Exploring Transformability of MPV into Ambulance

MOBILITY AND VEHICLE DESIGN PROJECT II

ASHWIN R KRISHNAN

156390003

GUIDE: Prof. NISHANT SHARMA

IDC SCHOOL OF DESIGN
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
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Ashwin R Krishnan

Date:

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1. INTRODUCTION

Over the centuries, medical science has developed to be increasingly effective and sophisticated. One particular branch of medical care that has gained prominence over the past few decades is Emergency Medicine. A medical emergency by its very nature is unpredictable and requires quick and intensive care. The most common examples include cardiac arrests, stroke, injuries pertaining to accidents, and labour pains. Attending to medical emergencies require swift and effective action. There have been varying approaches to handling this. Certain systems attempt to bring specialized personnel and equipment to the patient and provide emergency care on the spot. This system is popular in countries like Germany and France. In most countries, including India, the system is to take the patient from the spot of emergency to the nearest hospital, where specialists can attend to them.

Most systems are concerned with the 'Golden Window', an ideal timeframe within which the patient should be stabilized and given adequate preliminary care. In case of severe emergencies such as cardiac arrests, this window is as short as 10 minutes. This necessitates the need for quick and urgent transportation of the patient from the spot of emergency to the hospital. Accessibility is another key issue. Most systems are associated with an emergency hotline number which can be contacted in order to get an ambulance vehicle dispatched. However there is no guarantee on the timely arrival of the ambulance, especially in the chaotic traffic conditions of urban India.

With the advent of modern mobile technology, app-based taxi services such as Uber and Ola provide convenient and transparent booking and payment options for customers. The opportunities to integrate the features of ambulance vehicles into a taxi system could potentially elevate the current status of Emergency Medical Services especially in the congested cities in India.

2. PRE RESEARCH

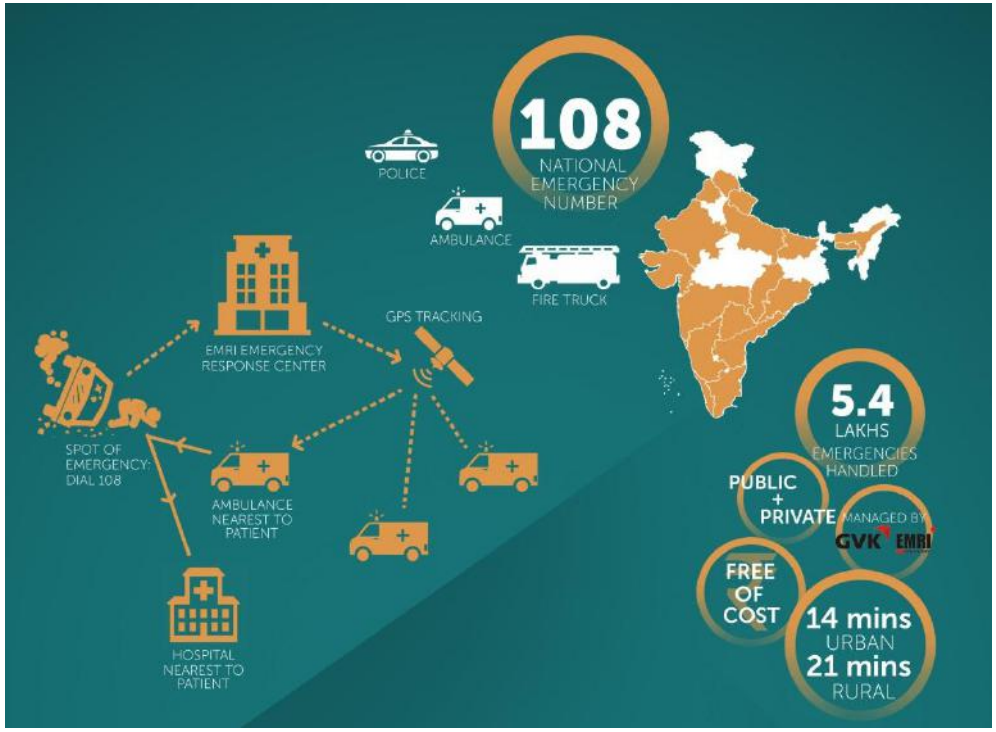
The aim of the pre-research was to learn the fundamentals of an Emergency Medical System and also the features of a regular Ambulance Vehicle so that the research phase would be supplanted with enough preliminary data to decide a direction for the project.

2.1 SYSTEM STUDY

2.1.1 – THE 108 NATIONAL EMERGENCY NUMBER

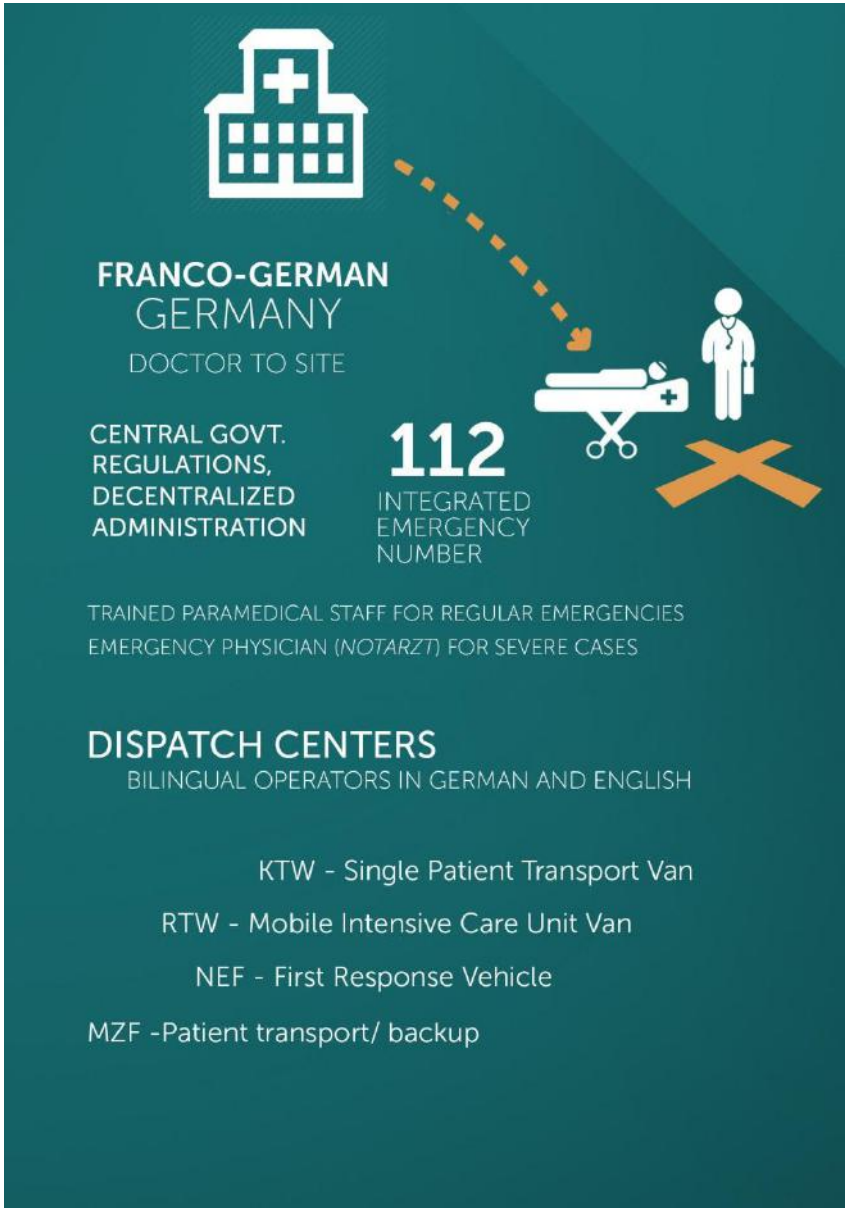
108 is the national integrated emergency number modelled after the famed 911 hotline in the United States. The number provides access to Police, Ambulance and Fire services according to the situation at hand. It is currently operational in 20 states, and is handled by the firm GVK-EMRI in a public-private partnership venture. The system provides its services free of cost, and has handled a total of 5.4 lakh emergencies till November 2014. GVK provides the base infrastructure for the system to operate, such as the response centres and paramedic staff. The vehicles themselves are owned and operated by the individual hospitals and organizations which are partnered up with the system.

In every city, there will be an EMRI Emergency Response Center, which is usually housed inside a major hospital. The ERC employs personnel who handle the incoming distress calls and dispatch ambulance vehicles, which will be stationed at strategic locations in the city. These vehicles are also GPS trackable. Whenever an emergency occurs, the 108 number can be called. The location of the emergency is confirmed by the operators verbally. By using GPS location, the ambulance nearest to the patient is located and dispatched. In case the ambulance is unavailable, the next nearest one is selected and so on. The hospital nearest to the patient is also located and the driver is routed to the particular hospital after collecting the patient. Even though accurate statistics are not available, the average response time is 14 minutes in urban areas and 21 minutes in rural areas.



2.1.2 – FRANCO-GERMAN SYSTEM

The Franco-German system believes in bringing the care to the patient, and not the other way. The trained emergency physician, called 'Notarzt', is taken to the site in a fast first response vehicle (NEF), armed with all the necessary equipment to provide preliminary care. The integrated emergency number of 112 provides access to the system. The dispatch centers take care of calls, with operators who are bilingual in German and English. The basic regulations for the system are set by the central government, while individual city municipal corporations can introduce additional regulations if they need to. Once the patient is stable enough, additional transport vehicles arrive on scene to take the patient to the hospital.



2.1.3 – ANGLO-AMERICAN SYSTEM

The Anglo-American model is more popular around the world, in which the patient is taken to the hospital as soon as possible, from where the emergency care is given. The 911 national emergency number provides integrated Police, Ambulance, and Fire services. The Public Safety Answering Point in each city has operators who attend calls and dispatch the vehicles to the locations, which are determined vocally. The federal laws regulate the base features of the vehicles, the qualifications of the personnel and so on. The individual state laws can add more regulations on top of this. Usually each ambulance vehicle contains two staff, one Emergency Medical Technician (EMT) and one Emergency Medical Responder (EMR). There are 4 types of vehicles based on the type of emergency at hand.

