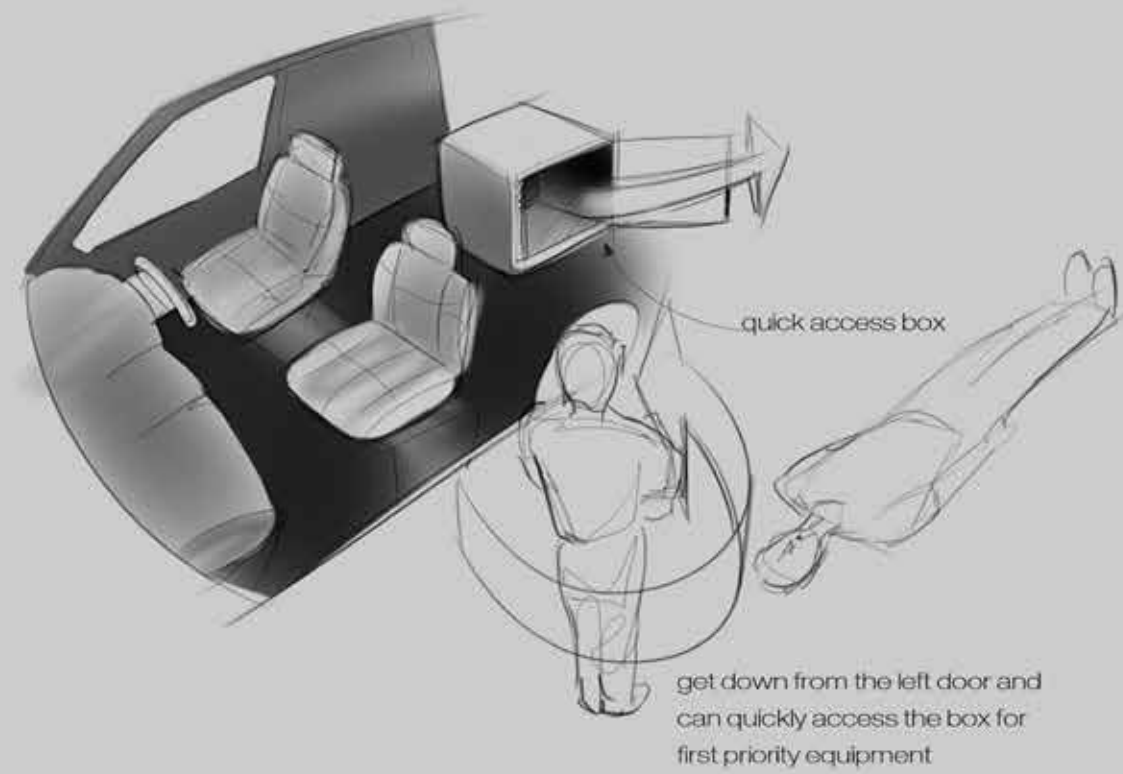


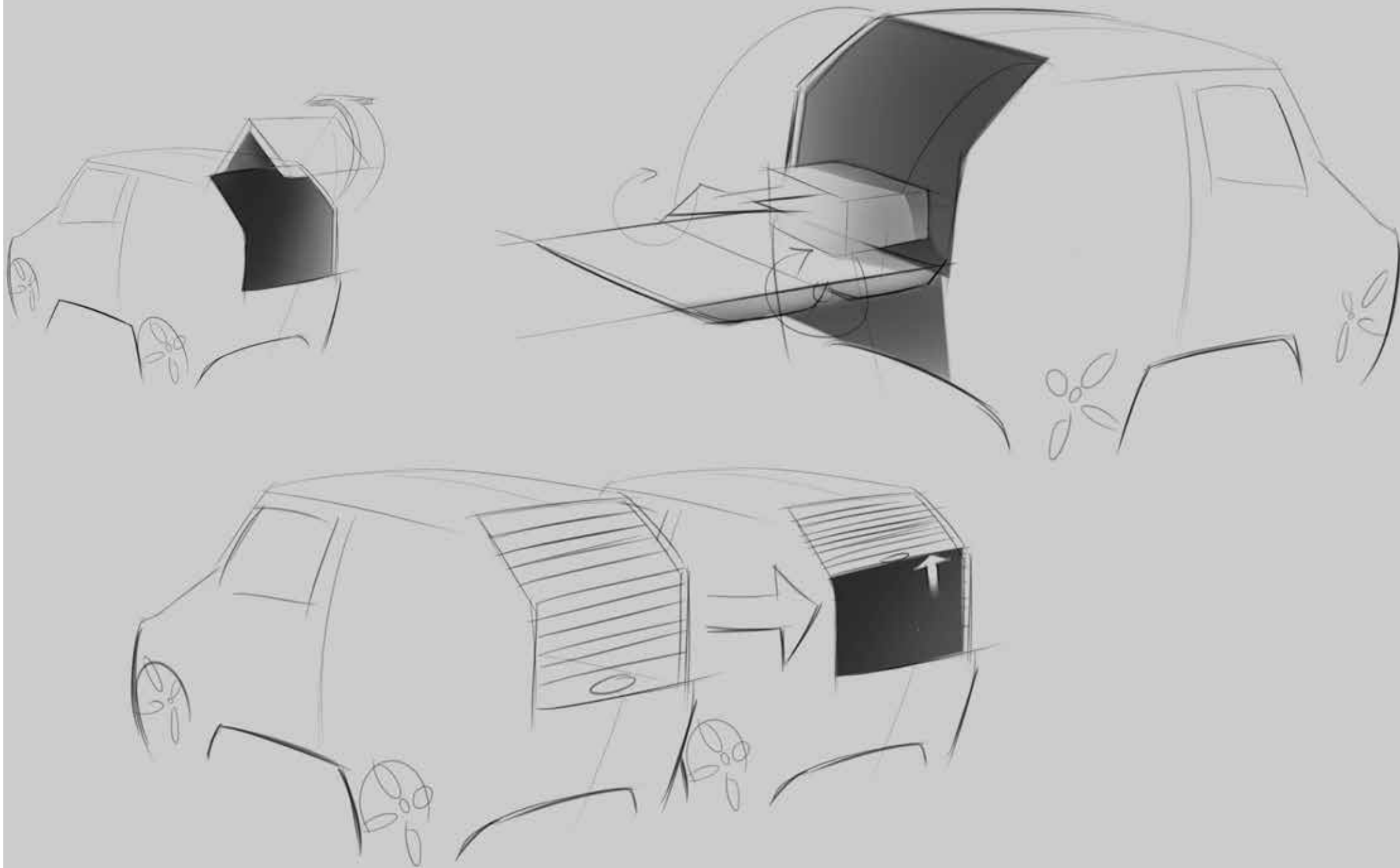


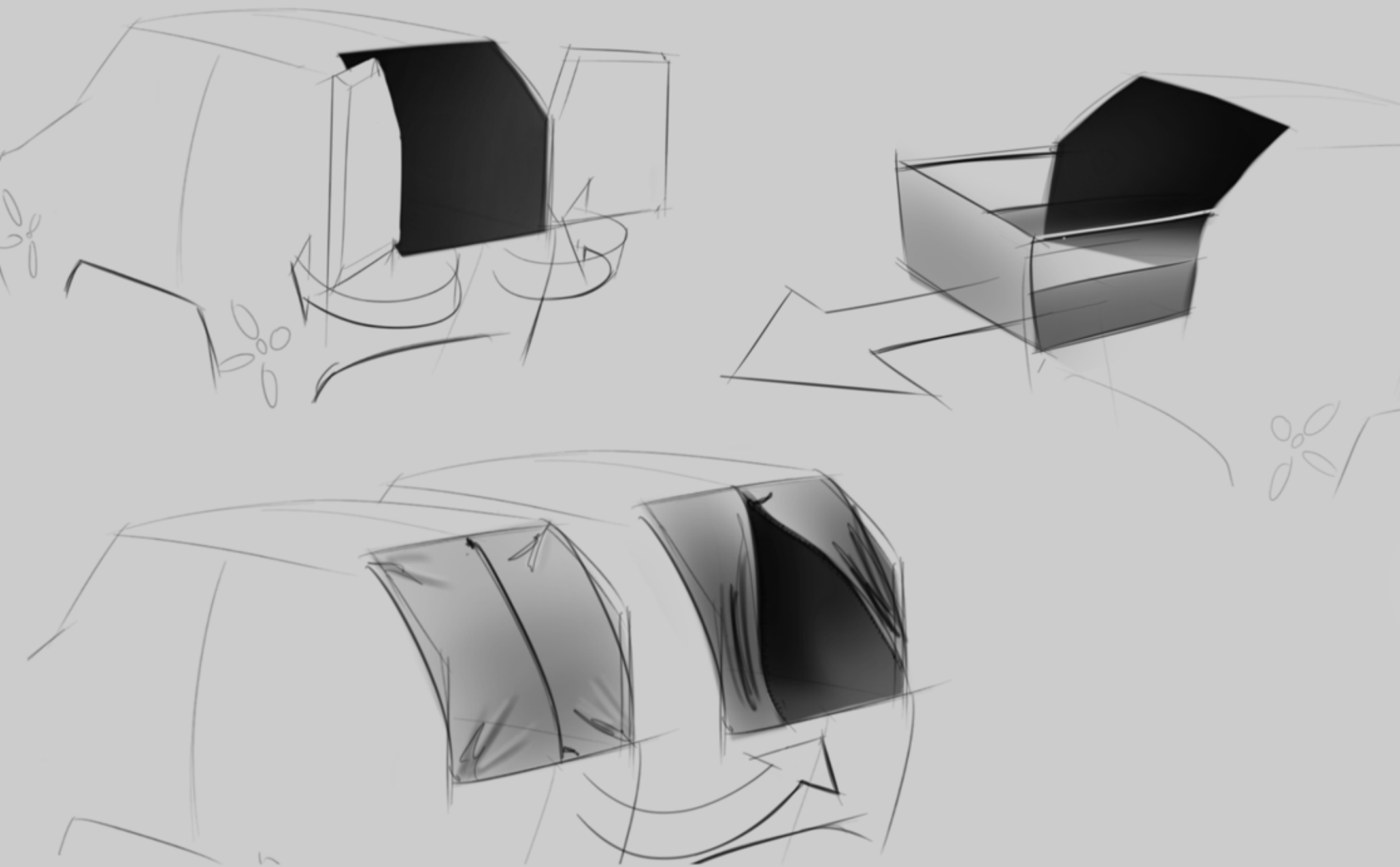








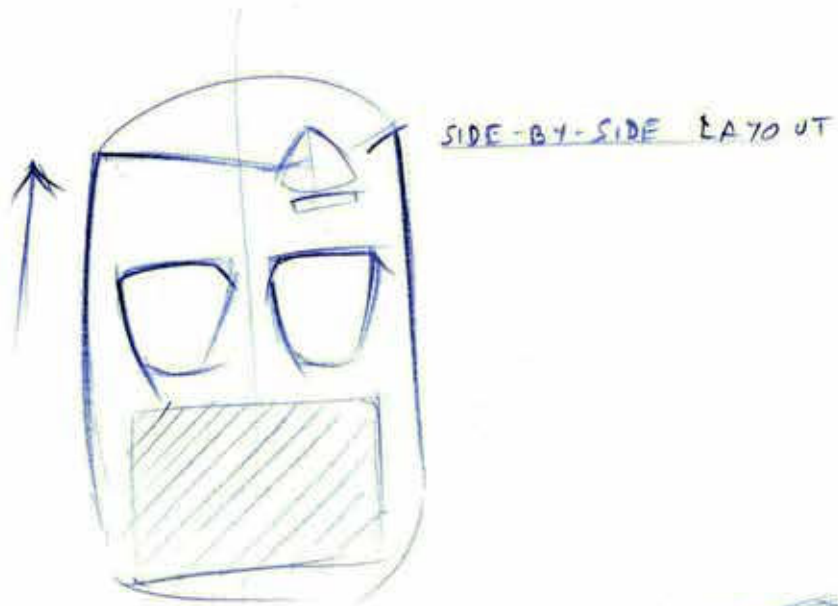




The above ideations were very rough and shows various areas like weather protection, night time illumination, Garbage disposal, ways to access doors quickly, where and all the panels can be cut open to remove the equipment and many more. But this is not going in any direction, hence it will be better if we bring in the paramedics and the equipment to come up with a clear package ideas. This packaging is very important in this project since it is going to change how the paramedic is going to access .Other options like rear hatch open mechanisms were also explored since the the Mahindra Reva E20 does not have a full hatch door, but it has a lip on the back which does not have any chassis member inside and can be cut open to make it as a bigger opening. The another main aim of this project is to reduce as many openings and contraption as much as possible. Lets make it simple and easy to understand. The next section explains the packaging more in detail.

