

Exploring Transformability of MPV into Ambulance

MOBILITY AND VEHICLE DESIGN PROJECT II

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2016

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APPROVAL SHEET

This Mobility & Vehicle Design project report entitled "Exploring Transformability of MPV into Ambulance", by Ashwin R Krishnan is approved in partial fulfilment of the requirement for Master of Design degree in Mobility and Vehicle Design.

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ACKNOWLEDGEMENT

This project would not have been complete without the help and guidance of a number of individuals and organizations, and I would like to express my sincere gratitude to all of them.

Prof. Nishant Sharma had provided his valuable guidance and supervision for the completion of this project. His suggestions and instructions were what helped me to steer this project in the correct direction and push myself to try and come up with better solutions. For this I am deeply indebted to him. I would also like to thank Prof. Sugandh Malhotra for his inputs on the project.

I would also like to thank all the people who provided much needed information and insights during the research phase of this project, including all the ambulance staff, doctors, patients and relatives with whom I had the great opportunity to talk with.

And my friends in IDC, who gave the right mix of encouragement and criticism at all the right moments which helped me to correct my mistakes and try to improve what I had. I cannot thank them enough.

Ashwin R Krishnan

Date:

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0. ABSTRACT

Emergency Medical Services (EMS) systems in India are still largely uncoordinated and decentralized. The absence of any nationalized standards or regulations mean different operators act on their own accord, resulting in widely scattered responses across different organizations and entities. There are the critical issues of accessibility and affordability, adding up to the fact that in many cases, the primary patient transport from the scene of emergency to hospital is usually done in other vehicles such as taxis, auto rickshaws or private cars. Such vehicles are more ubiquitous and easily accessible than a dedicated ambulance. So there is scope to adapt them into a patient transport vehicle. This is especially true for larger MPV taxis, which have enough interior room to adequately simulate the space inside an ambulance. Integrating an Emergency Medical Service into an existing online taxi service (such as Uber and Ola) can lead to a more accessible, affordable and trustworthy system.

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.