2.1.4 – THE INDIAN SCENARIO

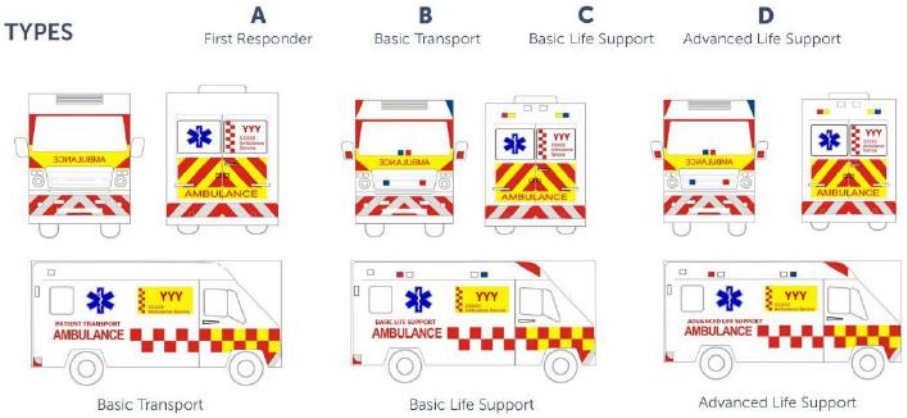
Even though the 108 emergency number is a step in the right direction, the scenario in India still leaves a lot to be desired. One of the major issues is the lack of clear regulations defining what an Emergency Medical System is. There are individual state government laws, but nothing that integrates and regulates ambulance systems on a nationwide basis. Even the prevalent 108 number hasn't been implemented nationwide yet. In addition, there are no standard training programmes for paramedic staff as well. In addition, any private company can own vehicles and register themselves as an EMS provider. There is no transparency in selecting organizations on merit basis for providing services. In addition, the persistent problems of heavy traffic and underdeveloped infrastructure are also major drawbacks in the system in existence.

Private ambulance operators can charge anywhere between 1200 for basic ambulances and 4000 for advanced cardiac vans with life support facilities. Many of these operators work based on private numbers, which are listed on directory sites like JustDial. There are also ventures like Ziquista, which provide the service for free for poor people. Most of the operators buy stock vehicles and kit them out at 3rd party coachbuilders. A Force Traveller ambulance, one of the popular models, costs about 12 lakhs for the basic patient transport ambulance and around 22 lakhs for the advanced life support models. State governments like Delhi issues vehicle permits which have a validity of 5 years after which the vehicles have to be inspected again. Even then, there is no special license required for qualifying as an ambulance driver.

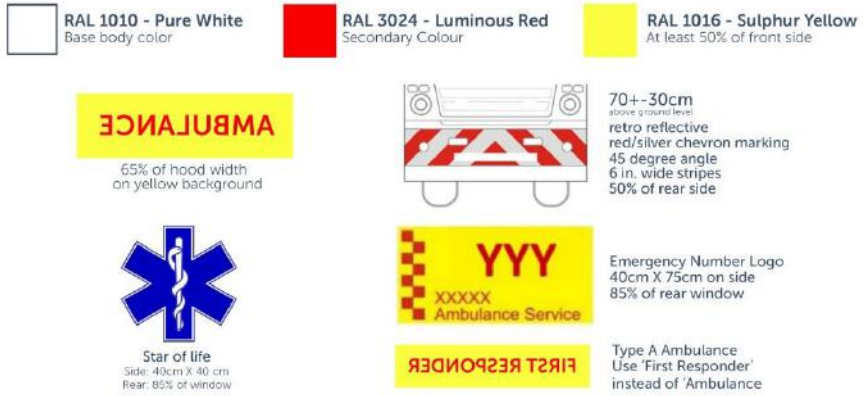
2.1.5 – THE NATIONAL AMBULANCE CODE

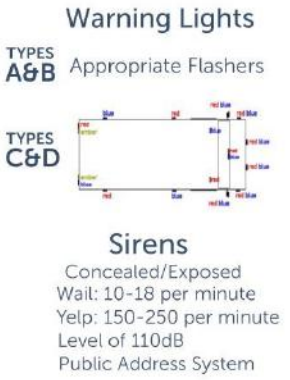
In a move to introduce centralized regulations to ambulance vehicles in India, the Ministry of Road Transport and Highways, in partnership with the Automotive Research Association of India (ARAI), has drafted the National Ambulance Code, and is currently in the approved state, and ready to be implemented in 2017. The vehicles are classified as four categories, and the class of First Responders is introduced for the first time.

2.1.5.1 – EXTERIOR REGULATIONS



There are stricter regulations which lay down the appearance of the vehicles in detail, most of which is focused on increasing the visibility of the vehicle. Standardized liveries and signages are mandatory for all the vehicles except first responders, which can just have a mirrored 'First Responder' on the front of the vehicle.





2.1.5.2 – INTERIOR REGULATIONS

Mandatory partition wall
between driver and patient areas

One or two windows
With direct view of driver
Material complying to CMVR
Max. area 0.12 sq.m
Adjustable blinds at driver side

TYPE B,C&D: ceiling, sidewalls, doors lined with nonpermeable material which is resistant to disinfectant

edges sealed to prevent liquid seep

drain plugs on the floor if needed

min radius of exposed edges 2.5mm

all installations above 700mm from floor should not have sharp edges. medical equipment is excluded

TYPE C&D: 40+-15cm aisle walkway between stretcher and side seats

stretcher positioned streetside

minimum 25cm clearance from the end of stretcher to rear door

equipped with lockable drugs compartment

floor covering with material that is easy to clean and grippy when wet

TYPE D: space of 64-76 cm at the head of patient, measured from face of backrest to forward edge of stretcher

Seating

		B	C	D
Minumum No.		1	2	2
Position(s)	On side of stretcher	1	1	-
	On side of stretcher, upper 2/3rd	-	1	1
	Head of stretcher	-	-	1

Stretcher Loading

Max. loading angle 16°

Loading height:
- stretcher to ground 825mm
- floor/loading assembly to ground 750mm max.

Loading Assembly must use anti-slip material

Load capacity 350kg

Max allowed travel for secured stretcher - 150mm

Seats

Either forward/sideward/rear facing

Seat cushion area
381mm X 381 mm

Backrest area
300mm X 100mm

Secured by 2-point or 3-point seatbelts

Refernce Standard
IS: 15546-2005

Lighting

Color temperature min. 4000 deg. Kelvin

	B	C	D
stretcher area	50 lux	150 lux	150 lux
surrounding area	30 lux	50 lux	50 lux

Type D: Additional light in the treatment area min 1650 lux.

Fire Safety

Type C,D: Two fire extinguishers 2kg each

Noise Level

Type B,C,D: Conforming to AIS 020

Oxygen Cylinders

Aluminum/Steel

Stored upright with valve up

Valve height max 1500mm

Individual pressure regulators

Low pressure, electrically conductive hose

Minimum flow rate at outlet: 100 LPM

Digital display for pressure level

Automatic changeover on empty

Emergency/backup outlet accessible to patient

Air Conditioning

Optional except in Type D

If outside temperature is 32 degrees cooling it down to 27 degrees should take no more than 15 minutes

cooling down to 25 degrees should take no more than 30 minutes

Stretchers

Conforming to European Standards EN 1865

Consists of:

- Stretcher part
- Undercarriage

Dimensions:

1950mm X 500 mm tolerance of 20 mm length reducable to 1800mm in certain vehicles

Weight:

- Stretcher part - 23kg max
- Undercarriage - 28kg max

Frame:

Sturdy, non twisting, enabling CPR radiused corners

Siderails 500mm X 150-200mm (min.)

Support for infusion attachment

Wheels:

4 wheels, min 100mm diameter
360 swivel wheels at rear, 2 brakes

lying area backrest min 600 mm and tiltable to 75 degrees

2 quick release restraints

lying area non slip material unaffected by disinfectanct

3. RESEARCH

The aim of the research phase was to understand the scope and depth of the problem at hand and gathering enough information to build a foundation on which possible design solutions could be thought of. At the end of the research phase, the design brief was made which comprehensively describes the project, its objectives and deliverables.

3.1 MEDICAL EMERGENCIES

To better understand the nature of emergency medical transport, there was a need to understand the medical emergencies themselves. Discussions with doctors helped to gather information on this regard.

SITUATION	TYPE OF CARE/TRANSPORT REQUIRED	SKILL LEVEL/ SPECIALIZATION REQUIRED
Road Traffic Accidents		
Abrasion	Basic Patient Transport	Physician/ Orthopedician/ Surgeon
Open Wounds	Basic Patient Transport	
Fractures	Basic Patient Transport	
Head Injury	Life Support	
Cardiac		
Chest Pain		Cardiologist/ Physician
Mild	Basic Patient Transport	
Severe	Life Support	
Cardiac Arrest	Life Support	
Shock	Life Support	
Respiratory		
Asthma	Basic Patient Transport	Physician/ Chest Physician
COPD	Basic Patient Transport	
Hemoptysis	Life Support	
ARDS	Life Support	
Neurological		
Stroke	Life Support	Physician/ Neurologist
Coma	Life Support	
Cerebral Hemorrhage	Life Support	
Seizure	Life Support	
Abdominal		
Intestinal Obstruction	Basic Patient Transport	Surgeon
Perforation	Life Support	
Mesenteric Angina	Life Support	
Hematemesis	Life Support	
Ureteric Colic	Basic Patient Transport	
Appendicitis	Basic Patient Transport	
Vomiting/Diarrhea	Basic Patient Transport	

Pregnancy		
Ectopic Pregnancy	Basic Patient Transport	Gynaecologist
Bleeding	Basic Patient Transport	
Labour Pain	Basic Patient Transport	
Decreased Fetal Movement	Life Support	
Oncological		
Febrile Neutropenia	Life Support	Medicine/Oncologist
Pathological Fracture	Basic Patient Transport	
Diabetic		
Hypoglycemia	Basic Patient Transport	Medicine
Keto Acidosis	Life Support	
Allergic		
Anaphylaxis	Basic Patient Transport	Medicine
Fall From Height		
Wounds	Basic Patient Transport	Ortho/Surgeon
Fracture	Basic Patient Transport	
Head Injury	Life Support	
Ophthalmic		
Penetrating Injuries	Basic Patient Transport	Ophthalmologist
Foreign Body	Basic Patient Transport	
ENT		
Foreign Body	Life Support	ENT Specialist
Stridor	Life Support	
Choking	Life Support	
Animal Related		
Animal Bite	Basic Patient Transport	Medicine
Venomous Bite	Life Support	
Unknown Bite	Basic Patient Transport	
Burns	Life Support	Surgeon
Drowning	Life Support	Medicine/Physician
Death	Basic Patient Transport/Hearse	Medicine/Forensic Medicine

3.2 GLOBAL AMBULANCES

A glance at ambulance vehicles used across the world, to understand the types of vehicles used and their features.

FORD F-350 CHASSIS
UNITED STATES

Based on the popular F350 pickup truck chassis, this ambulance has the patient cabin built (by third parties) separately on top of the chassis, accessible via rear and side doors. The interior has all the necessary life support equipment as well as space for two paramedic staff.

TOYOTA HI-ACE
JAPAN

Toyota has exclusive rights to manufacture ambulances in Japan, and this vehicle is custom built to adhere to the standards. There is monitoring equipment on board but minimal life support, as Japanese system believes in providing most of emergency care after reaching hospital.

FIAT DUCATO & BMW R1200RT
UNITED KINGDOM

The Fiat Ducato ambulance is a regular large capacity van converted into ambulance following regulations. It is available in patient transport and life support varieties, and is dispatched according to the emergency situation. The BMW R1200RT motorcycle is often dispatched as a first responder with a trained paramedic riding it, so they can arrive at scene and provide medical care before the actual ambulance arrives.