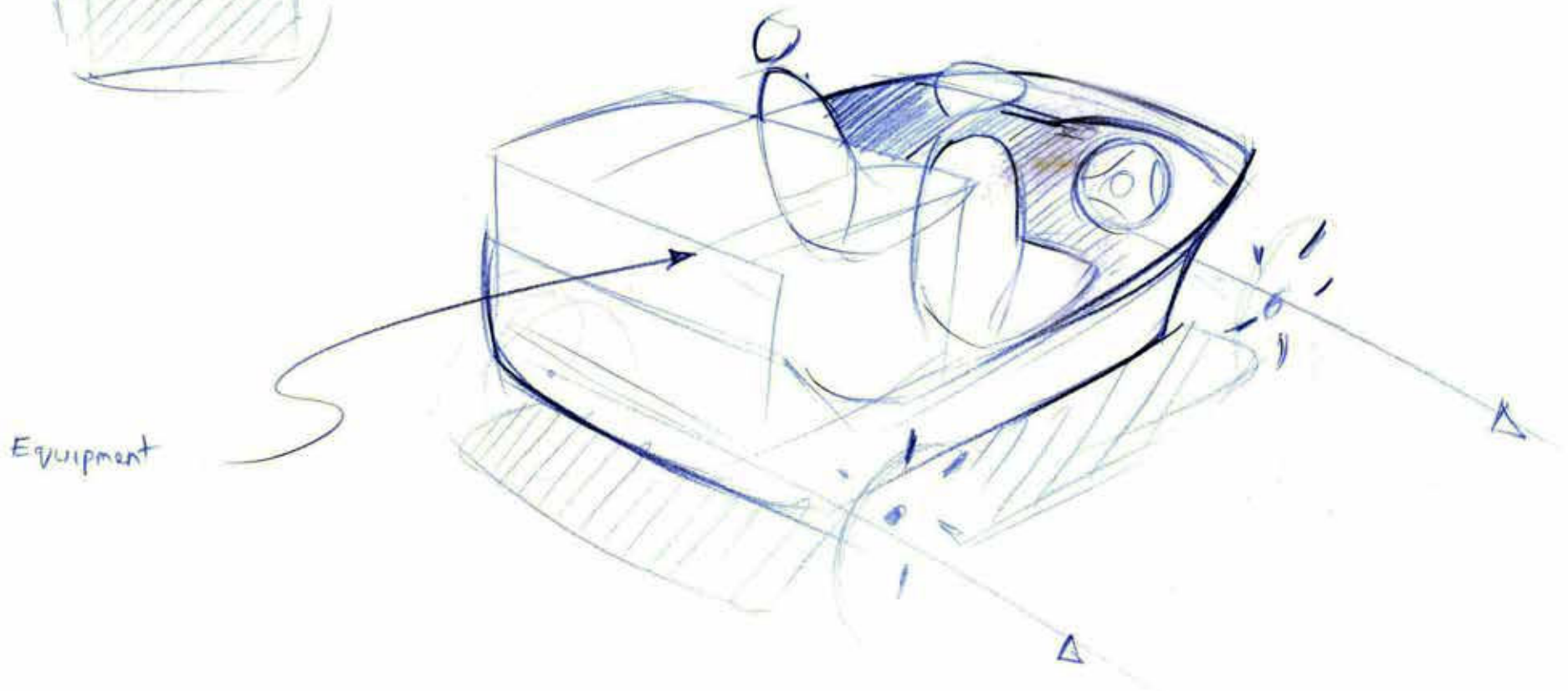
Packaging

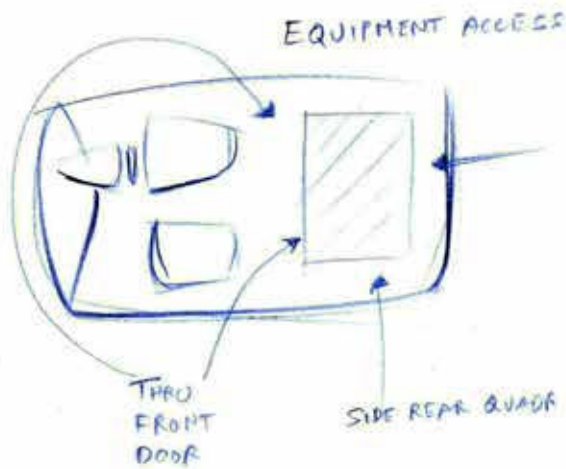
The vehicle packaging is very important in this case as it is going to decide the ingress, egress, access to the equipment and how fast they can load and unload the equipment. This is a part of concept exploration. Both the equipment and the paramedics are considered in this packaging. The following packaging explorations are made.



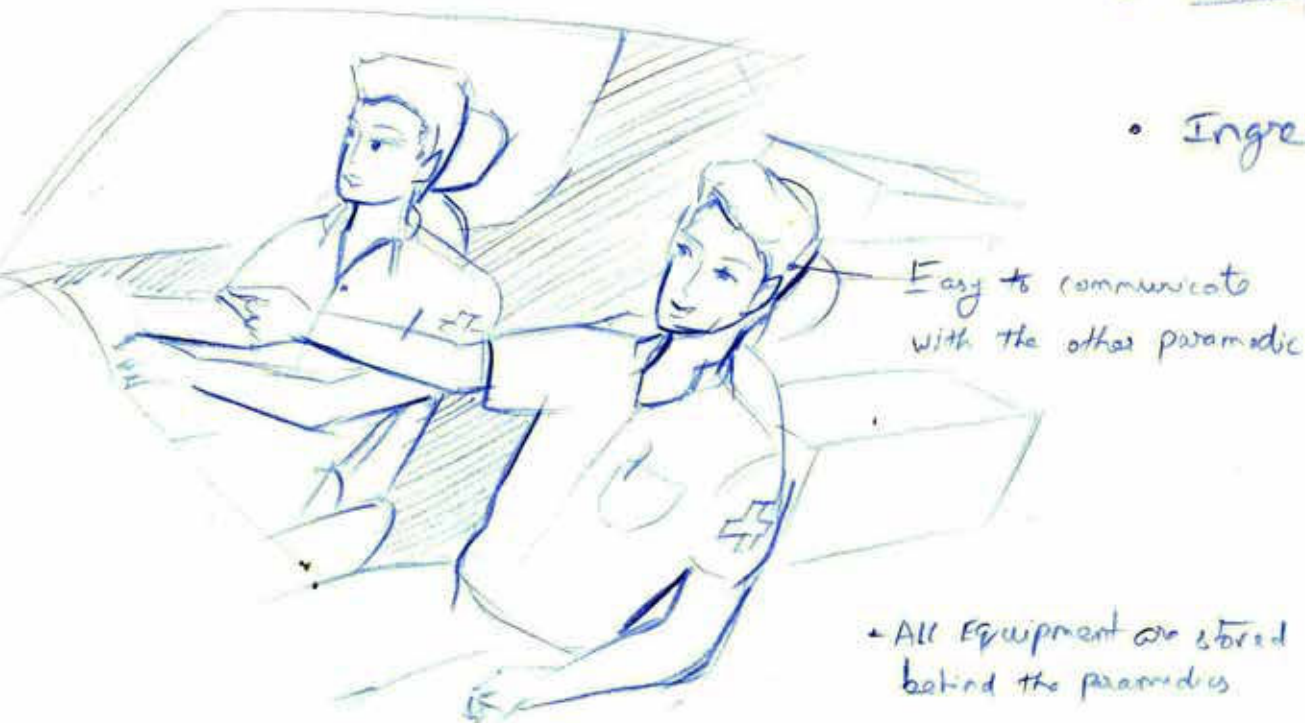
Package 1 - Side by side

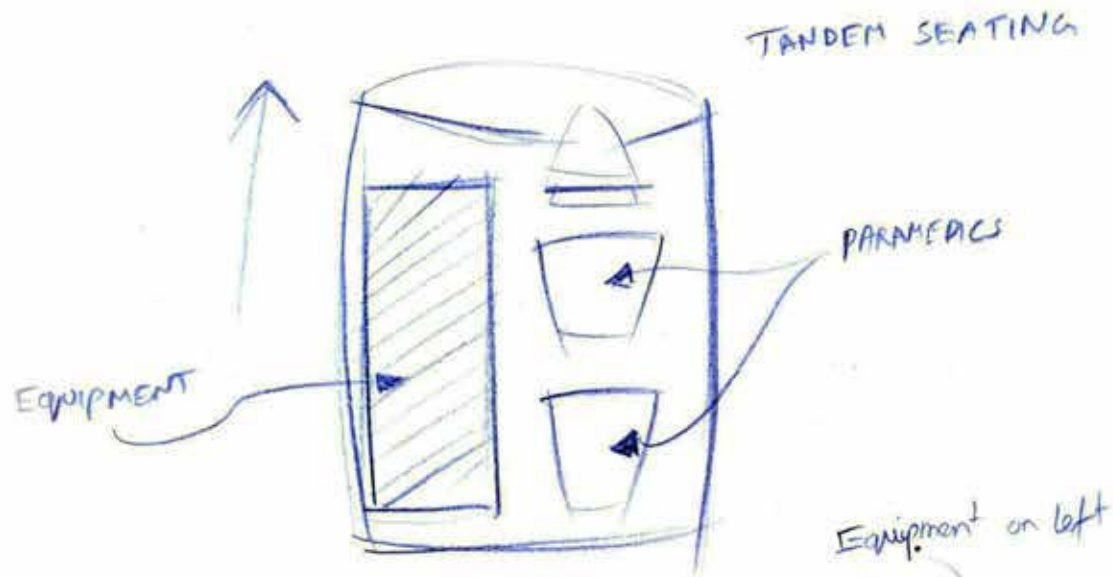
The package 1 is simple. The paramedics sit side by side. Rest of the equipment are kept behind them. The paramedics can get down from the front two doors and they have to get down and then take out the equipments. This layout will be best suited for communication between paramedics. But the speed of retrieval of the equipment is reduced in this layout, since they have to get down and access the equipment.





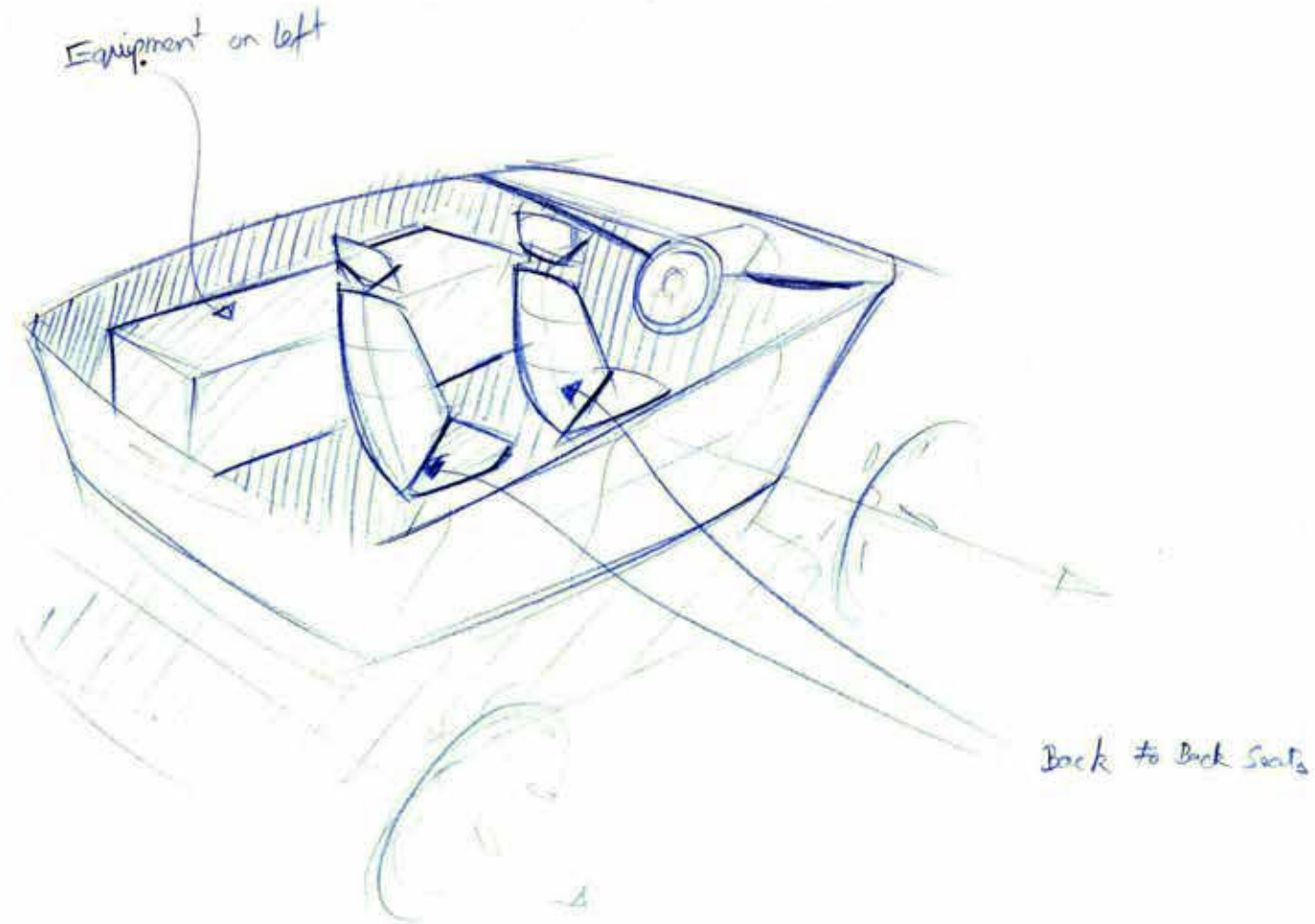
- ALL access from rear
- No immediate access
- Needs to stop, get down and then take the equipment out
- Ingress / Egress is easy