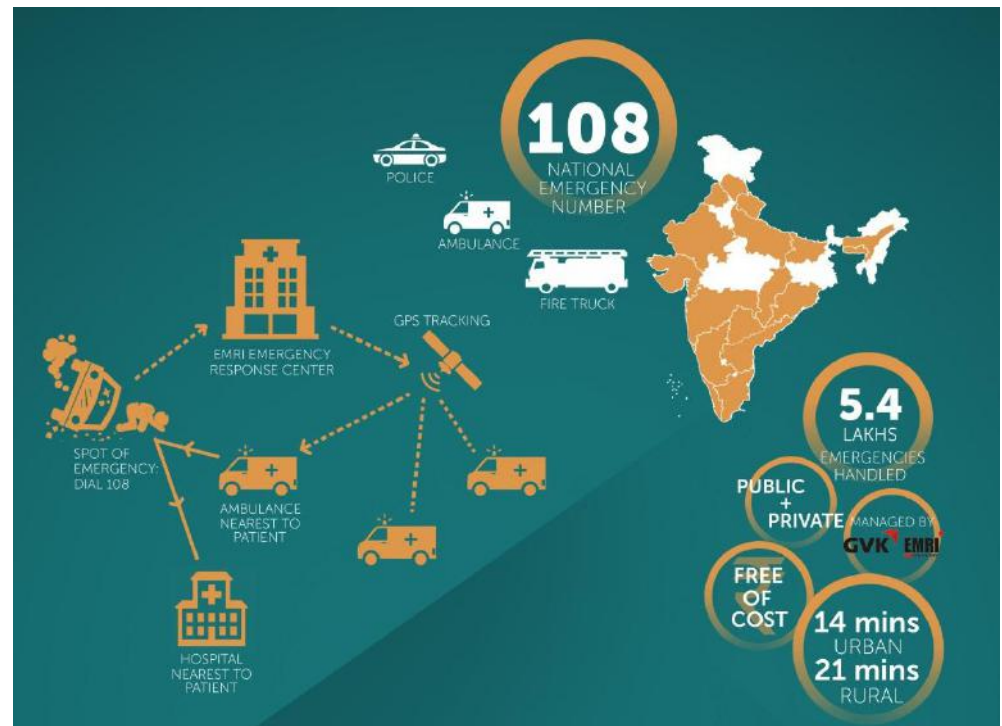
2.1 SYSTEM STUDY

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

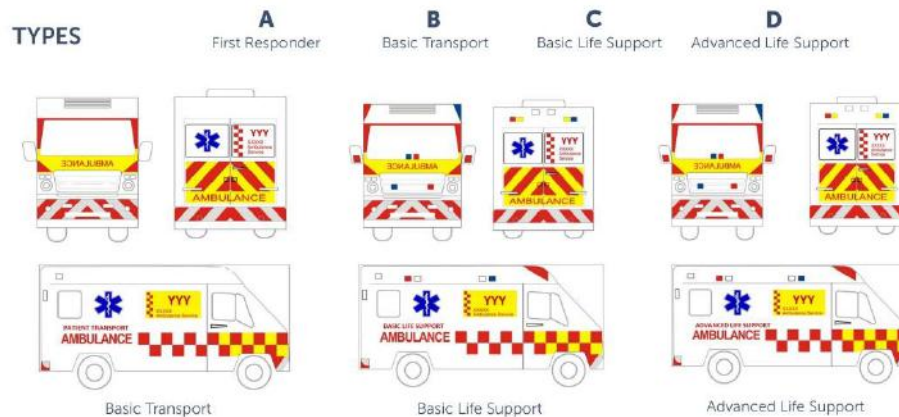
22 lakhs for the advanced life support models. State governments like Delhi issues vehicle permits which have a validity of 5 years after which the vehicles have to be inspected again. Even then, there is no special license required for qualifying as an ambulance driver.



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.



Openings		A	B	C	D
Side	Height	Stock	Stock	1200	1300
	Width	Stock	Stock	660	660
Rear	Height	-	900	1100	1300
	Width	-	900	1050	1050

For Windows - 450mm X 450mm for type C&D
Reference Standard - IS:2553

Warning Lights

TYPES A&B Appropriate Flashers



Sirens

Concealed/Exposed
Wail: 10-18 per minute
Yelp: 150-250 per minute
Level of 110dB
Public Address System

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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

Reference Standard
IS: 15546-2005



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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 disinfectant

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 Open Wounds Fractures Head Injury	Basic Patient Transport Basic Patient Transport Basic Patient Transport Life Support	Physician/ Orthopedician/ Surgeon
Cardiac Chest Pain Mild Severe Cardiac Arrest Shock	Basic Patient Transport Life Support Life Support Life Support	Cardiologist/ Physician
Respiratory Asthma COPD Hemoptysis ARDS	Basic Patient Transport Basic Patient Transport Life Support Life Support	Physician/ Chest Physician
Neurological Stroke Coma Cerebral Hemorrhage Seizure	Life Support Life Support Life Support Life Support	Physician/ Neurologist
Abdominal Intestinal Obstruction Perforation Mesenteric Angina Hematemesis Ureteric Colic Appendicitis Vomiting/Diarrhea	Basic Patient Transport Life Support Life Support Life Support Basic Patient Transport Basic Patient Transport Basic Patient Transport	Surgeon

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



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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.



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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.



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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

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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 inexperienced 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

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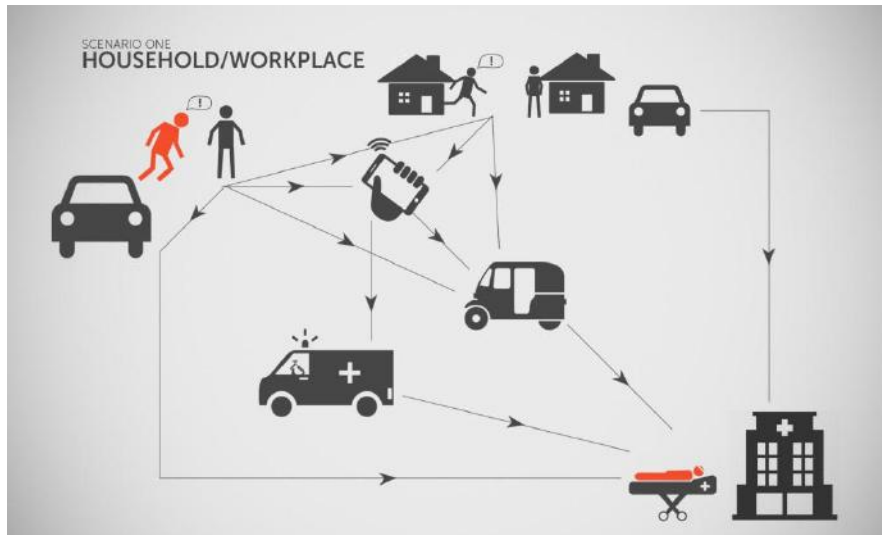
with this is that more often than not, the transfer is done very inexpertly. In case of emergencies like spinal injuries, this puts a huge amount of risk on the patient.