VOLKSWAGEN T5
GERMANY

Germany uses lighter, faster sedans and SUVs as first responders due to their system of bringing the Emergency Physician (Notarzt) to the scene to provide primary care. A regular patient transport van such as the Volkswagen T5 is taken to the spot later so that the stabilized patient can be transported back to hospital for further care. It is equipped with all basic life support and monitoring equipment.

MERCEDES SPRINTER
AUSTRALIA

Australia's particular geography and population distribution means ambulances might have to cover very long distances in the rural areas to get to people, while being nippy enough in the cities. The Mercedes Sprinter van is a popular choice in this regard. Compared to other ambulances, the Sprinter doesn't have a raised roof. The driver's cabin is also only partially separated from the patient area. Other interior features remain roughly similar.

MERCEDES E220
SWEDEN

As one of the most economically developed nations, Sweden prefers a highly modified version of the fast and powerful Mercedes E Class sedan as their Emergency Patient Transport. The raised patient cabin houses advanced life support and monitoring equipment. The vehicle suspension is modified as well to accommodate this change. The vehicle is designed and built to speed through highways and city streets with ease.

3.3 OBSERVATION STUDY

Study done by visiting hospitals and streets in Mumbai in order to understand the current state and issues faced by Emergency Medical Services in India.

3.3.1 INDIAN AMBULANCES

MARUTI SUZUKI EECO
IIT BOMBAY

The Eeco is one of the smallest ambulance vehicles, second to only the Maruti Omni. The campus ambulance vehicle is bare essential patient transport. There is just a stretcher inside, which is not long enough for the average student to lie down on. Seating room is also very limited, especially in terms of headroom. In most cases there is just the driver inside. The stretcher needs a separate undercarriage to be brought out from the hospital to be unloaded from the vehicle.

ASHOK LEYLAND DOST
GHATKOPAR RAILWAY STATION

This ambulance was built by the Greater Mumbai Metropolitan Corporation (GMMC) to participate in the 108 ambulance service. The boxy cabin was built as a separate area on the Dost chassis, similar to the US ambulances. The interior houses a modern stretcher made by Ferno and also a foldable wheelchair. The stretcher, with its foldable legs, can be deployed without requiring any undercarriage to be taken from the hospital. The tall cabin also means that the vertical space is utilized for storage cabinets. The ambulance that I got to observe was stationed outside Ghatkopar railway station. The driver cabin had walkie-talkie and mobile phone holster which helps when GPS navigation is required. It also had a small fire extinguisher fitted to the A Pillar.

TATA 407 CHASSIS
RAJAWADI HOSPITAL, GHATKOPAR

The 407-based ambulance van is owned and operated by the Municipal Corporation, and is used only for non-urgent patient transport. The vehicle in question was about 15 years old and contained barely any safety and support features. The interiors were bare, and had just two long benches for seating. There was no stretcher holding assembly as well. The vehicle is often used to transfer a number of patients at the same time, often between hospitals. Patients on stretcher were observed to be loaded directly on the floor space between the bench seats while the relatives, crew and other patients sat on the seats. The high floor level also meant loading and unloading the patient was difficult.

FORCE TRAVELLER
JJ HOSPITAL, MUMBAI CENTRAL

The Force Traveller based ambulance is also participant of the 108 ambulance scheme. The vehicle is built based on a stock Traveller at third party workshops. The spacious interiors house basic monitoring equipment as well as a foldable Ferno stretcher, which can be deployed easily by the crew. The air conditioned cab also has room for seating for relatives and crew.

3.3.2 MISCELLANEOUS OBSERVATIONS

Auto rickshaws and taxis are used for preliminary transport to hospital

Smaller omni cannot house a fully foldable stretcher, making it difficult to unload and transfer the patient

Bare and spacious cabin of the 407 ambulance

Driver and assistant are present while the 108 Dost ambulance is dispatched

Bare metal stretcher without any transfer mattress, held against the floor of the vehicle for support

Patient lifted awkwardly and transferred, causing pain. Ambulance crew as well as inexpert bystanders are participating in transfer.

3.4 SCENARIO BUILDING

3.4.1 CASE STUDY - NARRATIVES

In order to identify the opportunity where the MPV ambulance can be implemented, a number of scenarios were considered in which ambulance services were required. These narratives were collected by talking to a number of individuals who had either experienced or had an acquaintance or relative experience a medical emergency.

MALE, 40s, LIC OFFICER

"I was driving at night with family when I experienced a sudden, sharp stomach pain. I stopped and had medicine, drove for some more. In some time the pain intensified, and I vomited. Wife drove us to a nearby clinic. They referred to a hospital. Since there were no ambulances available, a private driver arranged, who drove their car to hospital. Found out arterial block, transfer to a specialty hospital in ambulance, with 2 paramedical staff. Ambulance was arranged from a nearby hospital for this transfer"

FEMALE, UNKNOWN

"I was travelling in a bus when it crashed into an electric pole. Multiple people injured. The lady suffered from a broken kneecap and ankle injury. Bystanders called a private ambulance in their locality, whose phone number was available with them. Autos and taxis were also involved. Private vehicles did not stop. Patient taken to hospital in ambulance, accompanied by another passenger."

FEMALE, 50s, SCHOOL TEACHER

"I was travelling in bus, which had a collision with an oncoming truck. I suffered a deep wound across face. Nearby auto rickshaws immediately responded, some even cancelling their trips. Taxis and jeeps were also involved. Drivers helped the injured into the vehicles and asked for accompanying people. I was taken to nearby hospital, attended by duty doctor in casualty, who cleaned the wound and put stitches. A further check-up was done for eye damage."

MALE, 20s, COLLEGE STUDENT

"Riding two wheelers at late night with friends while drunk. Collision with truck, leaving them Injured and delirious. There were a few bystanders, one of whom called police. Police alerted ambulance service and responded themselves. Ambulance took them to nearby hospital, but one person did not survive."

FEMALE, 50s, HOUSEWIFE

"Suffered paralytic episode while at home around 7 pm. daughter in law was present, who called the neighbours. A taxi driver in the neighbourhood was called and she was taken to hospital, accompanied by daughter in law and neighbours. Waiting for ambulance was not an option, as immediate treatment was needed. "

MALE, approx. 10, SCHOOL STUDENT

"Attacked by dog on the way back from school. Suffered multiple wounds and abrasions due to falling. Incident happened in the boy's home neighbourhood. Neighbours intervened. One of them took the boy to a nearby clinic on his bike and alerted the parent after reaching there. Discharged after dressing wounds and taking rabies shot."

FEMALE, 20s, HOUSEWIFE

"Gave birth at government hospital. New-born baby suffered from breathlessness. Doctors referred to a medical college hospital. Life support ambulance was not available in the hospital. Arranged one from a private ambulance service immediately."

INSIGHTS

One of the common factors of these narratives is the first call made after the emergency, and how almost none of them were made to an emergency number like 108. Most of the calls were made to either personal contacts like a neighbour or relative, or to a private ambulance number.

The presence of an accompanying person is another important factor in most of these cases. They provide a mental support to the patient as well as facilitate the transport itself.

Often an ambulance vehicle itself may not be available at the spot of emergency. This is where taxis and auto rickshaws come into play. In many cases, patients are transported to the hospital in these vehicles, since they are readily available on the spot. However, one of the problems

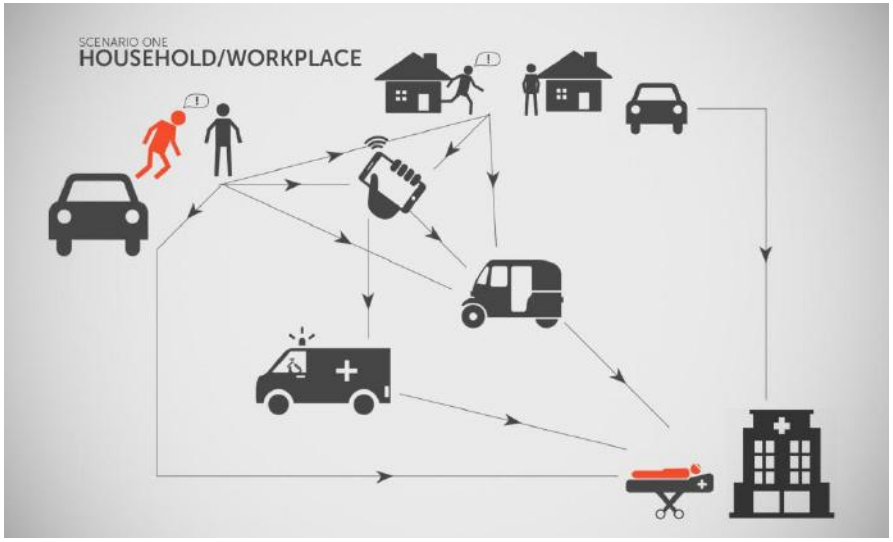
with this is that more often than not, the transfer is done very inexpertly. In case of emergencies like spinal injuries, this puts a huge amount of risk on the patient.

Ambulance vehicles are generally more widely used in inter-hospital transfer and returning the patient to home rehabilitation. This ensures the patient is secure and stable while properly monitored.

The role of bystanders and strangers at an emergency is also considerably important. Often in case of accidents, the patient or immediate relative might be in a state of panic and unable to make calls. In such situations, bystanders jump to action and facilitate the transfer of the patient.

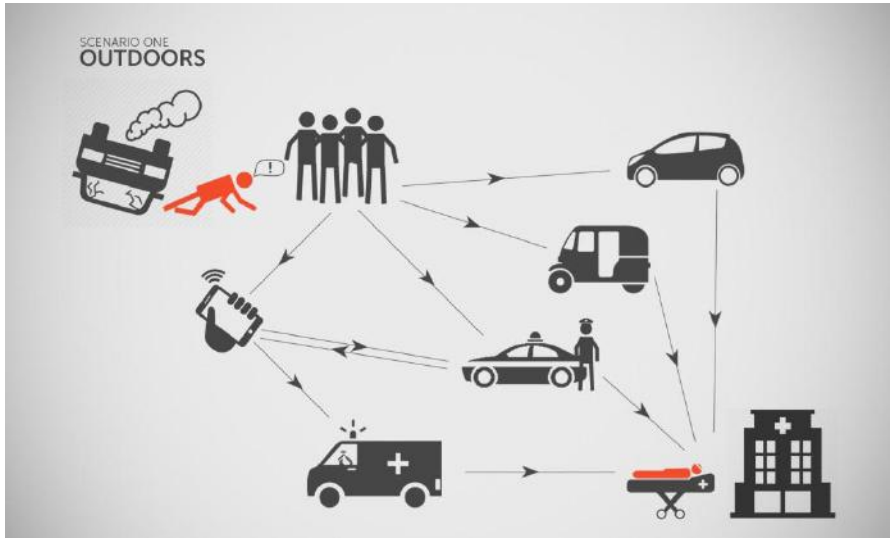
3.4.2 - SCENARIOS

Based on the research till this point, the following scenarios describe how the system works at the moment and how the MPV-ambulance system could possibly work.



The emergencies which occur in the house or workplace often involves a relative or colleague who can either take the patient to hospital in their personal vehicle or call either a taxi or an ambulance. The alternate scenario is where the relative or the patient themselves go to a neighbour and the same process can happen from there. The patient himself/herself can also call the ambulance or other transportation, which is rare but can also happen. After the patient is taken to the hospital, the paramedic staff or doctors present there will start the emergency healthcare procedures.