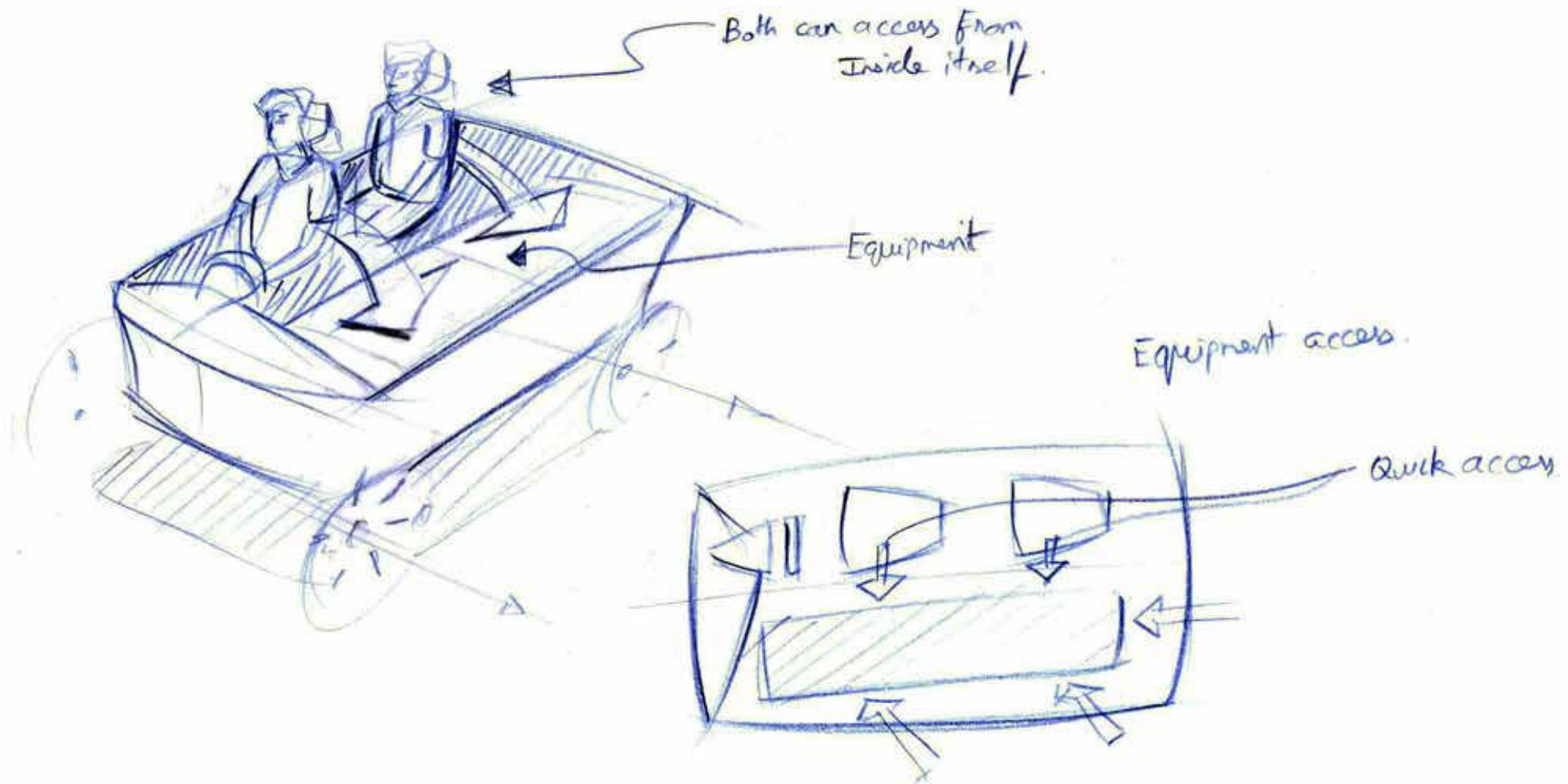




Package 2 - Tandem

The package 2 is the tandem layout, here the paramedics will sit back to back. The rear paramedic can get down only if the front paramedic gets down first. The main advantage of this layout is that the paramedics can access the equipment from inside itself, for both the paramedics, the equipment is kept on the left side. They could easily prepare and then get down.

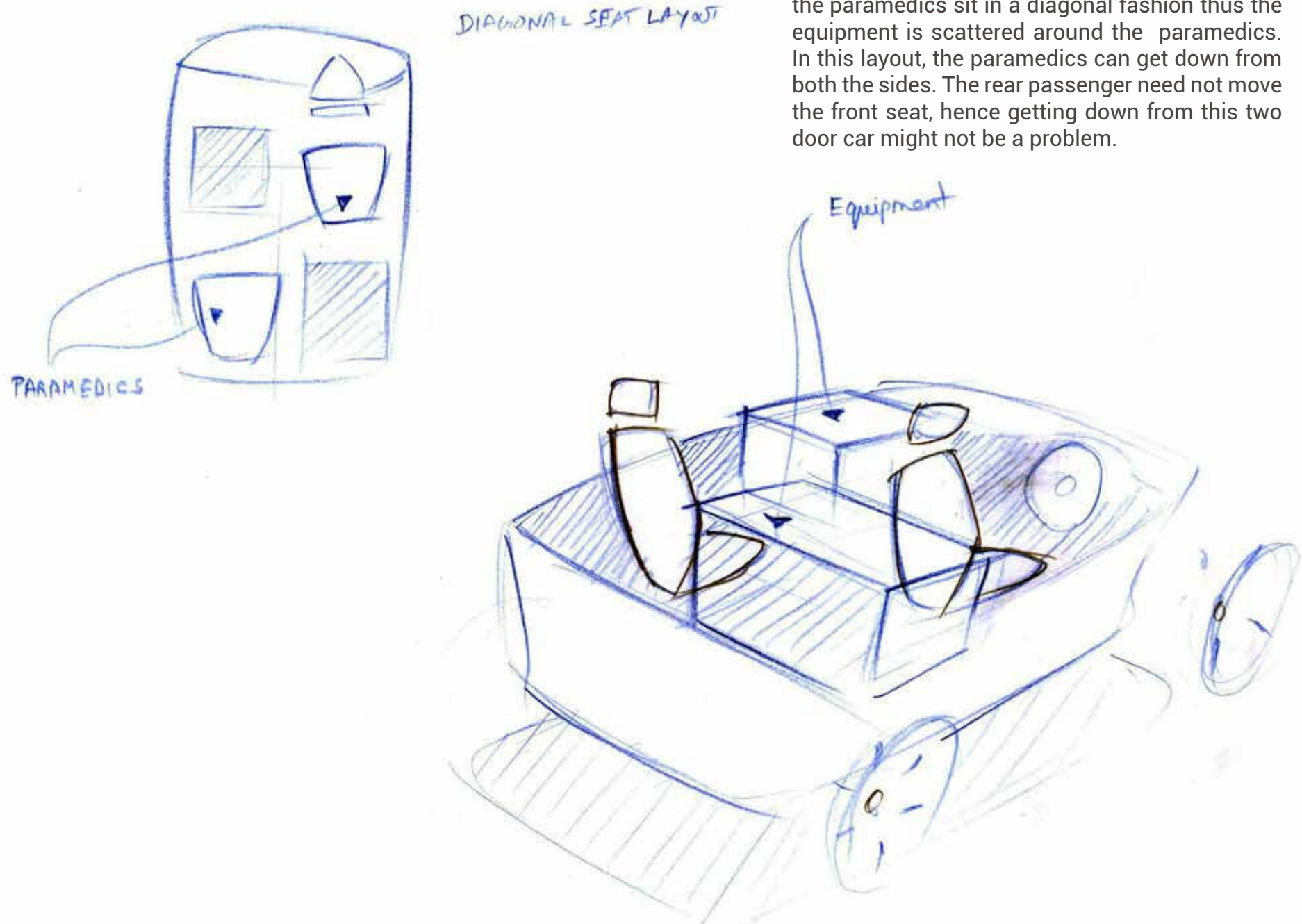




- * Ingress/Egress for non passengers will be hard!!
- * Paramedics can't see both the sides while riding
- * Not so good for communication

Package 3 - Diagonal seating

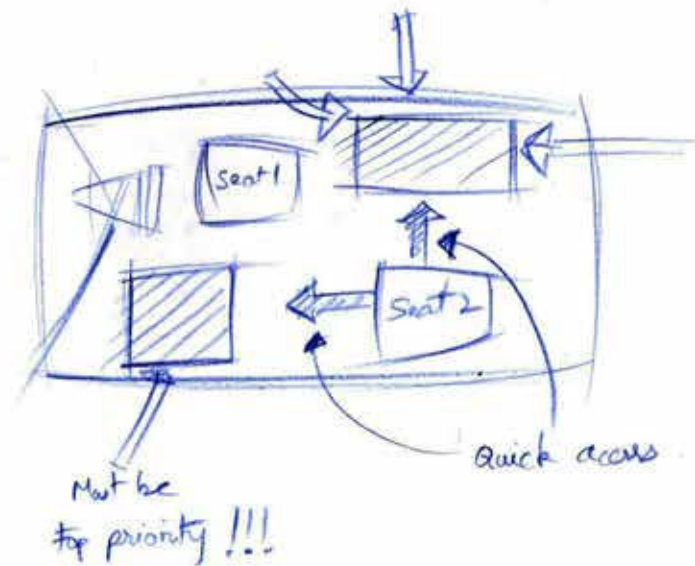
Package 3 is following the diagonal layout. Here the paramedics sit in a diagonal fashion thus the equipment is scattered around the paramedics. In this layout, the paramedics can get down from both the sides. The rear passenger need not move the front seat, hence getting down from this two door car might not be a problem.



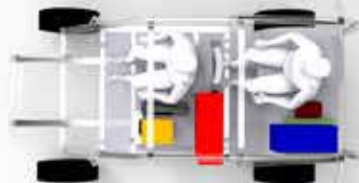
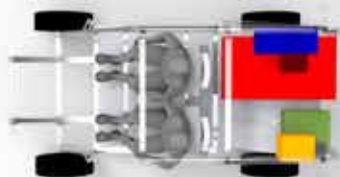


Allows paramedic
to get down
with the equipment

Equipment access



- + Ingress/Egress is a bit hindered as there is no rear seat
- + Quick access is very useful, can prepare the equipment before getting down
// very useful if it is very sunny outside or raining.