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

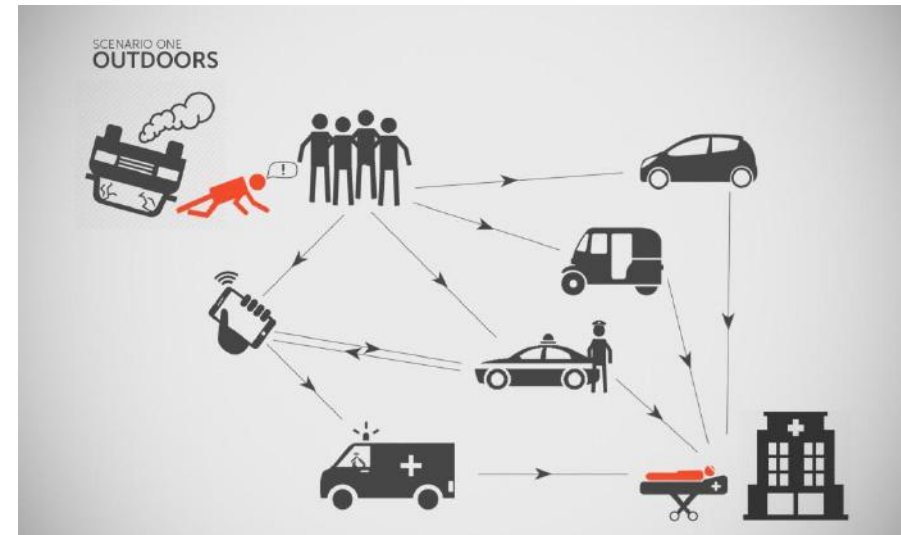
Based on the research till this point, the following scenarios describe how the system works at the moment and how the MPV-ambulance system could possibly work.



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 is 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

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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