The scenario plays out a bit differently if the emergency



occurs outdoors. An outdoor environment has the presence of bystanders, who can call the vehicles, including ambulances, autos, taxis or even private vehicles. Another possible scenario is calling the police, who in turn arrange for emergency transport to the hospital.

MPV-AMBULANCE SCENARIOS

Since the role played by taxi vehicles in the transport of patients to hospital from a scene of emergency is apparent, the following points are considered while exploring of an ambulance system based on taxi vehicles:

1. Taxis are more ubiquitous and therefore more accessible
2. Transporting patients to hospitals in taxis pose a greater risk than ambulance due to improper handling
3. Mobile app based taxis like Uber provide a very transparent booking and fare system which eliminates a lot of uncertainty regarding the availability and ETA of the vehicles.

There are three possible scenarios for an MPV ambulance system to work:

1. Via mobile app: A patient or a bystander can call an ambulance using the mobile app interface. Similar to the 108 emergency system, a GPS satellite can keep track of all the vehicles which are in a particular area. The vehicle that is available and closest to the patient is dispatched to the patient, at which some sort of interior adjustments can be made to transform the vehicle from a taxi into a patient transport vehicle. The vehicle can reach the patient and transport him/her to the hospital.
2. Mobile App - Scenario 2: In case there are no available vehicles at the moment, the system can look for vehicles that are just about to finish their trip. In such case, a small delay could be added within which the vehicle finishes its trip as soon as possible and proceeds to collect the patient.
3. The vehicle can be called directly in case the patient or relative has the driver's number, in which case the driver can transform the vehicle and take it to collect the patient.

3.5 UNDERSTANDING FRAGILITY

The patient is the most important part of the patient transport system, and is often in a very fragile state, both physically and mentally. Ensuring adequate safety and comfort of the patient is one of the primary goals while designing any kind of patient transport system. In order to develop effective solutions for such a problem, the problem of fragility itself had to be understood from different aspects. The following inspirations were taken from both natural and man-made objects where fragility was handled in a comprehensive way.

GLASS

Glass in very important in several facets of life, and is extremely fragile in most cases. Transporting glass objects requires utmost care to prevent it from breaking. Glass panels as well as glass kitchenware are usually transported upright, with rigid packaging lined with softer foam or paper. Large glass panels are packed in wooden frames which cover the edges and padded with foam. Even while carrying, care is taken to reduce unnecessary forces on the object.

EGGS

Eggs are another important household commodity which requires proper handling to avoid breakage. Egg packaging has a lot of variety. The simplest involve dimpled cups in which each egg can sit vertically, taking advantage of the facts that the eggshell is relatively stronger at the two ends than in the middle. A number of materials such as papier mache and plastic are used to manufacture these packaging.

KANGAROO

The Kangaroo Joey is born extremely prematurely compared to other mammals.

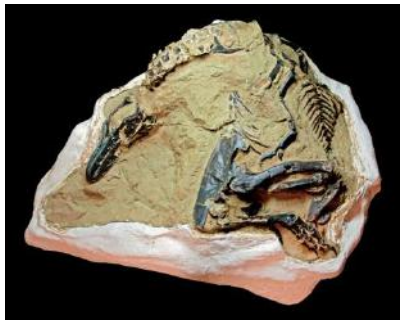
In order to protect such a delicate foetus, the mother is equipped with a belly pouch, into which the joey is born. The joey then nurses on its mother's teats, while being insulated by the thick skin of the pouch. The inside of the pouch is coated with a sticky liquid which has the dual purpose of holding the joey in place while the mother hops around, and also acts as a natural antiseptic.

SCULPTURES

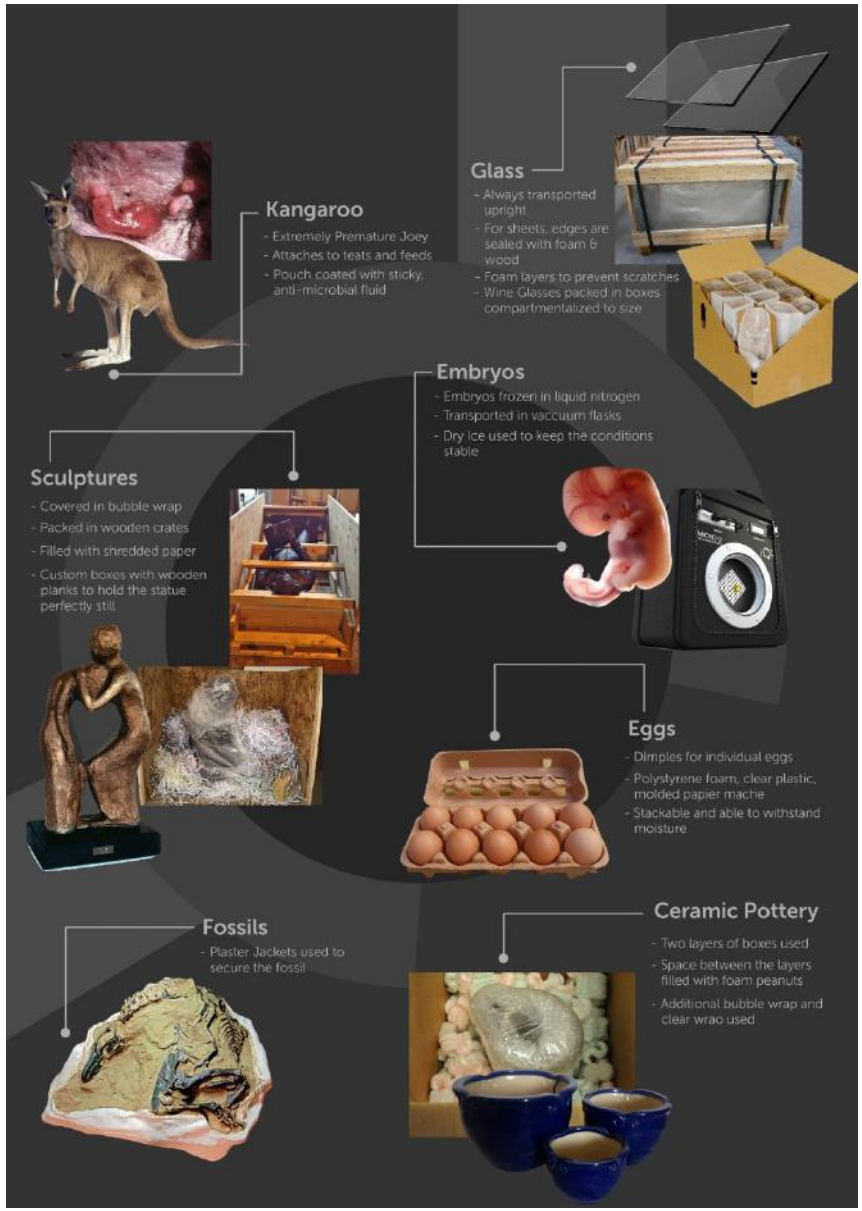
Sculptures are usually transported by covering it in air filled bubble wrap. The covered sculptures are kept in wooden crates that are filled up with shredded paper to reduce impact shocks. Specialized wooden frames are also made which can keep the statue completely immobile in its position while it is being transported

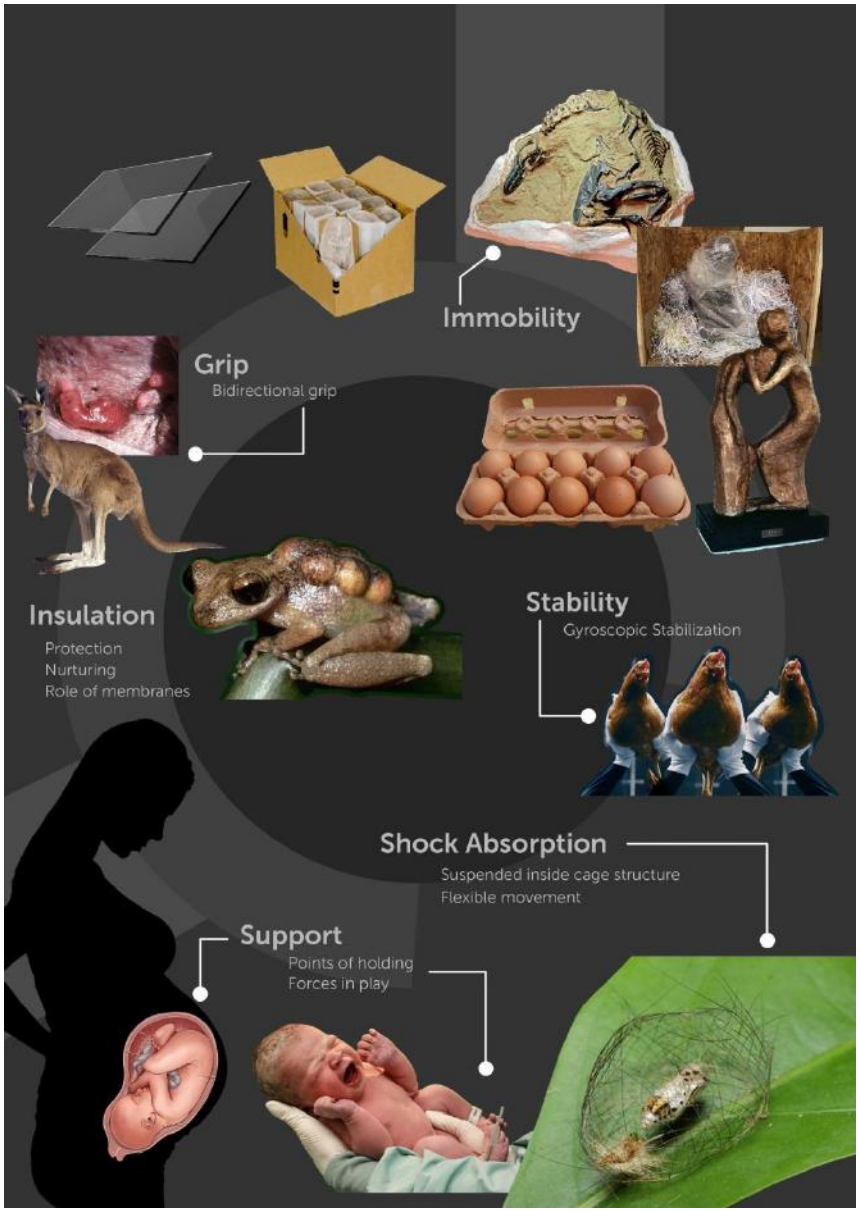
FOSSILS

Fossils are priceless archaeological evidence that have to be handled with utmost care while being transported. The primary concern is to immobilize the fossil, which is to ensure that the fossil remains completely still while it is being transported.



One way to do this is by covering the fossil with plaster, which solidifies into a rigid jacket that can protect it from impact and shocks. The jacket can be later removed by carefully breaking it or chemically dissolving it away.