Foldable stretcher



Rucksack



Oxygen cylinder



Laryngoscope



AED



Suction apparatus



Ambu Bag

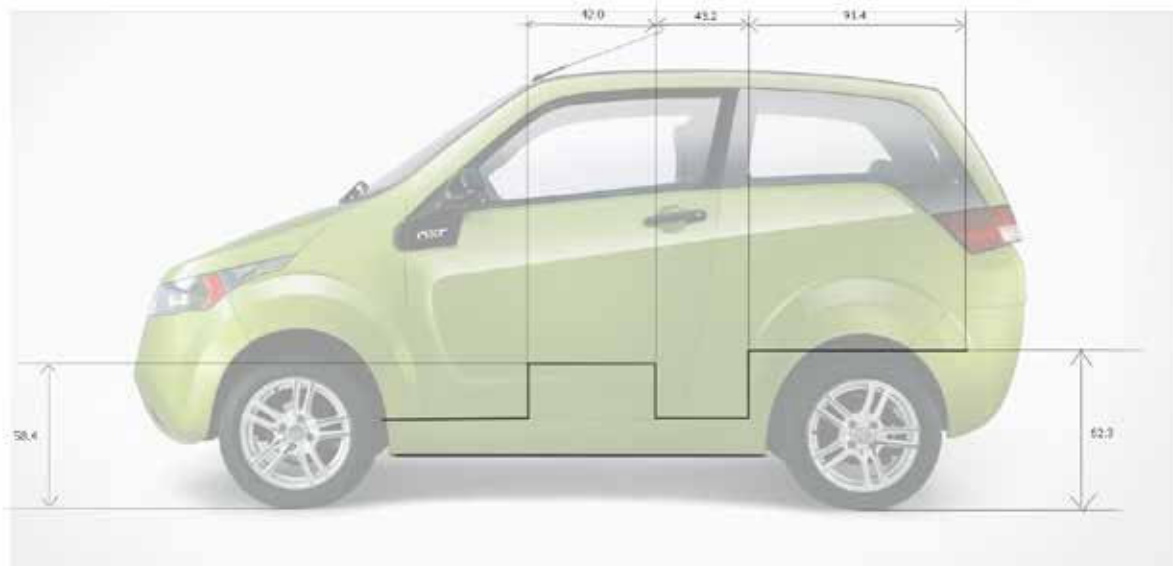
The three layouts

On the left, the three layouts are made in a CAD file to test out the size and positioning with respect to the priority of the equipment. For example, the AED has more priority, hence it will need more protection and must have a very quick access. Similarly, the foldable stretcher need not be placed in a place which could be accessed very quickly, ofcourse it needs quick access, but the priority is less compared to others. Hence it is kept on the floor or placed straight in case of back to back

layout. Likewise all three layouts were worked upon and the three different possible layouts were shortlisted. The previous ideations just suggested where the seats will come, but this CAD model helps us to organize the equipment in the optimal

place based on the priority of equipment access.

As we can see the floor of this car is not flat. There a battery pack just below the front two seats and the rear portion is lifted to place the motor below it.



The floor board dimensions (in cms)

Package Evaluation

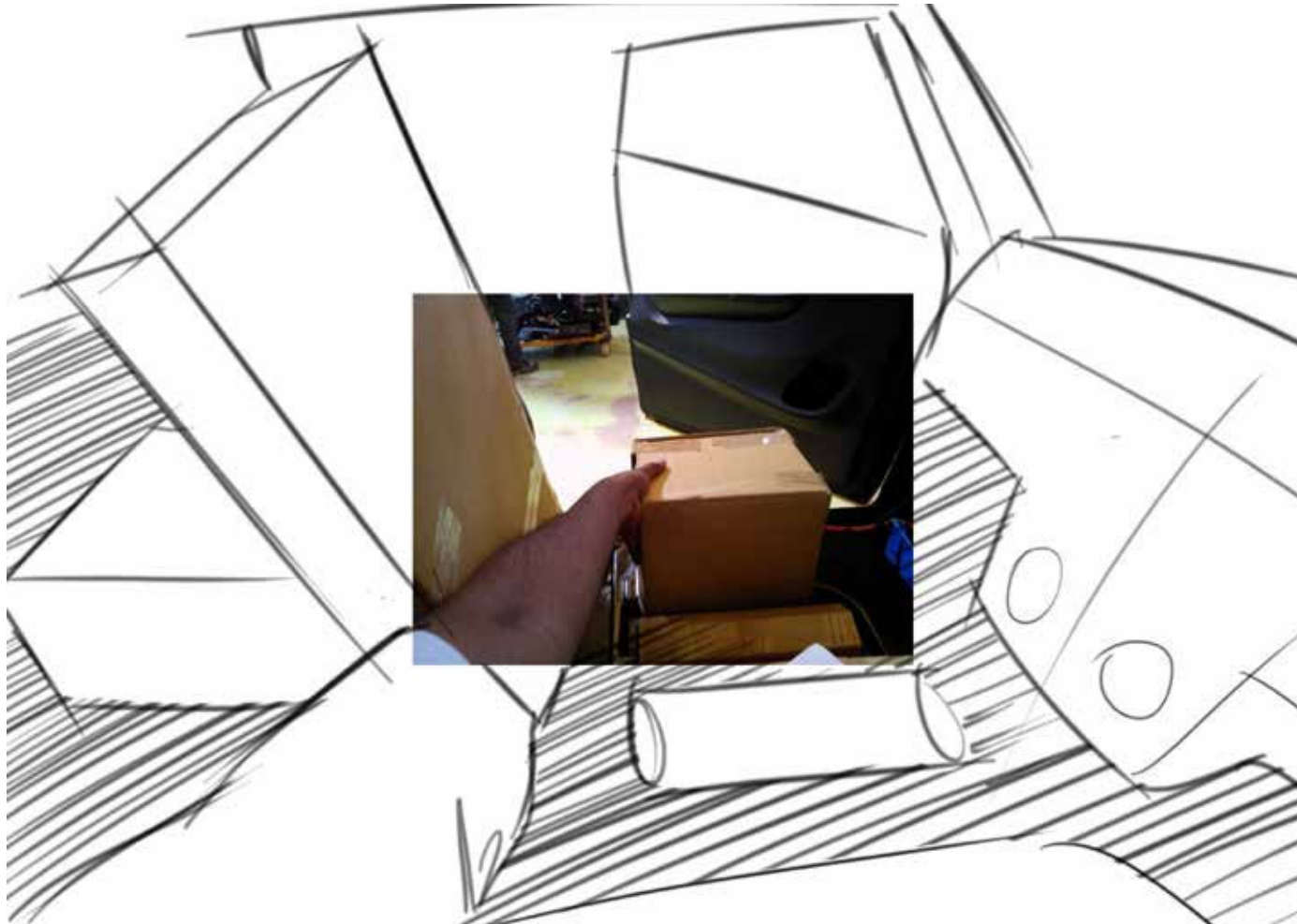
As seen in the previous sketches, there are three possibilities, the paramedics can sit side by side, tandem or in a diagonal. Accordingly the way the equipment is packed will vary. There are advantages and disadvantages in each of these packages. This can be evaluated by simulating the equipment sizes and the weight. The following boxes are then fitted inside a Mahindra Reva E20 to check the accessibility, space constraints and basic ergonomic factors.

Boxes of cardboard, which simulate the dimensions and weight of the equipment are made. Then these were taken to Mahindra Reva plant, Bangalore and tested out for the above said

factors.

The seats of the car were removed and these boxes were fitted inside based on the cad diagram shown in the previous page. Then two seats were added in all three orientations and then tested out for easy access, comfort of the passenger while the equipment are near him, safety, quick access from outside and inside. Then these were evaluated with a weighted matrix to fix a layout.

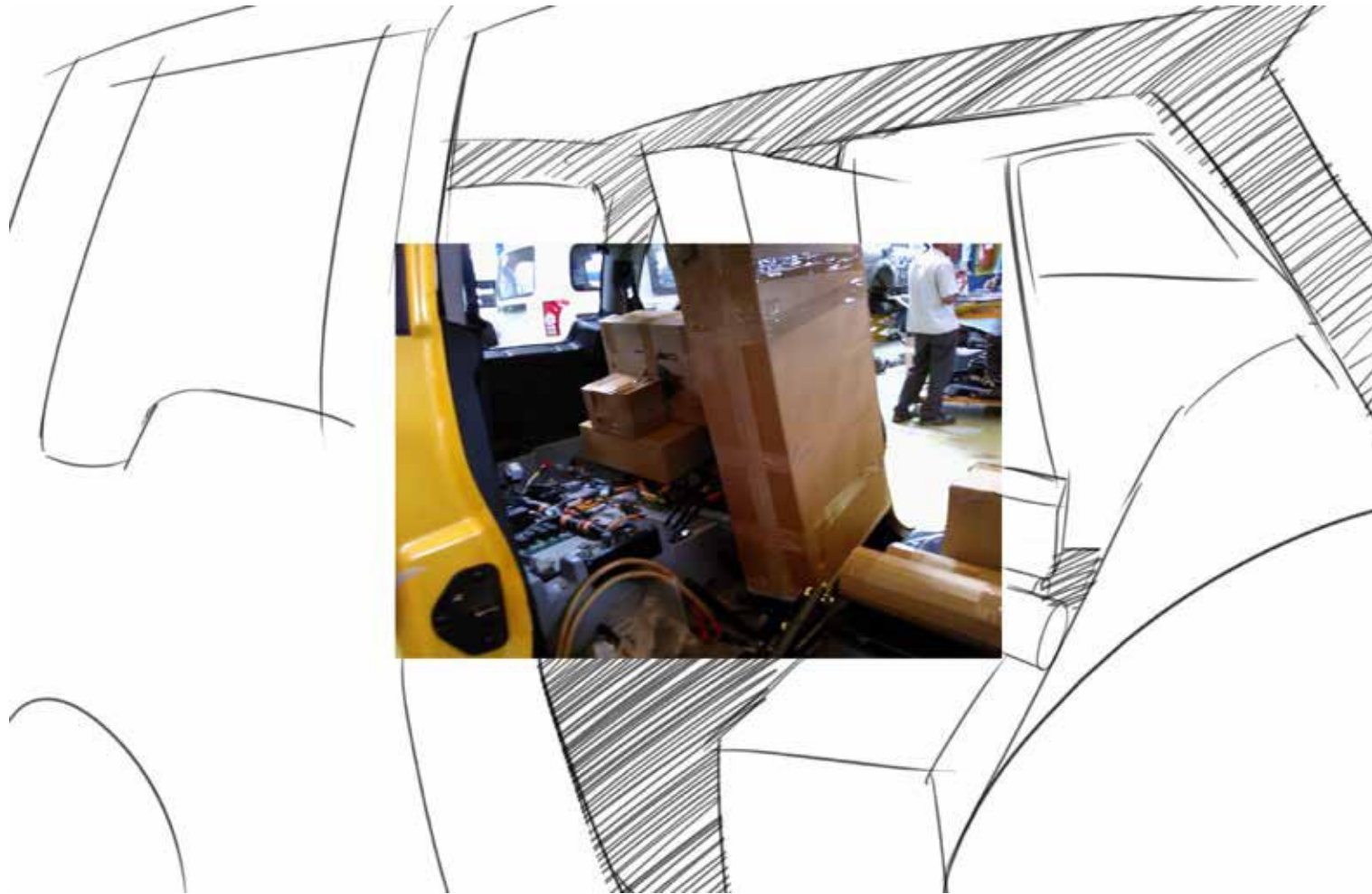




Back to back -
from drivers point of view



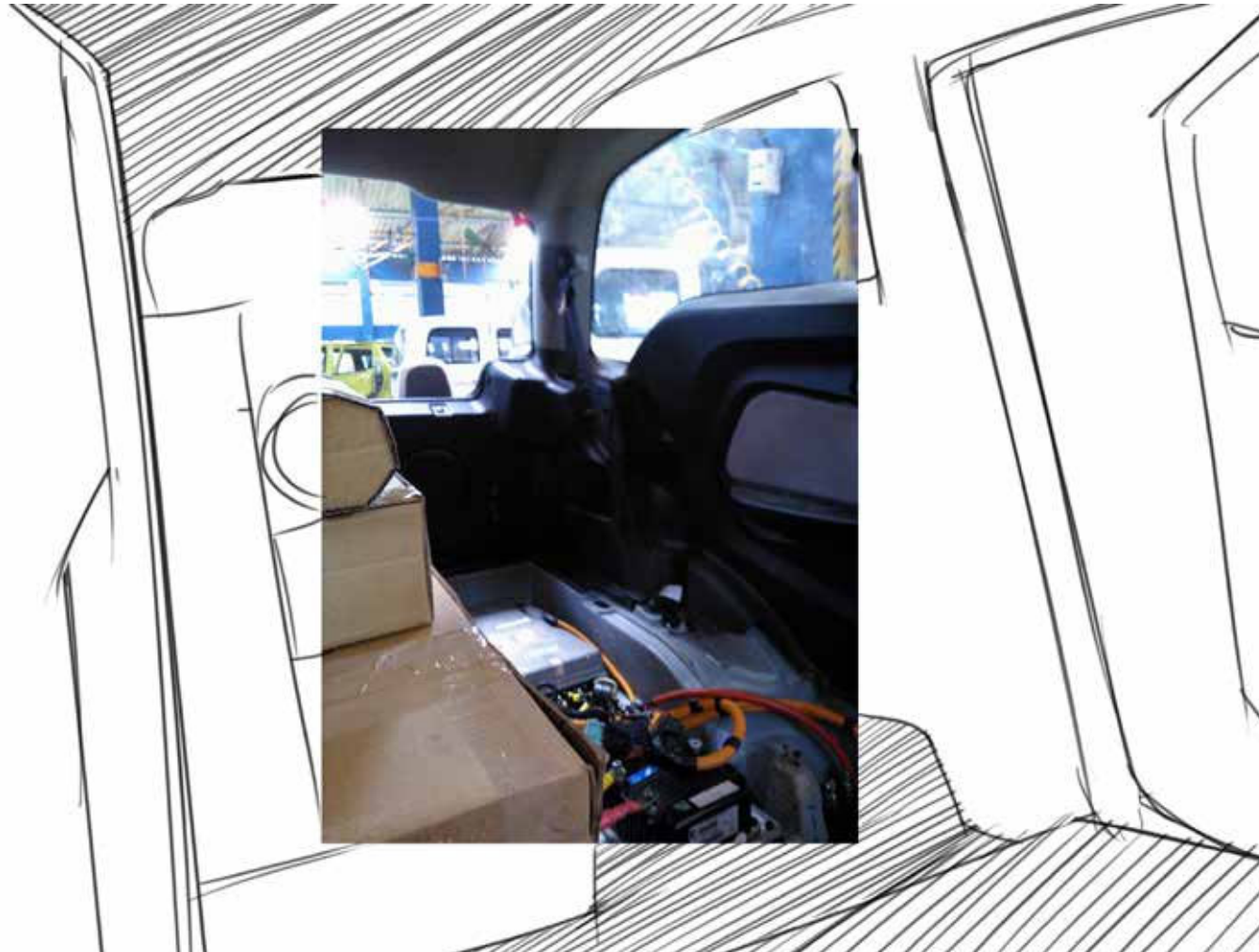
Back to back -
from rear view



Back to back -
from right side door



Diagonal layout-
from right side door



Diagonal layout-
looking from driver view
towards the rear passenger

Side by side layout-
from co-passenger view



Package Evaluation

From the experiment did above, the following criterias are made and evaluated along with the weightage. Here Ingress and Egress, equipment accessibility, will be the major concern. From the observation done, the package with diagonal layout