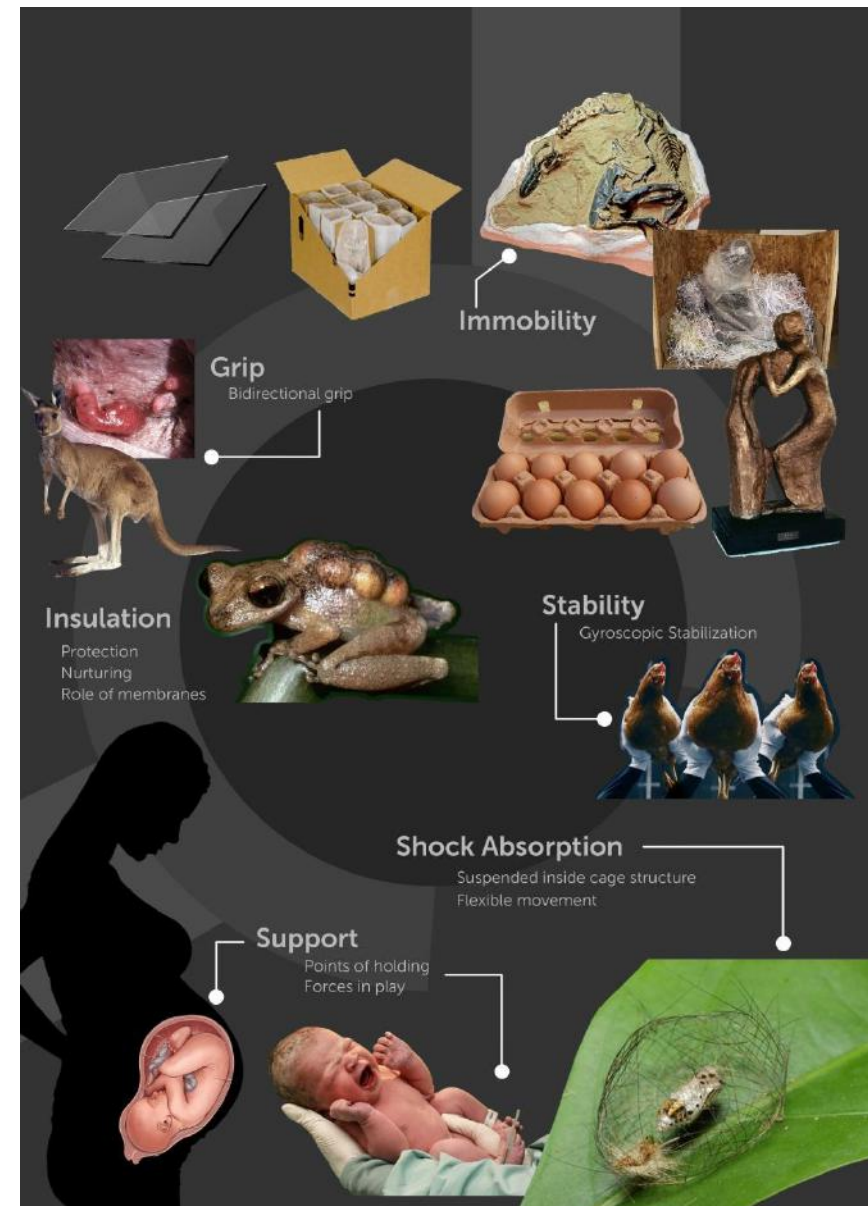
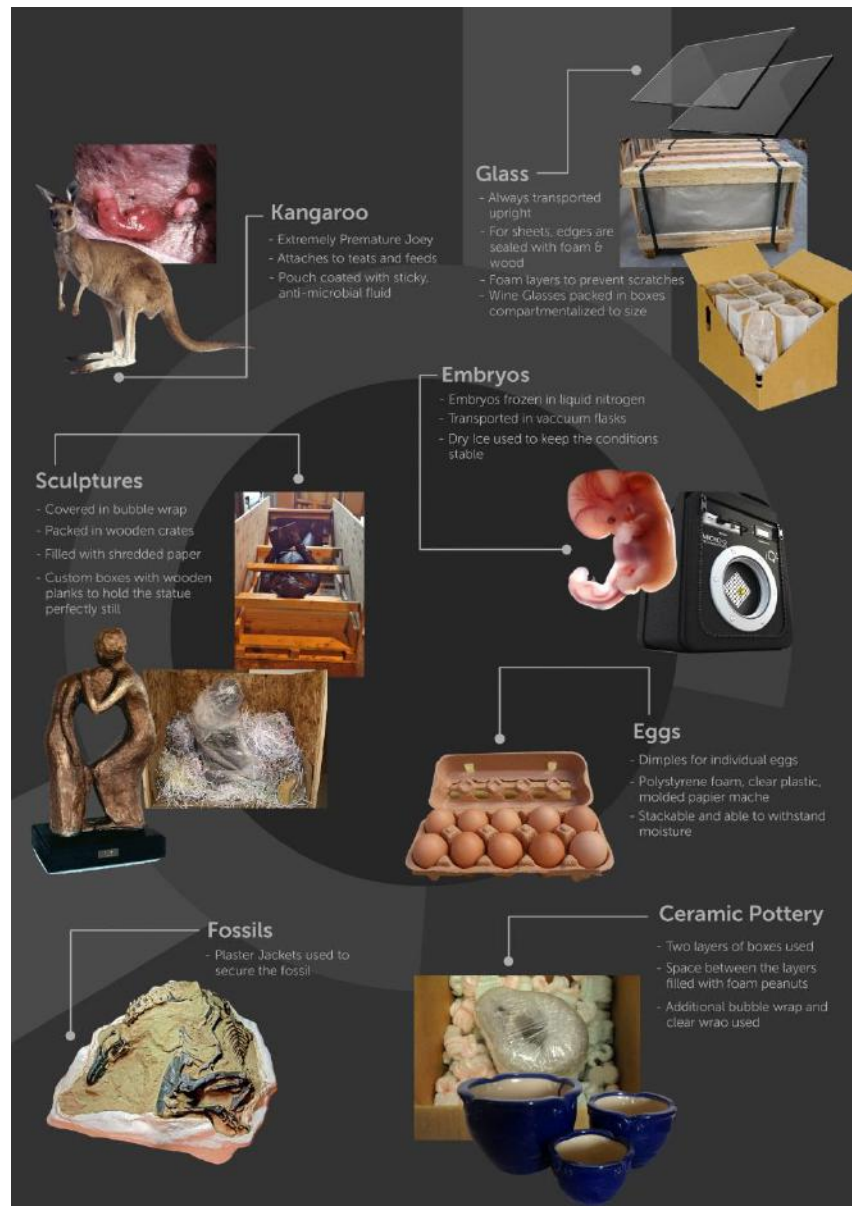
FOSSILS