Kangaroo
- Extremely Premature Joey
- Attaches to teats and feeds
- Pouch coated with sticky, anti-microbial fluid
Glass
- Always transported upright
- For sheets, edges are sealed with foam & wood
- Foam layers to prevent scratches
- Wine Glasses packed in boxes compartmentalized to size
Embryos
- Embryos frozen in liquid nitrogen
- Transported in vaccuum flasks
- Dry Ice used to keep the conditions stable
Sculptures
- Covered in bubble wrap
- Packed in wooden crates
- Filled with shredded paper
- Custom boxes with wooden planks to hold the statue perfectly still
Eggs
- Dimples for individual eggs
- Polystyrene foam, clear plastic, molded papier mache
- Stackable and able to withstand moisture
Fossils
- Plaster Jackets used to secure the fossil
Ceramic Pottery
- Two layers of boxes used
- Space between the layers filled with foam peanuts
- Additional bubble wrap and clear wrap used


Immobility
Grip
Bidirectional grip
Insulation
Protection
Nurturing
Role of membranes
Stability
Gyroscopic Stabilization
Shock Absorption
Suspended inside cage structure
Flexible movement
Support
Points of holding
Forces in play

4. DESIGN BRIEF

After the research part has been done, the next step was to create a comprehensive brief for the project. It is as follows:

To design the interior space of an MPV so that it satisfies the following requirements:

1. Function as an urban taxi while:

- Seating the driver + 5 passengers

- Having all the basic features found in existing products

2. Transformable into a Patient Transport Vehicle which:

- Can accommodate a patient in safety and comfort

- Can accommodate the following equipment:

  - A stretcher or similar carrying equipment, which can be taken out of the vehicle, carry the patient, loaded back into the vehicle and secured properly

  - An oxygen supply tank for the patient (D type – 4.3 inch dia., 16.5 inch height)

  - First aid kit containing basic medications and equipment

- Seating a driver and an accompanying person for the patient

3. Being part of a system which has the following characteristics:

- Uses internet and location services to provide access to the vehicles

- Mobile-app based platform which functions for both taxi and ambulance purposes

- Provision for offline/direct access to the vehicle

- Provision to handle ongoing/imminently completing fares in case of emergency

Considerations for designing the stretcher and transforming mechanism:

- Quick and easy transformation, possible to be carried out by the driver alone
- No structural modification of the base vehicle
- Stretcher storage should not affect the interior space of the vehicle
- Provision to securely hold the stretcher and patient
- Easy to load and unload the patient

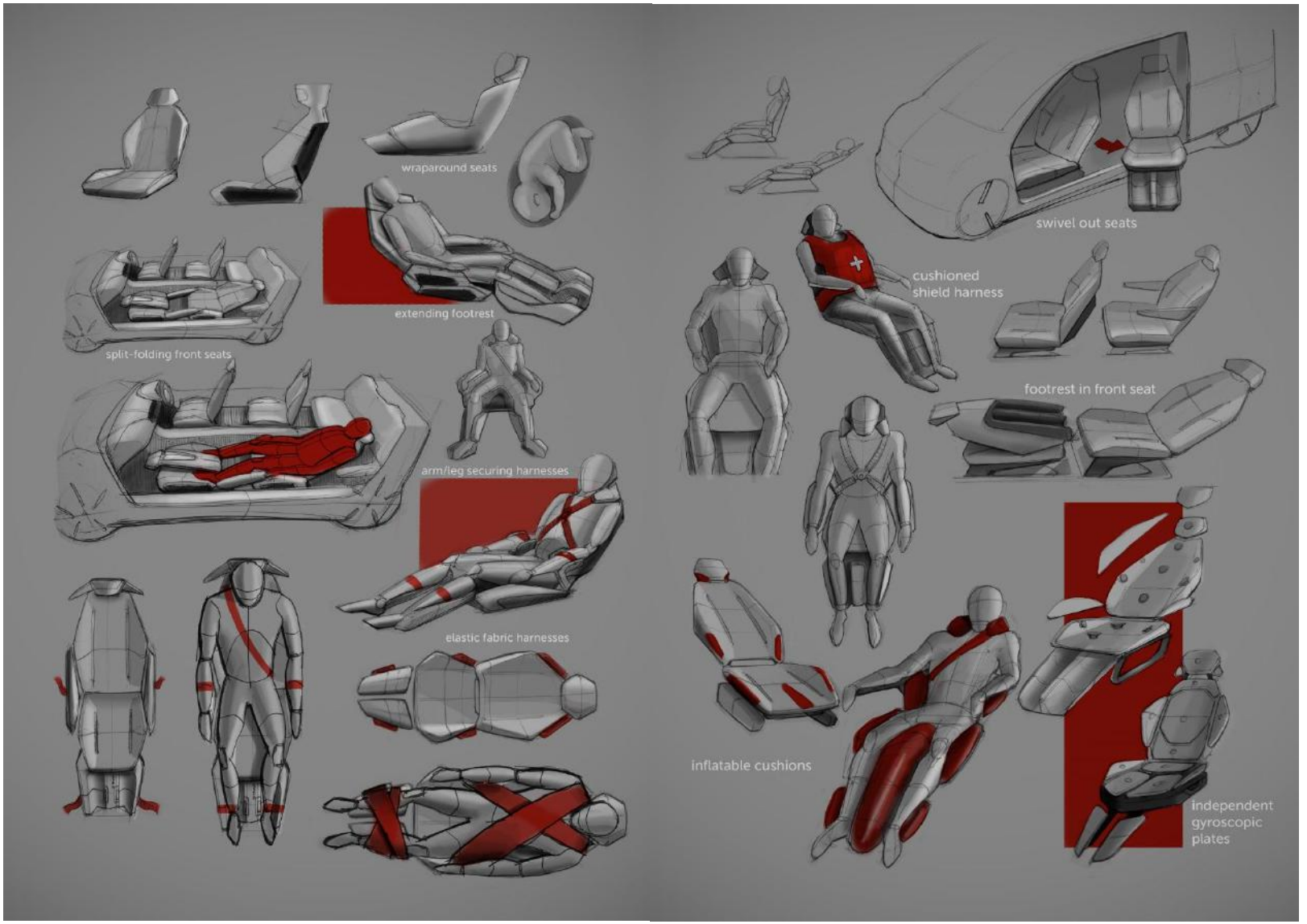
- Considering their fragility, minimize discomfort on the patient
    - Immobilizing the patient
    - Providing ample support
    - Keeping the patient stable
- Ensuring the safety of the patient

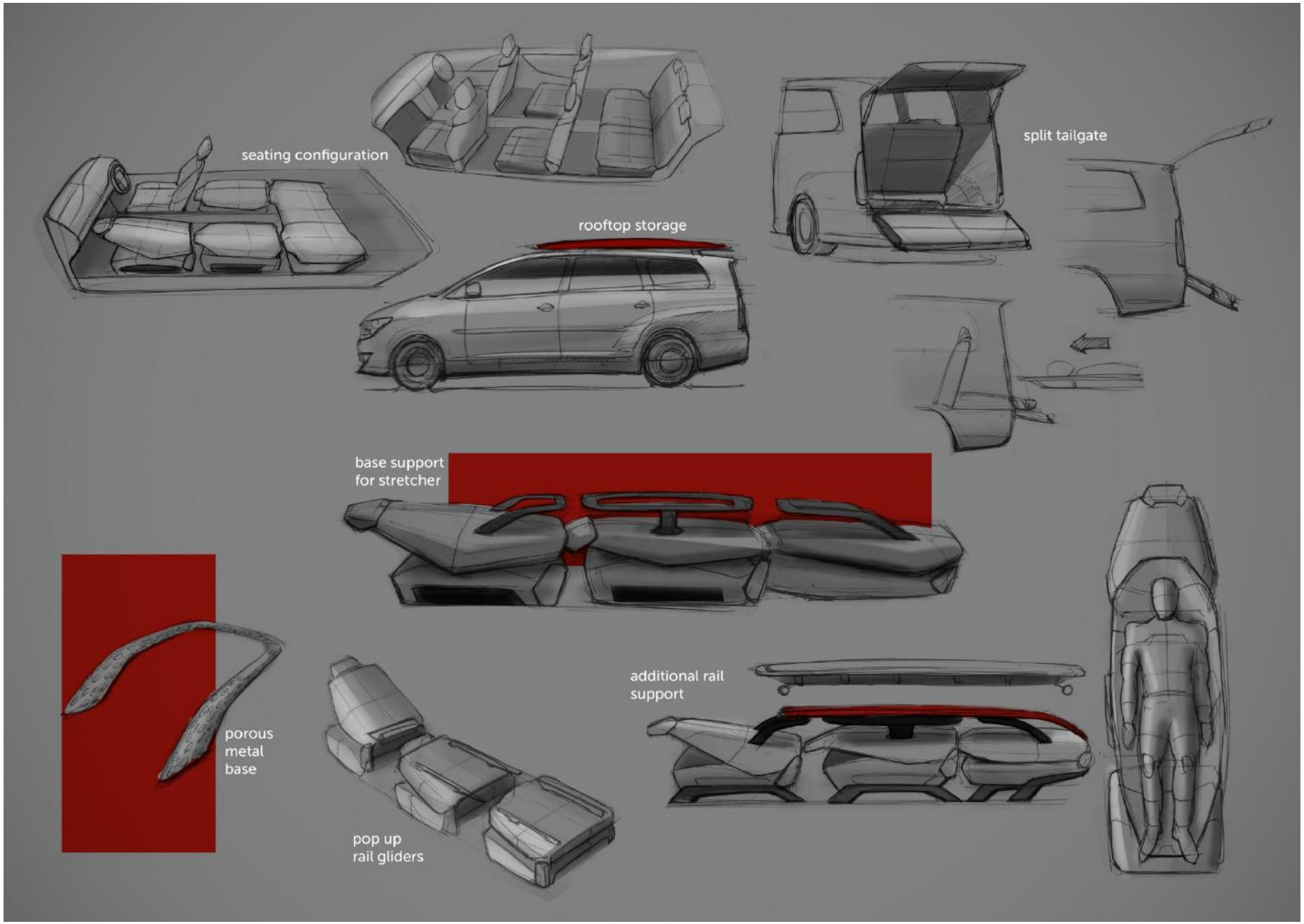
Considerations for vehicle:

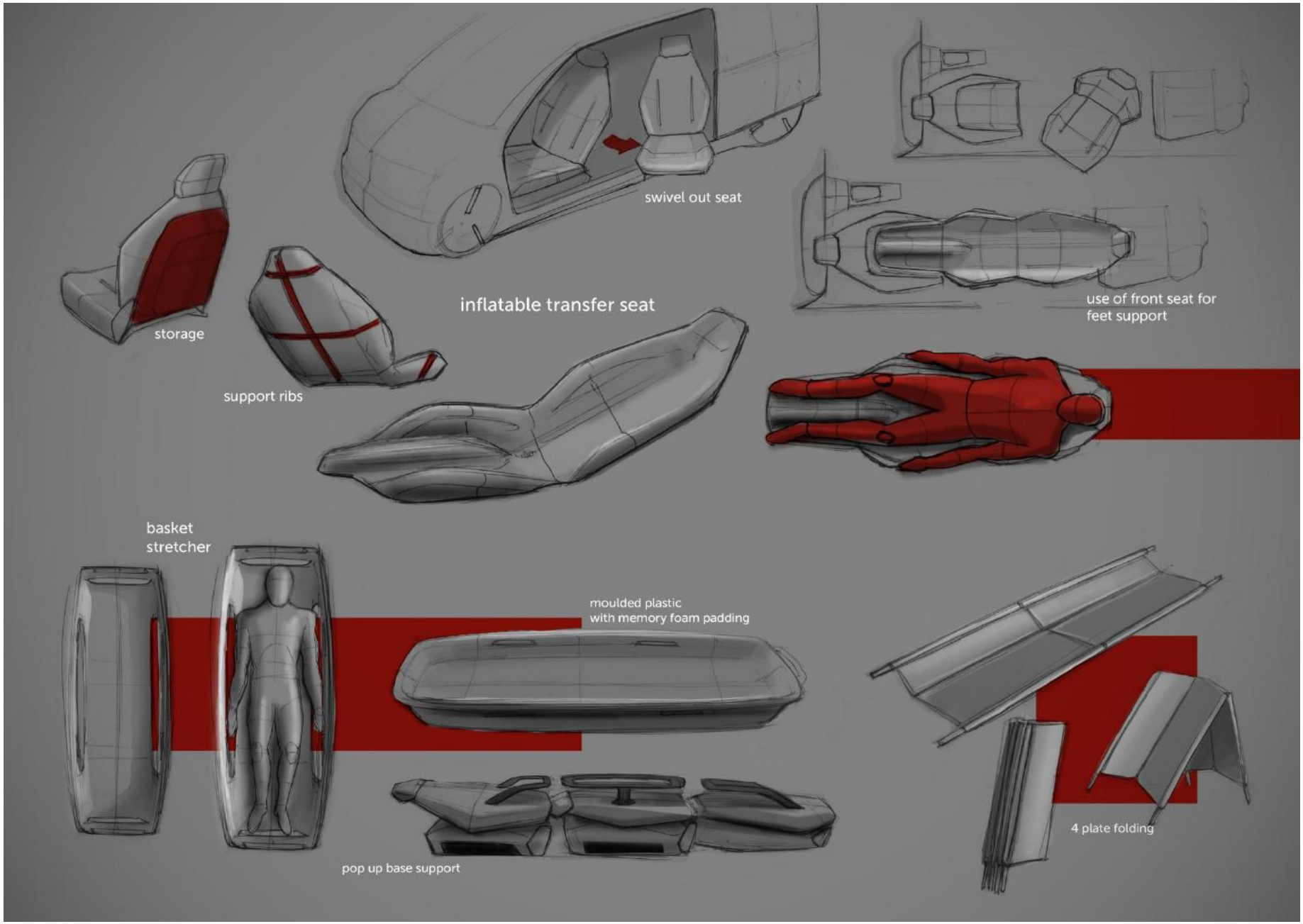
- Tentative dimensions Exterior (LxWxH) : 4600mm X 1800mm X 1780mm
- Tentative dimensions Interior (LxWxH) : 2900mm X 1500mm X 1250mm

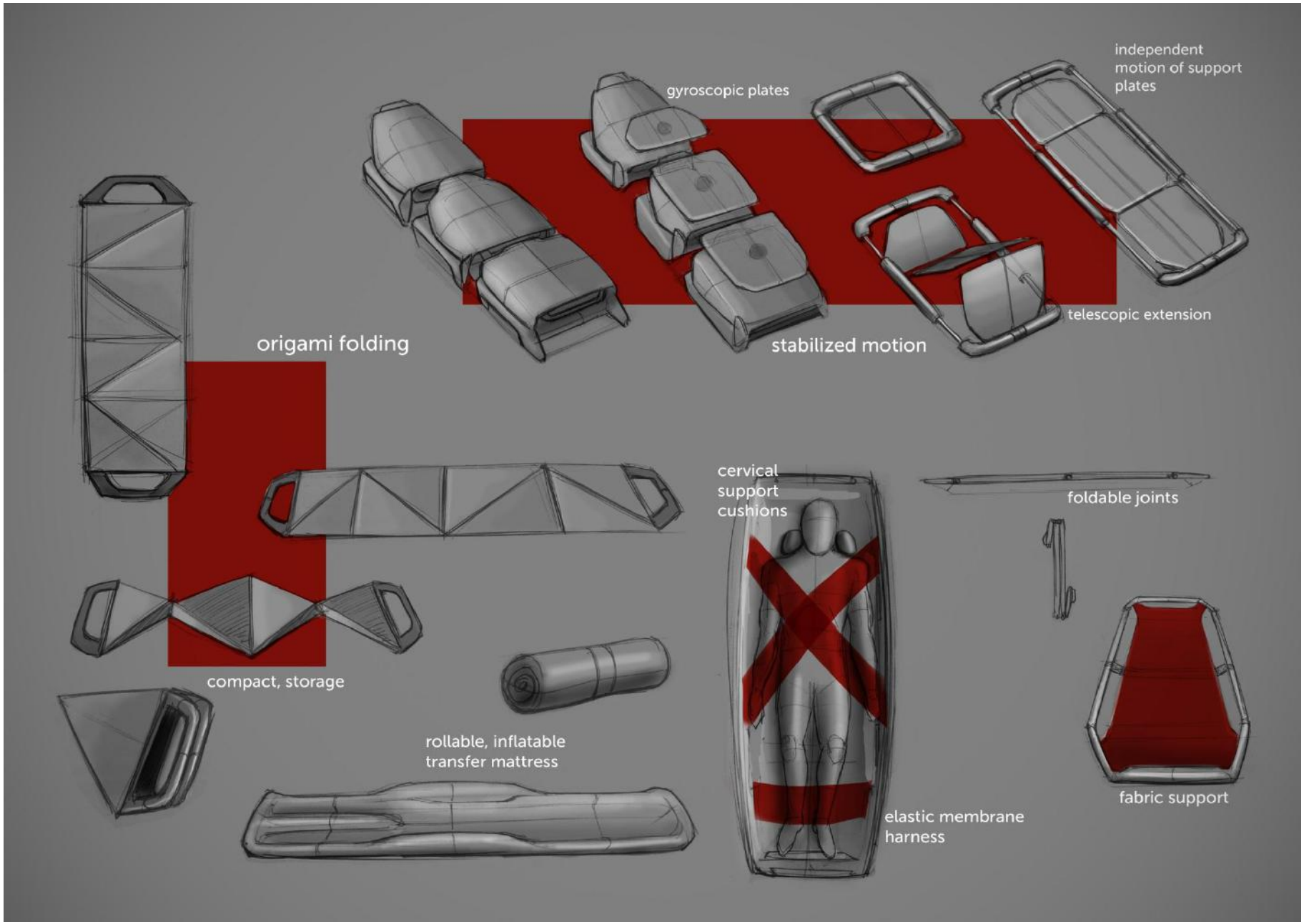
5. IDEATION

Using the inspirations mentioned in the previous pages, the initial stages of ideation involved developing varied solutions which encompass the qualities of each of those inspirations. Initial ideations were more focused on converting the seat of the vehicle itself into some sort of patient support mechanism, as opposed to a dedicated stretcher. From inflatable cushions to gyroscopic stabilizing plates, different ideas were explored and critiqued. The problem encountered with converting the seat itself into a patient holding space was that there was no proper mechanism to bring the patient in and out of the vehicle. So further ideations were focused on introducing a stretcher into the interior space. The primary aim was to keep the stretcher and its support mechanisms light and unobtrusive, so that normal taxi operations are not hampered.

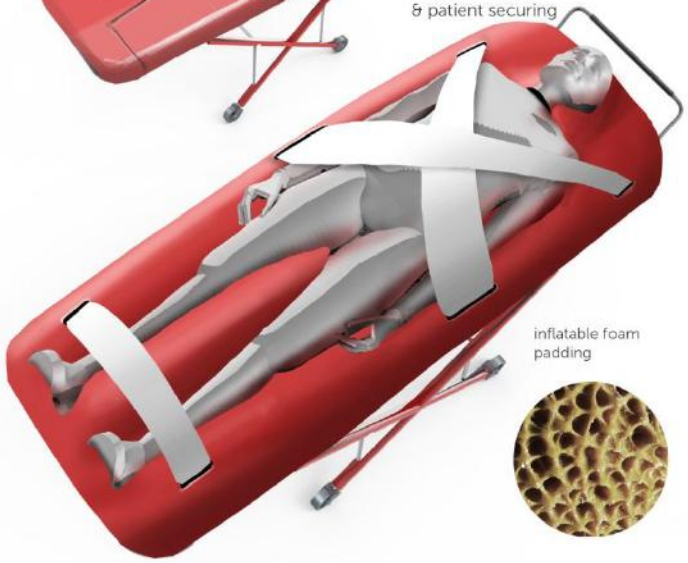

wraparound seats
extending footrest
split-folding front seats
arm/leg securing harnesses
elastic fabric harnesses
swivel out seats
cushioned
shield harness
footrest in front seat
inflatable cushions
independent
gyroscopic
plates

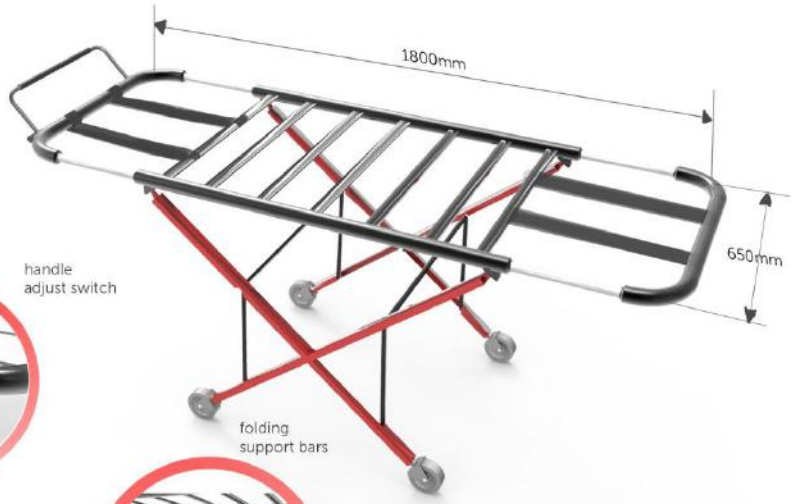

seating configuration
rooftop storage
split tailgate
base support
for stretcher
porous
metal
base
pop up
rail gliders
additional rail
support

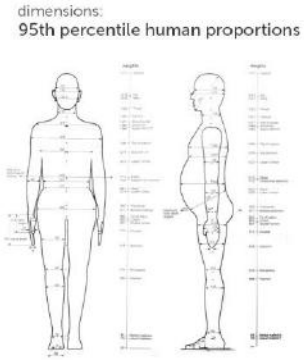

swivel out seat
storage
inflatable transfer seat
use of front seat for
feet support
support ribs
basket
stretcher
moulded plastic
with memory foam padding
4 plate folding
pop up base support