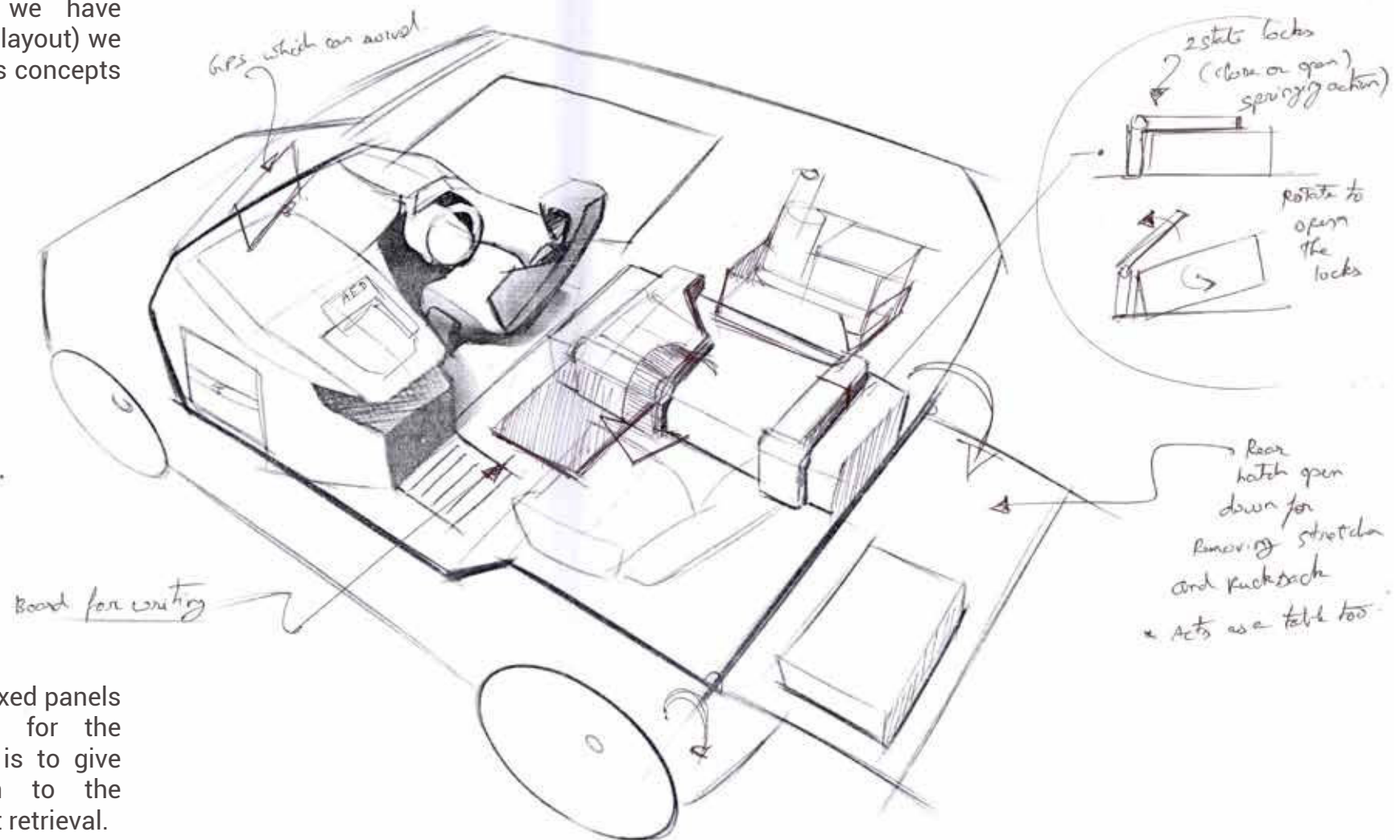
wins. There are more points as in why this package will be a better option. This layout allows the paramedic to prepare even before he gets down. Being AED as the first priority equipment, and it is heavy and expensive, it will be safer if it will be kept in a

concealed place. The paramedic can get down with the equipment rather than getting down first and then start to prepare everything.

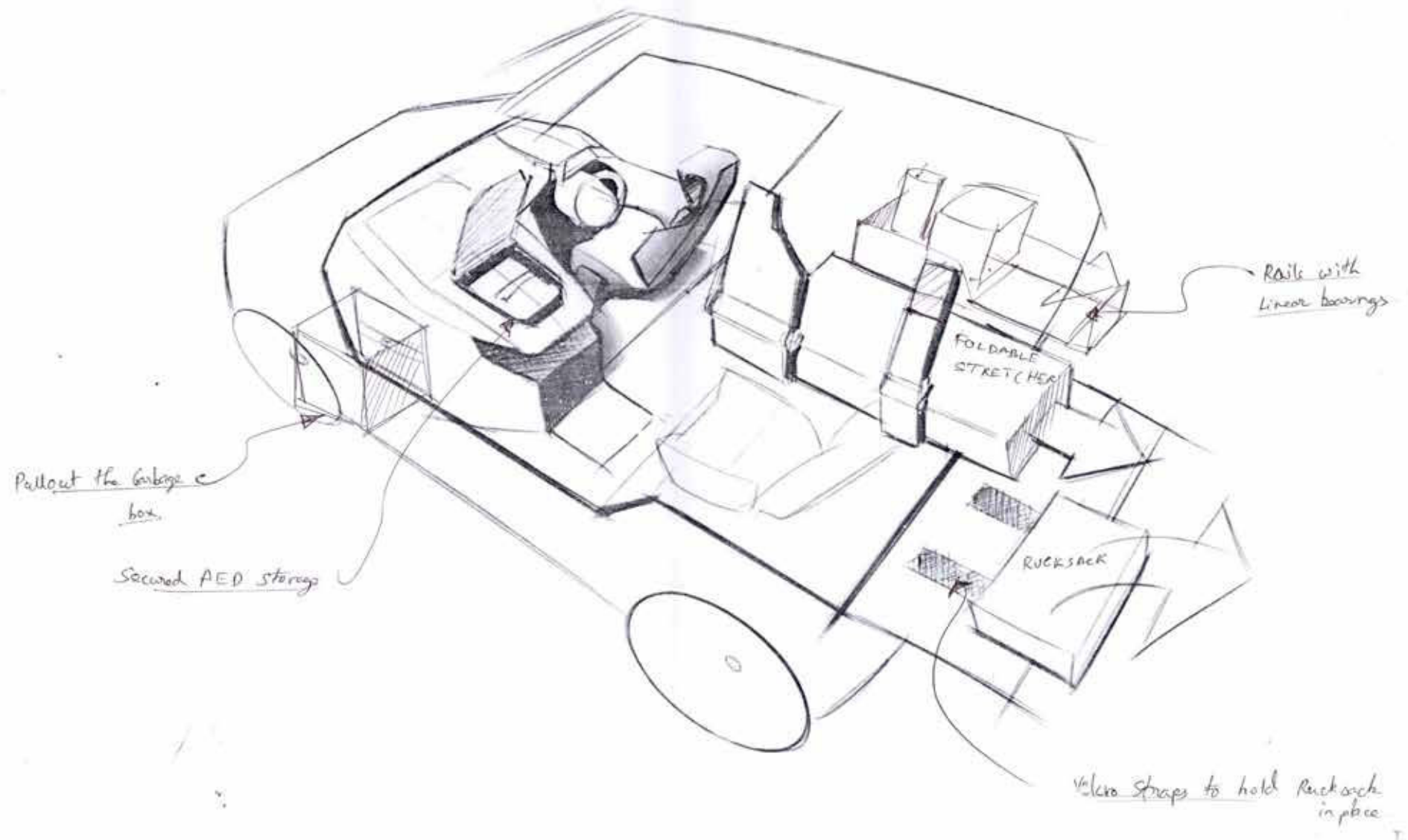
Criteria	weightage	Package 1 (side by side)	Package 2 (back to back)	Package 3 (diagonal)
Ingress/egress	5	5	2	4
Equipment accessibility	5	3	4	5
not claustrophobic	4	5	2	5
Communication between paramedics	3	5	2	4
Visibility (for both paramedics)	2	4	3	4
Total		83	47	85

Concepts

From the Package we have chosen (the diagonal layout) we will explore the various concepts for it.



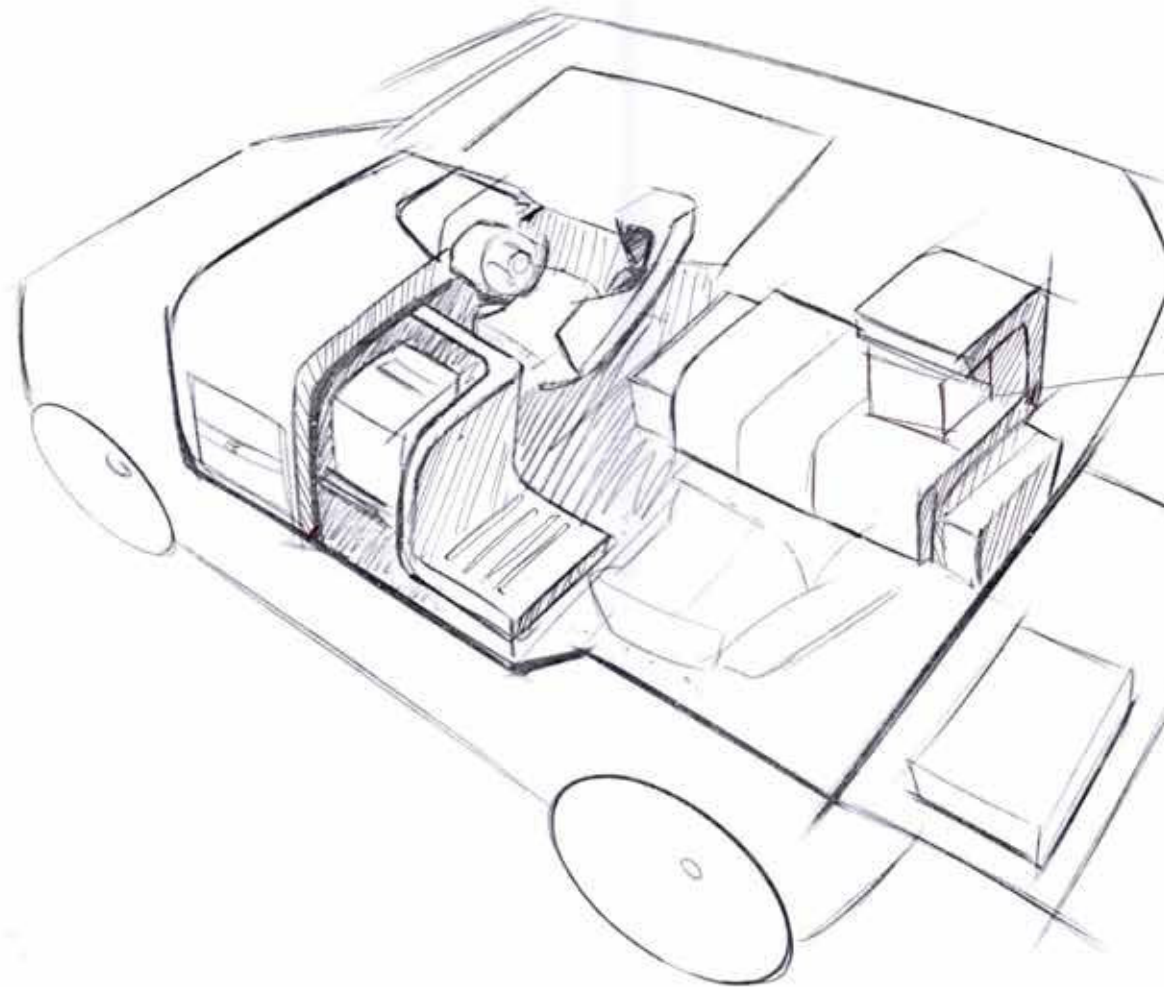
Concept 1 has these fixed panels specifically designed for the equipment. The goal is to give maximum protection to the equipment and for fast retrieval.



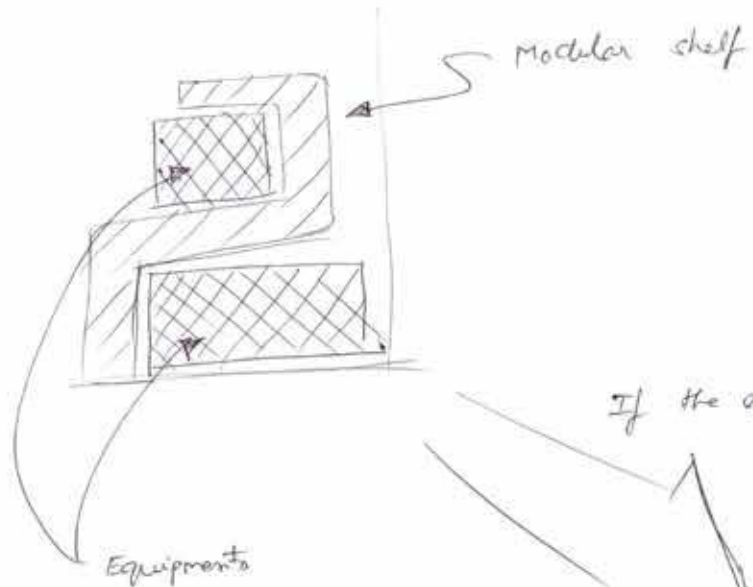
The concept 2 is modular racks. Here some flexibility in the structure holding the equipment is introduced. The whole shelf can be replaced by another shelf which holds different kind of equipment. Still the shelf is specially designed for the equipment itself, the paramedics can only change the shelf which suits their need.

The need for such a modular kind of system is that the paramedic can vary the equipment based on the location and the frequently occurring cases.

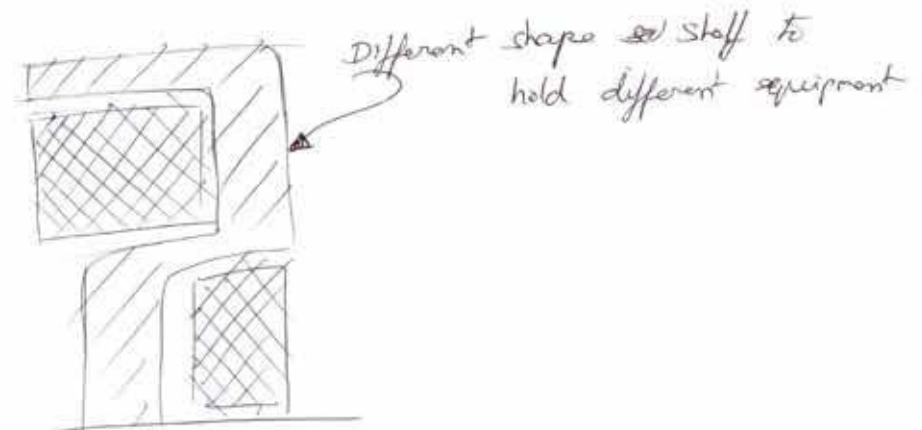
CONCEPT 2 MODULAR RACKS



Racks which can be removed and another one can be kept for the purpose of the vehicle.



If the equipment vary in size

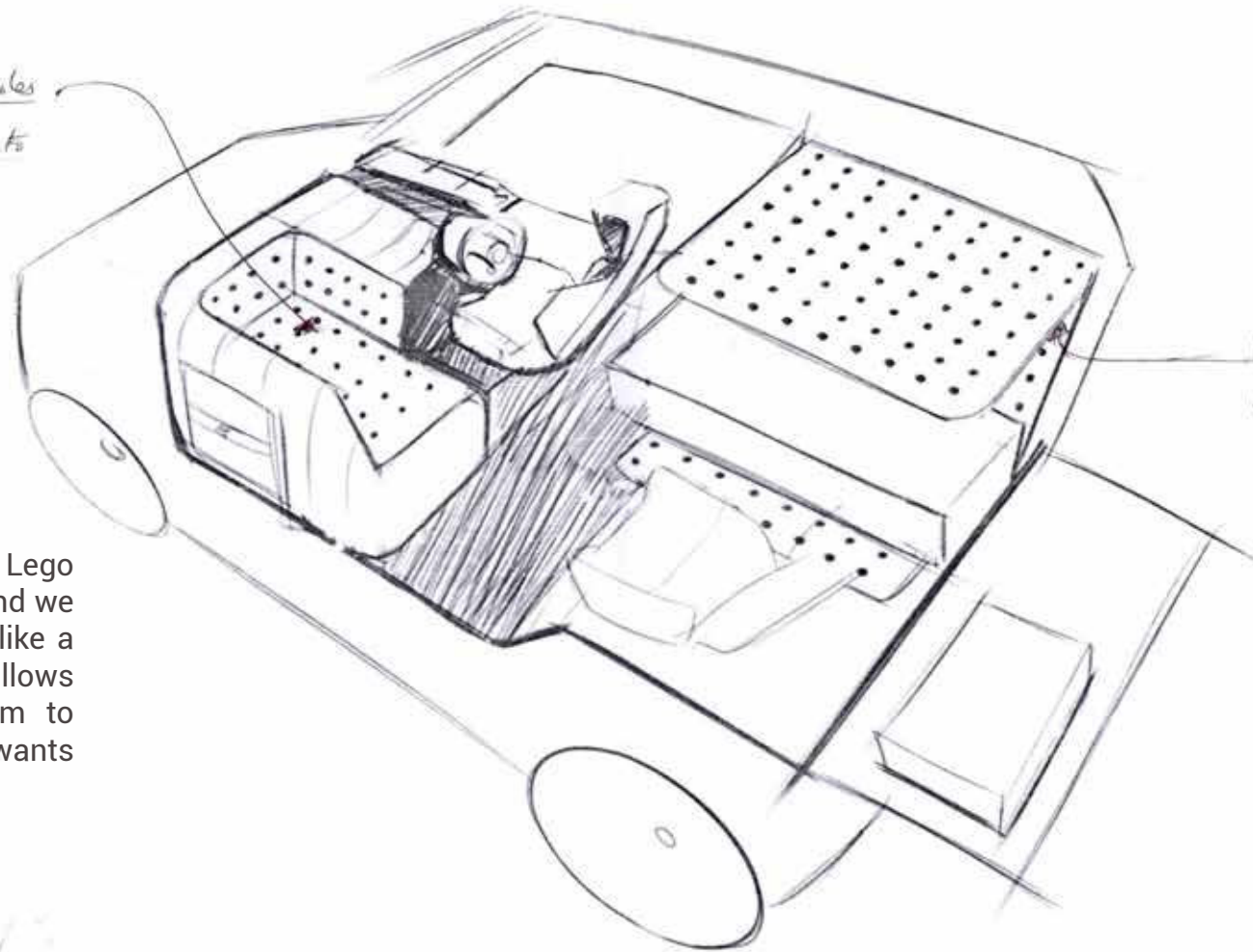


Side section of two different shelves are shown. Each holds different kind of equipment. But the whole shelf will fit inside the car.

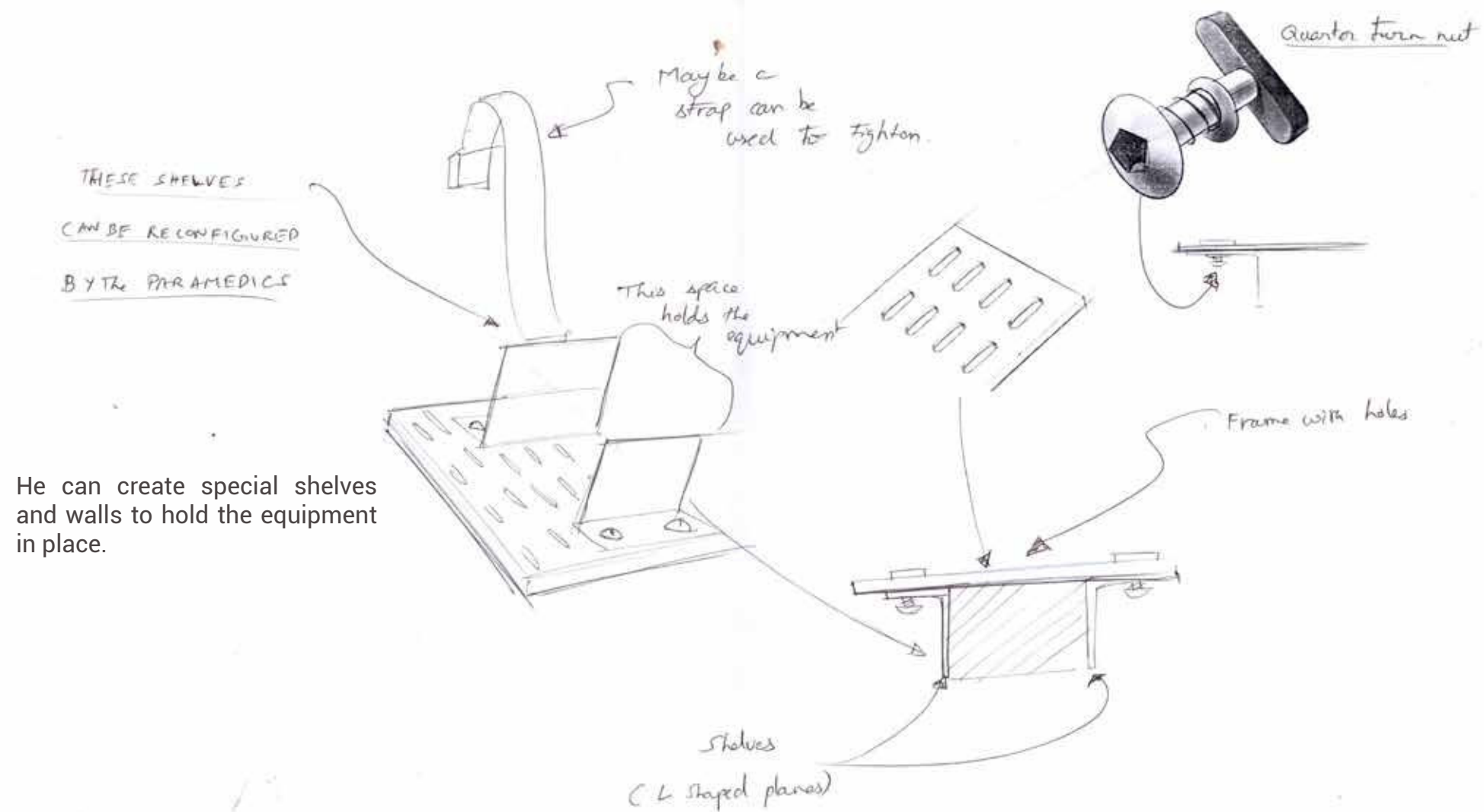
CONCEPT 3
LEGO CONCEPT

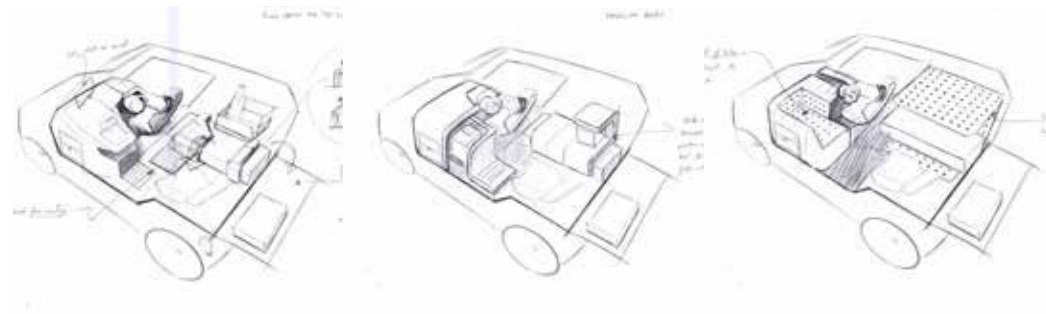
Another set of holes
in the front to
hold AED.