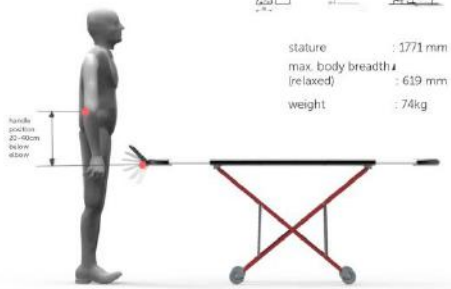

independent motion of support plates
gyroscopic plates
telescopic extension
origami folding
stabilized motion
cervical support cushions
foldable joints
compact, storage
rollable, inflatable transfer mattress
fabric support
elastic membrane harness

INITIAL STRETCHER CONCEPT







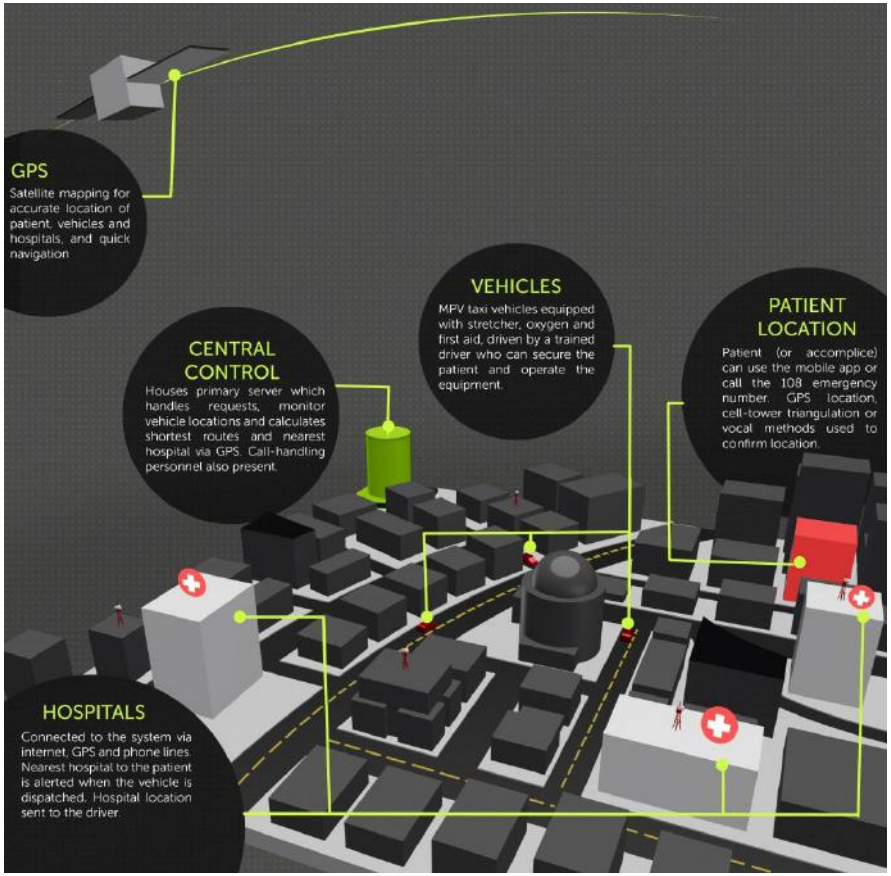


The stretcher concept here is a collapsible and telescopically extendible stretcher which is compact enough to be stored in the boot area of the vehicle. Once taken out, it can be stretched out to its full size. The patient area is of a length of 1800mm and a breadth of 650mm. The dimensions were taken in accordance with both the National Ambulance Code as well as the dimensions of a 95^{th} percentile Indian.

The patient is secured on to the stretcher using a transfer mattress which can be inflated at certain areas to hold the patient's limbs in place. The mattress is filled with inflatable foam padding. In normal conditions, the bed can be rolled up and stowed away inside the vehicle. In the first stage of inflation, the mattress is inflated to resemble a normal mattress and is secured on the stretcher base. Once the patient is placed on the mattress, the second stage of inflation can be done in order to fit the patient more snugly as well as providing a certain degree of immobilization to the patient. Once this is done, the next step is to strap the patient in. Instead of a narrow, uncomfortable strap, wide elastic straps are proposed which will hold the patient in better comfort as well as provide a better insulation from external factors.

6. THE SYSTEM

The system is designed around an urban environment in India, considering the presence of modern mobile and GPS technology.



The components of the system are:

CENTRAL CONTROL

It is the nerve center of the whole system, an area where the entire control and coordination operations happen. Since the system is mobile web based, the central control houses the primary server which handles the incoming requests for both taxis and ambulances. It also facilitates all the communication between the vehicles, patients and hospitals. The central control can also include on-call personnel, who can attend to calls vocally in case the customer opts to do so.

GPS

Global Positioning System is the backbone of the entire system, since it is dependent on GPS to locate and track the vehicles. Locating the vehicles helps the system to identify the vehicle closest to the patient and dispatch it, and also helps to generate live tracking data so whoever called the ambulance can see the vehicle approaching in real time.

VEHICLES

All the vehicles are driven by drivers who are also trained to carry out the necessary operations needed to transform the MPV into an ambulance vehicle on demand. The vehicles

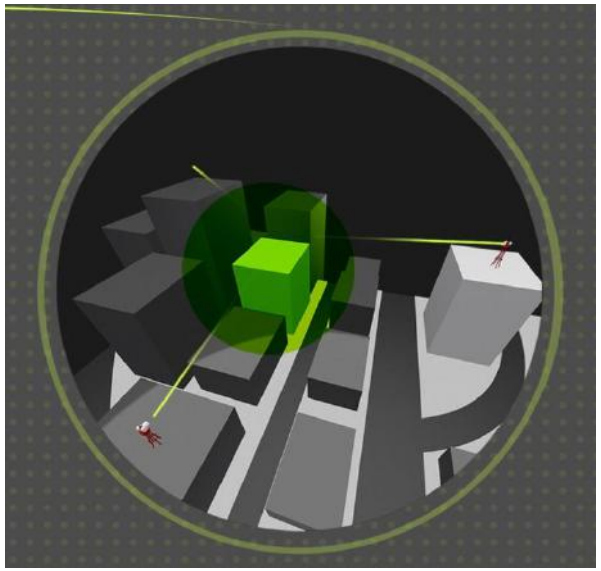
are equipped with a mobile interface which can communicate with the central control as well as the patient to coordinate the operations.

HOSPITALS

Hospitals are also part of the system, and the hospital nearest to the patient is alerted when the patient is loaded into the vehicle. On-call personnel can be stationed at the hospital to provide real time assistance to either the patient or the accompanying person.

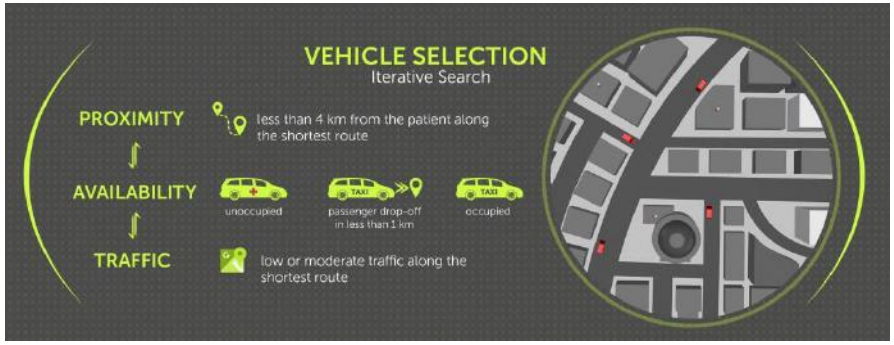
LOCATING THE PATIENT

In many cases, the patient (or bystander) may not have an active mobile data network access on their phone. In such cases, accurately locating the patient becomes a problem.



Cell tower triangulation is one of the possible solutions to this problem. In triangulation, the patient's location is roughly estimated by using the signals sent by the three nearest mobile towers to the patient. This method is nowhere as accurate as GPS, but still can provide an initial direction to dispatch the drivers in. Once the driver has been dispatched, he can call up the patient and confirm the location verbally.

SELECTING VEHICLE FOR DISPATCH



At any given moment, there can be a number of vehicles situated near the patient's location. Selecting the most suitable vehicle is important. There are three factors in consideration here:

PROXIMITY: Only the vehicles close to the patient should be eligible for dispatch. Considering the urban conditions and a golden response time of 10 minutes, vehicles outside

a 4km radius from the patient location are not considered for dispatch.

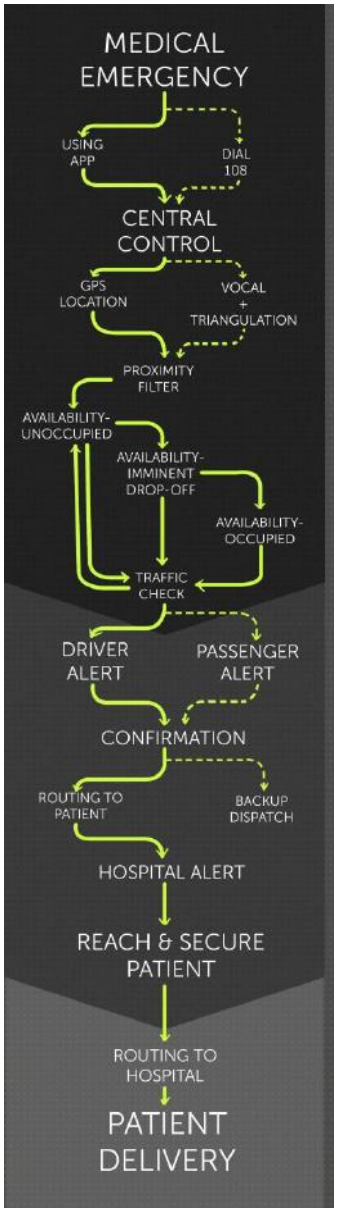
AVAILABILITY: The vehicle to be selected must be available for transporting the patient. There are three levels of priority for selecting an available vehicle:

1. The vehicle is unoccupied and available, i.e. not running any current fare.
2. The vehicle is occupied, but about to complete its trip in less than 1 km.
3. The vehicle is occupied.

In the third case, a request is sent to both the driver and the passenger so that they can come to a consensus on whether to accept the distress call or not. In case the passenger agrees to forfeit their ride, a backup ride will be provided to them as soon as possible.

TRAFFIC CONDITIONS: Using live traffic data, it can be estimated whether the vehicle is currently in heavy traffic or not. This factor can overrule the proximity and availability factors if the traffic level is too high. In such a situation, the system goes back to search mode and tries to find a more suitable vehicle.