Frame which has
holes to hold shelves



- Concept 3 is inspired from Lego or game which has holes and we can fix wherever we want, like a mechano game set. This allows the paramedic full freedom to explore whatever way he wants to arrange the equipment.



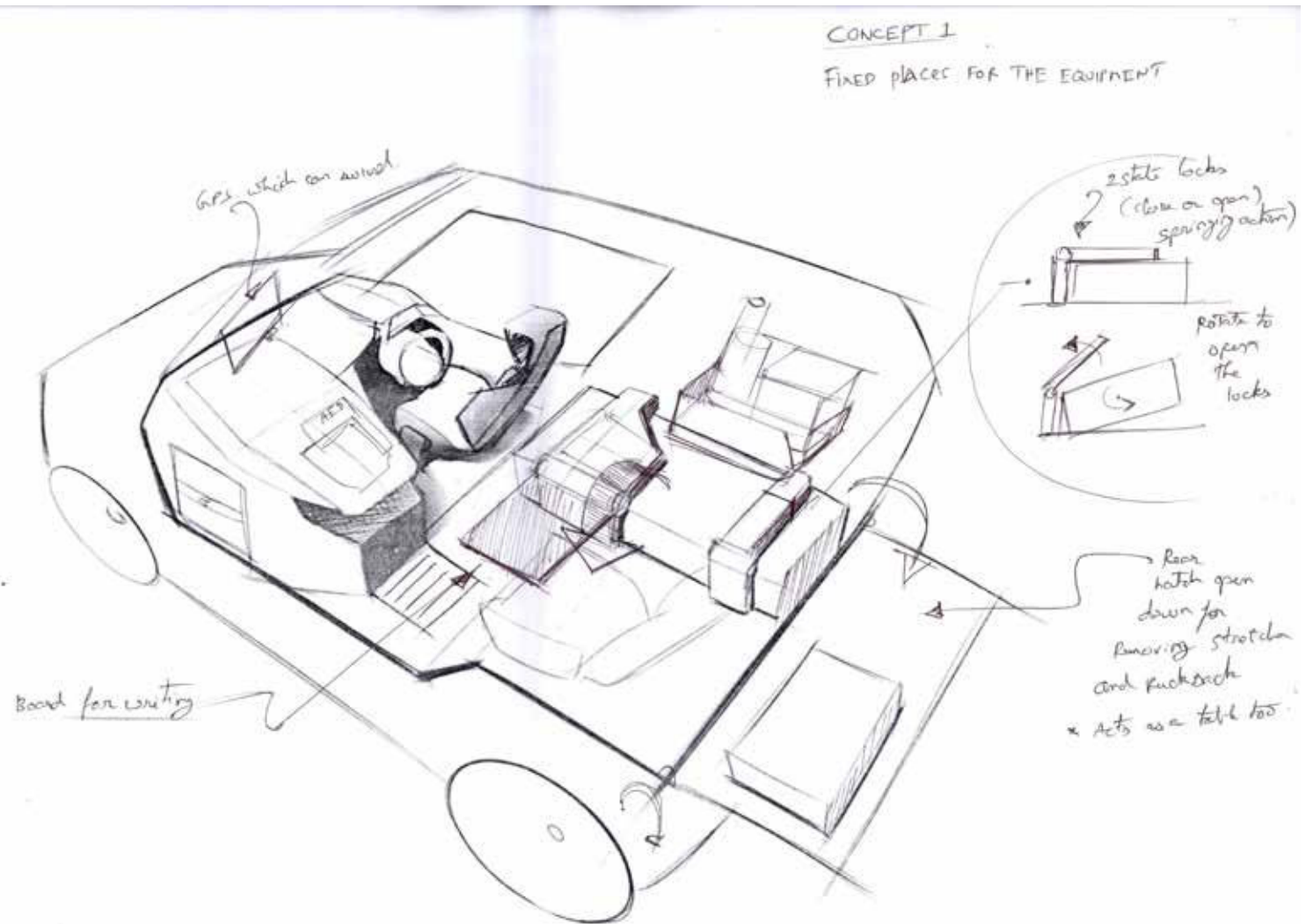


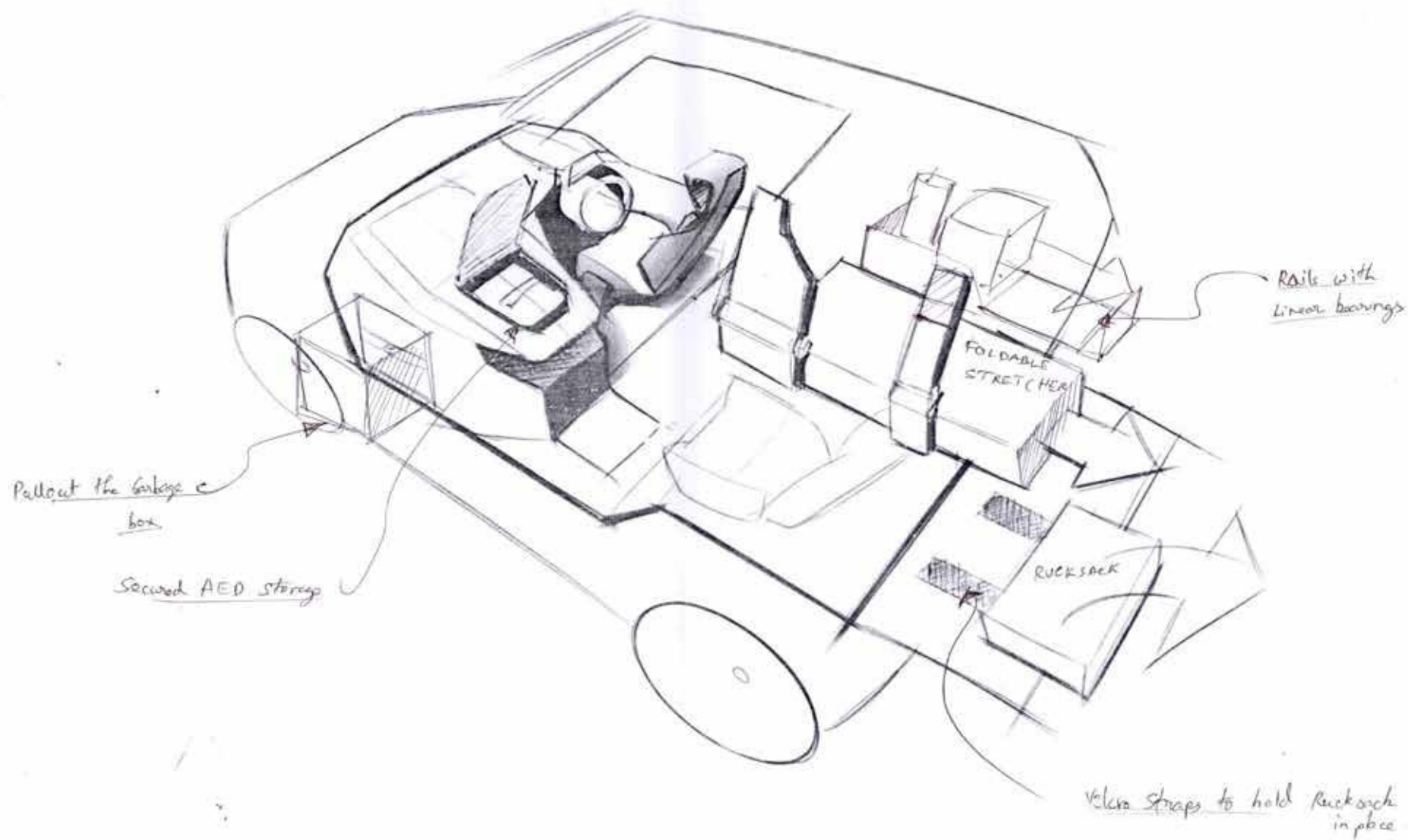
Criteria	weightage	Concept 1	Concept 2	Concept 3
Speed of retrieval	5	25	15	15
Securing equipment	5	25	15	10
Cleanability	4	12	16	8
Flexibility	3	3	9	15
Aesthetics	2	10	8	4
Total		75	63	52

Concept 1 is selected and taken for further detailing

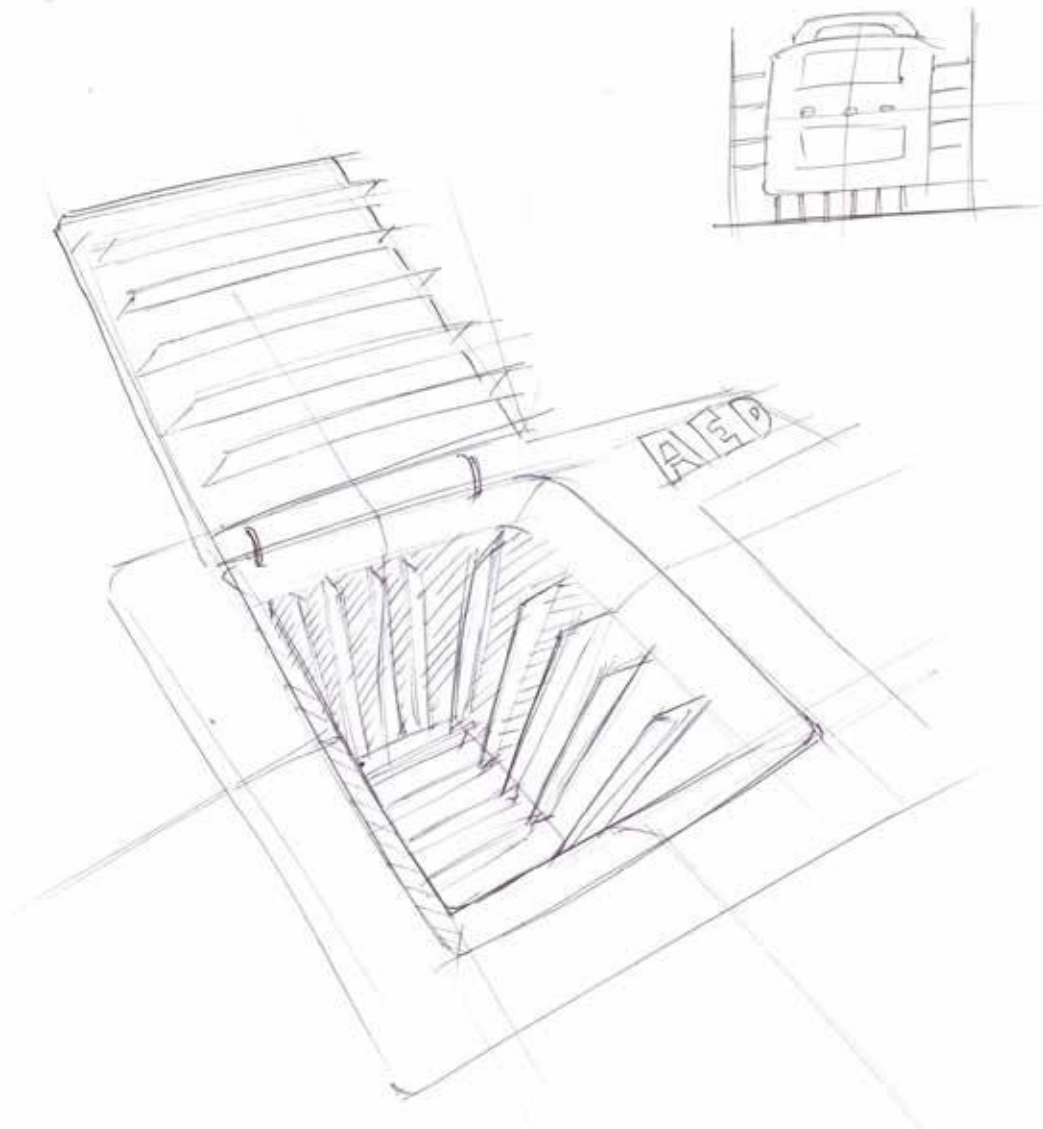
4 Detailing and model making

The selected concept, which is the fixed panel approach, is then taken into more detailing like how the equipment will be secured, what form it might take and the colour schemes. Only the interior is focused in this case. Making a model for showing the layout will be a good option to make the layout and the form more clear. Digital models can be used to show, but it will not give the actual product feel, hence a tangible physical model is necessary for this purpose.