An overall flow diagram of an ideal dispatch and delivery is illustrated here:

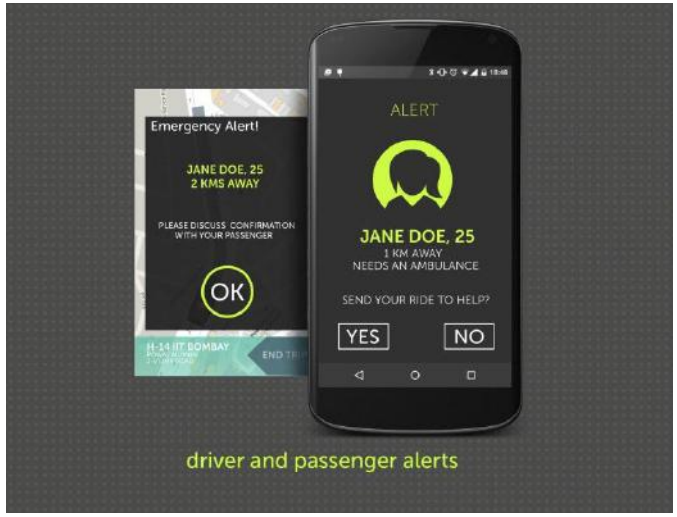


MOBILE INTERFACE

The mobile app interface is designed to be as simple and straightforward as possible, especially considering the fact that the users will be in a state of panic and distress while using it. The app can be accessed from the lockscreen of the smartphone itself by a 'double-tap-and-hold' gesture. In case the mobile data and GPS in the phone are turned off, the app automatically turns them on so that the user does not need to go to another menu to do it.

In case there is no data available, there is also provision in the app to call the 108 emergency number. There is a quick menu to specify the type of emergency which helps the system to alert the hospital. Once the vehicle is dispatched, the GPS interface shows the live progress of the vehicle as it approaches, and gives the user an option to track the vehicle also.

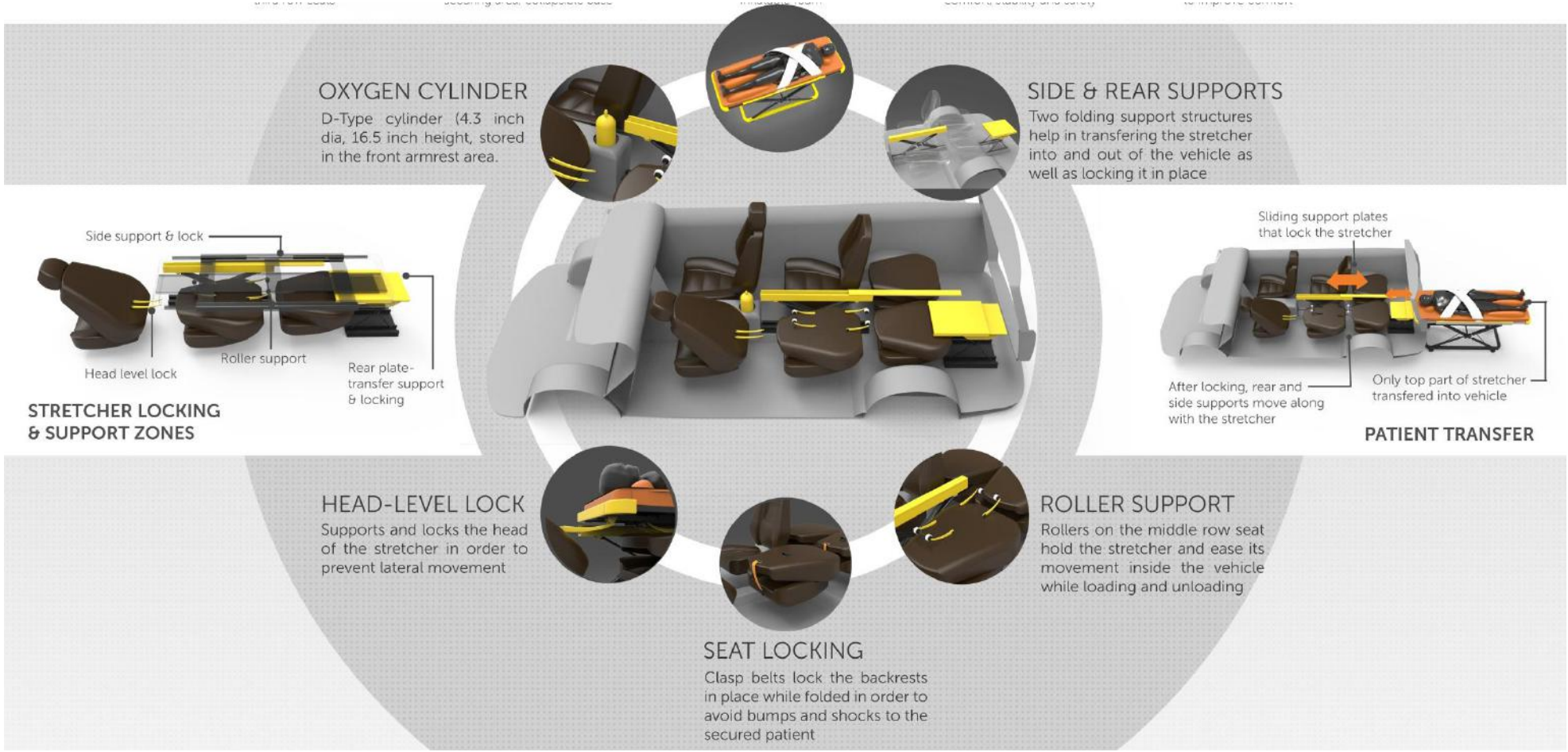
On the other end of the user scenario, if there are no free vehicles near the patient at the moment, the system sends a request to the passenger to the vehicle nearest to patient so that they can decide whether to give up their ride or not. This is completely optional, and if the passenger accepts the request, a backup ride will be provided to them at their location.

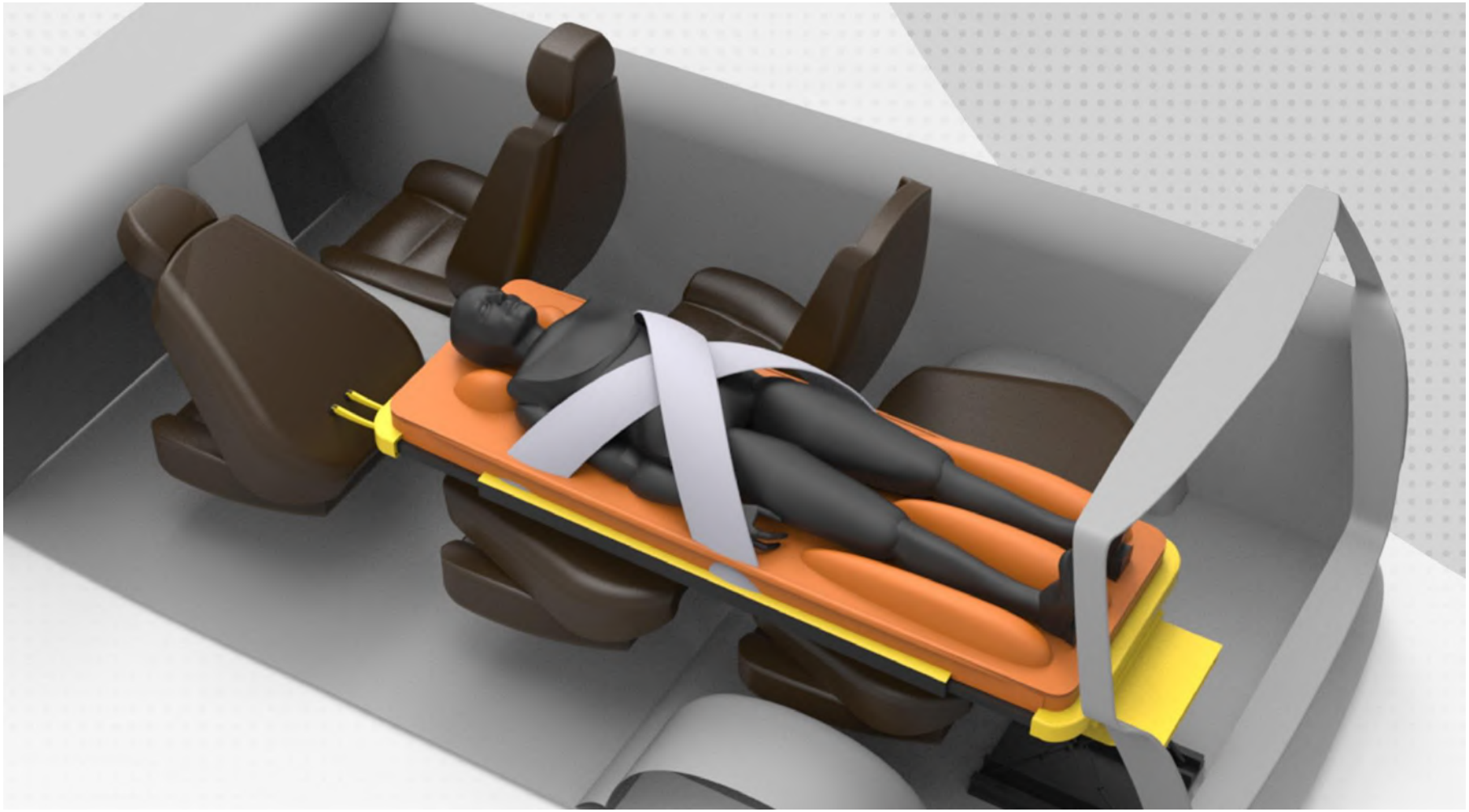


7. CONCEPTS

The stretcher is stored at the rear boot space of the vehicle. It can be telescopically extended as well as collapsed to make it compact and space saving. Once the stretcher is taken out the patient mattress can be placed on the stretcher and inflated as in Stage 1. Once the patient is placed on the bed, Stage 2 inflation can take place, helping to immobilize the patient's limbs as well as making them more comfortable. The patient is finally secured using wide, comfortable elastic straps that do not cut into their body and provides better insulation for them.

The stretcher is supported on the inside by two primary supports: one at the rear boot area and one between the two middle row seats. Both are electronically collapsible so that they won't interfere with the regular operations of the taxi. These supports have sliding plates which can reach out and helps to provide an interface to transfer the stretcher into the vehicle. Only the top part of the stretcher is moved into the securing position. Secondary supports are there in the form of rollers over the middle row seats and also another support attached to the front seat which secures the head end of the stretcher in place.


OXYGEN CYLINDER
D-Type cylinder (4.3 inch dia, 16.5 inch height, stored in the front armrest area.
SIDE & REAR SUPPORTS
Two folding support structures help in transfering the stretcher into and out of the vehicle as well as locking it in place
Side support & lock
Roller support
Head level lock
Rear plate-transfer support & locking
STRETCHER LOCKING & SUPPORT ZONES
Sliding support plates that lock the stretcher
After locking, rear and side supports move along with the stretcher
Only top part of stretcher transfered into vehicle
PATIENT TRANSFER
HEAD-LEVEL LOCK
Supports and locks the head of the stretcher in order to prevent lateral movement
ROLLER SUPPORT
Rollers on the middle row seat hold the stretcher and ease its movement inside the vehicle while loading and unloading
SEAT LOCKING
Clasp belts lock the backrests in place while folded in order to avoid bumps and shocks to the secured patient



Interior space with the stretcher and patient loaded and secured.

8. SCALE MODEL

9. REFERENCES

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