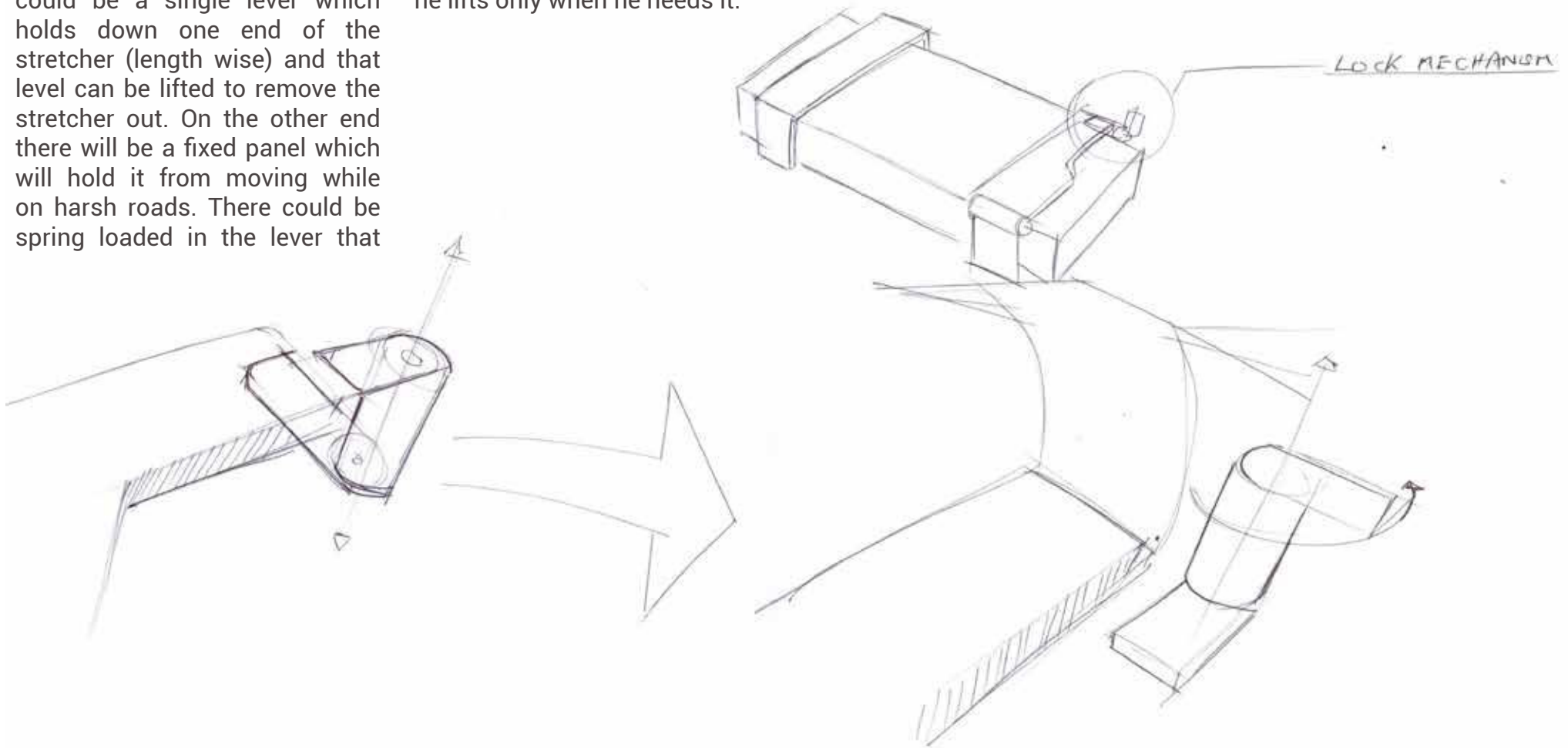
 ← Relaxed when not present
 ← Bend under shock



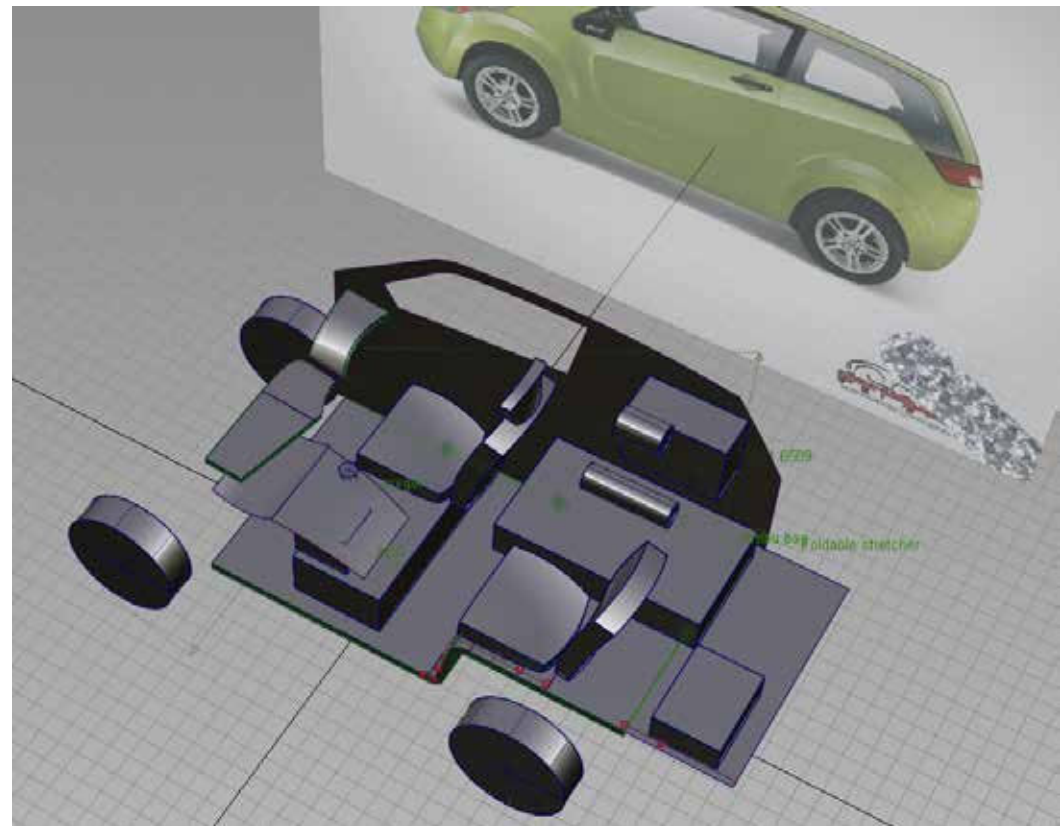
The automatic external defibrillator as mentioned is one of the most important equipment being carried and one of the most expensive too. It weighs six kilograms too. Hence this equipment, which is placed in the front, needs to be secured properly and proper vibration reduction mechanism, should be given. For example by having some strips of rubber which is perpendicular to the walls of AED cavity provided in the vehicle, will be a good option to reduce the vibrations. It holds the equipment intact too.

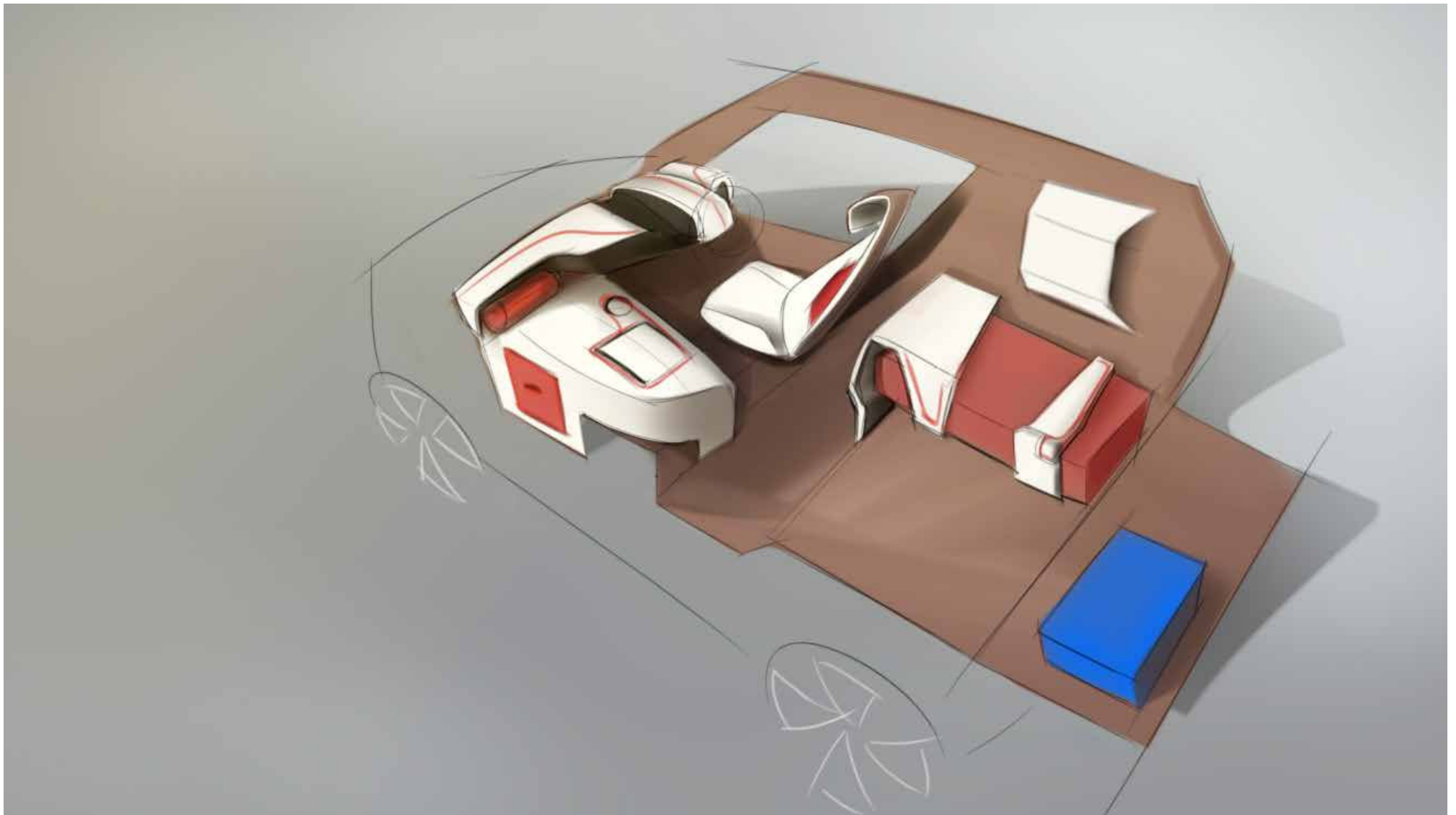
The locking mechanism of the foldable stretcher is explored. Here the foldable stretcher lies on the ground and how it can be retrieved is discussed. There could be a single lever which holds down one end of the stretcher (length wise) and that lever can be lifted to remove the stretcher out. On the other end there will be a fixed panel which will hold it from moving while on harsh roads. There could be spring loaded in the lever that

could lift automatically, but that might hit the paramedic when he tries to remove the stretcher in a hurry. Hence the manual mechanism will be better where he lifts only when he needs it.



The model making started with building a CAD model to make sure that the dimensions are kept intact. The CAD model was built using alias surface modeling tool to generate basic surfaces which will be present in the vehicle. The major components like the AED holder which starts from dashboard and extends till the front seat, the dashboard which is minimal and also helps in holding the fire extinguisher were made.





Design explained

Then with the alias model as a reference, the above rendering was made to visualize how the panels will look like. The form of the front panel is made so that the entry of the person is not restricted while getting in and getting out. The seats were made thin so that the interior space opens up and makes it look roomier. There are places like the dashboard and the AED panel; floating surfaces are used so as to make the volume look lighter. Floating surfaces gives the illusion of only a surface is present instead of the whole volume. The idea about the front AED panel is that, If a mold for that part is made and given to local fabricators in Chennai, then it will be easy for the local hospitals to quickly adapt it to their needs and depending on the specifications

they need. This will also help the local fabricators to work for this project. The communication with the ambulance coordinators and the local fabricators is the key driving force. Modifications can be done by the hospital officials themselves. Thus there is no fixed rule that the panel should be of this form only, but the mechanism of how the equipment's are secured is the same. The colour scheme used in the following model and the render is such that the main components in the interior like the equipment are highlighted. White and Brown gives a heavy contrast which helps in the floating surface feel.

Model making

The main intention of model making is to convey how the interior layout is done and get a better idea about the proportions and colour scheme. This model was made majorly out of acrylic sheets using laser cutting and thermal bending process. The parts like the dashboard and AED panel where there are a lot of form transitions, industrial clay is used. The model is made with the 2D rendering as reference and the surface model for dimensional reference.





Final scaled down interior model





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