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.

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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

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

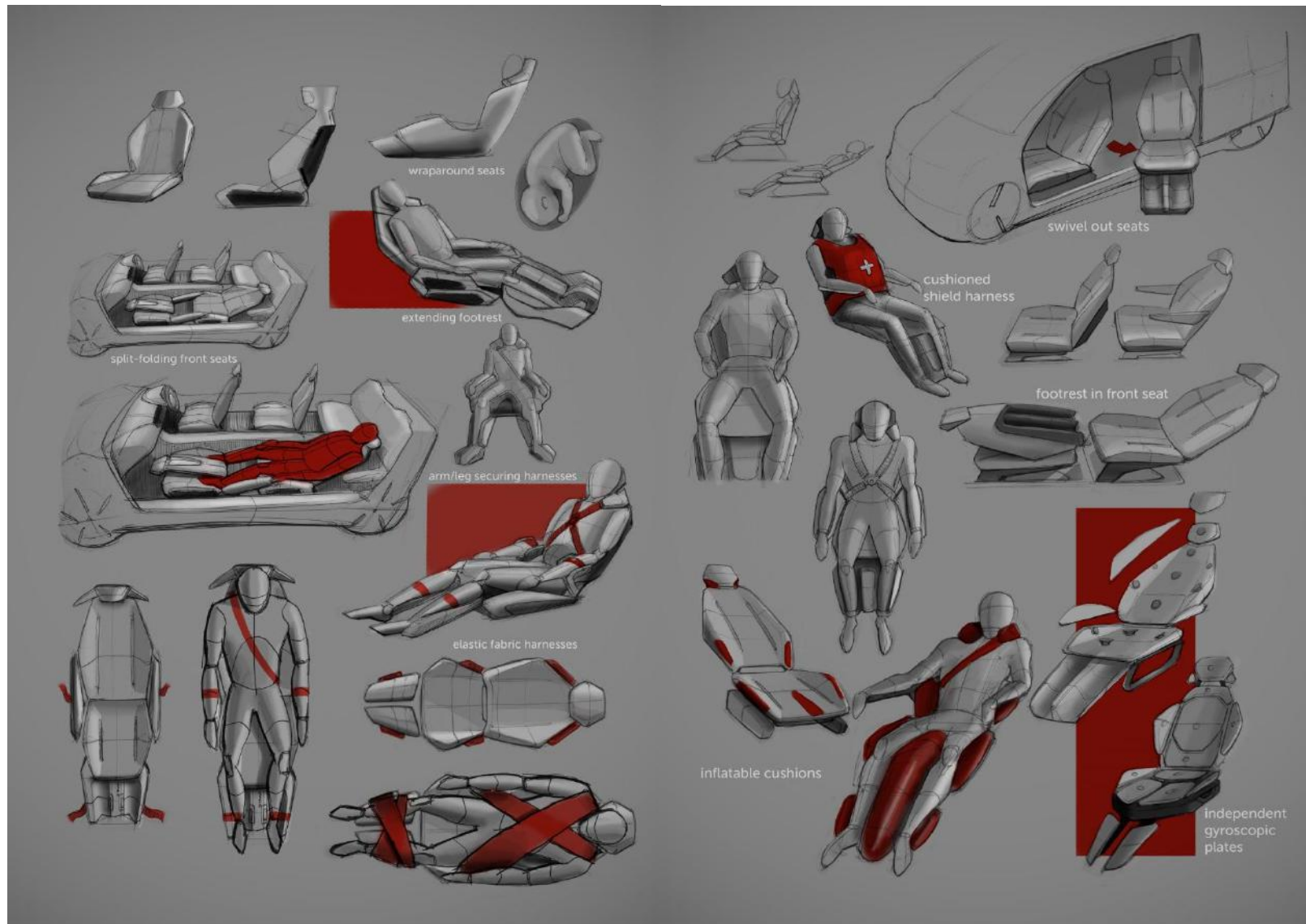
Considerations for vehicle:

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

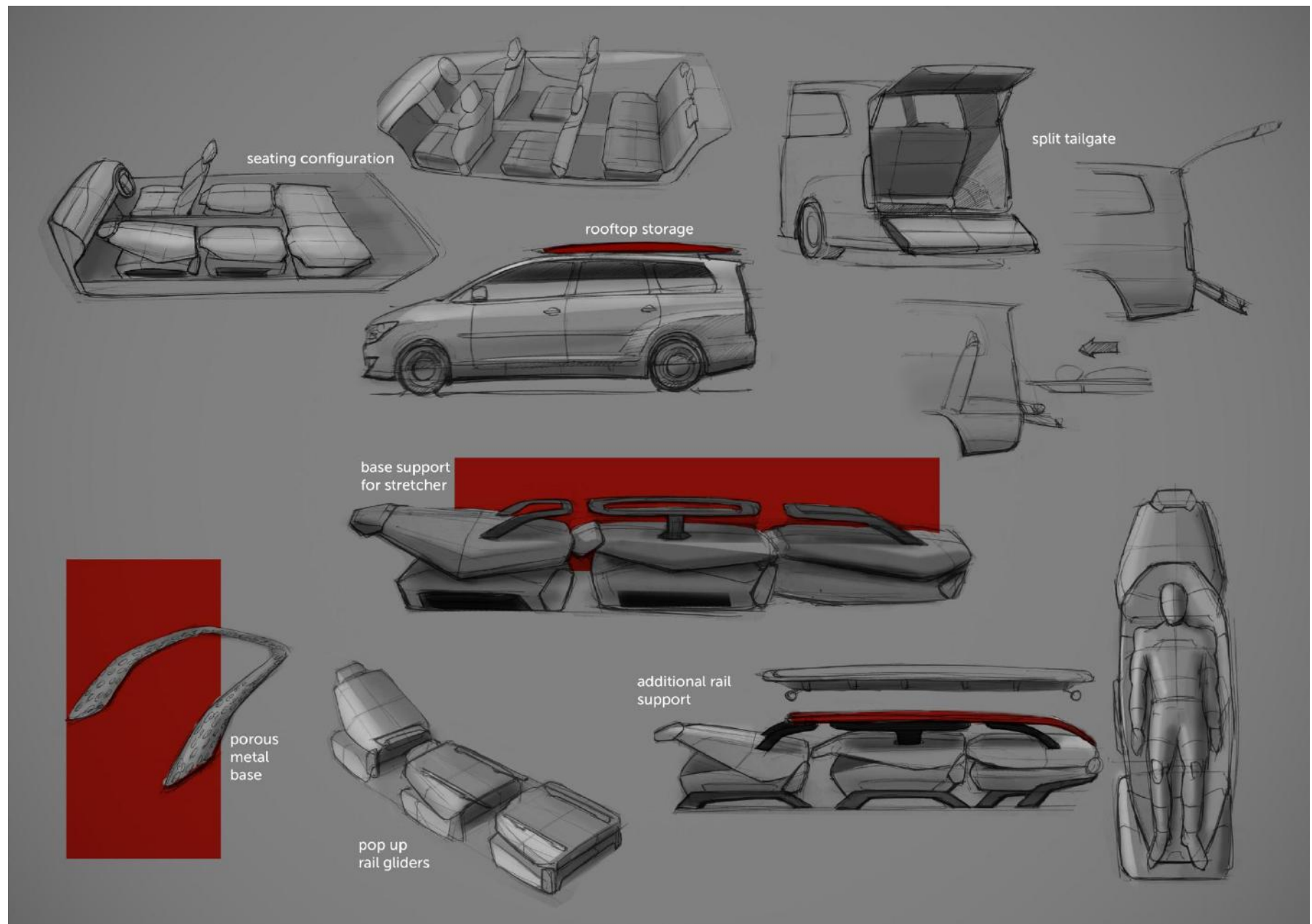
5. IDEATION

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.

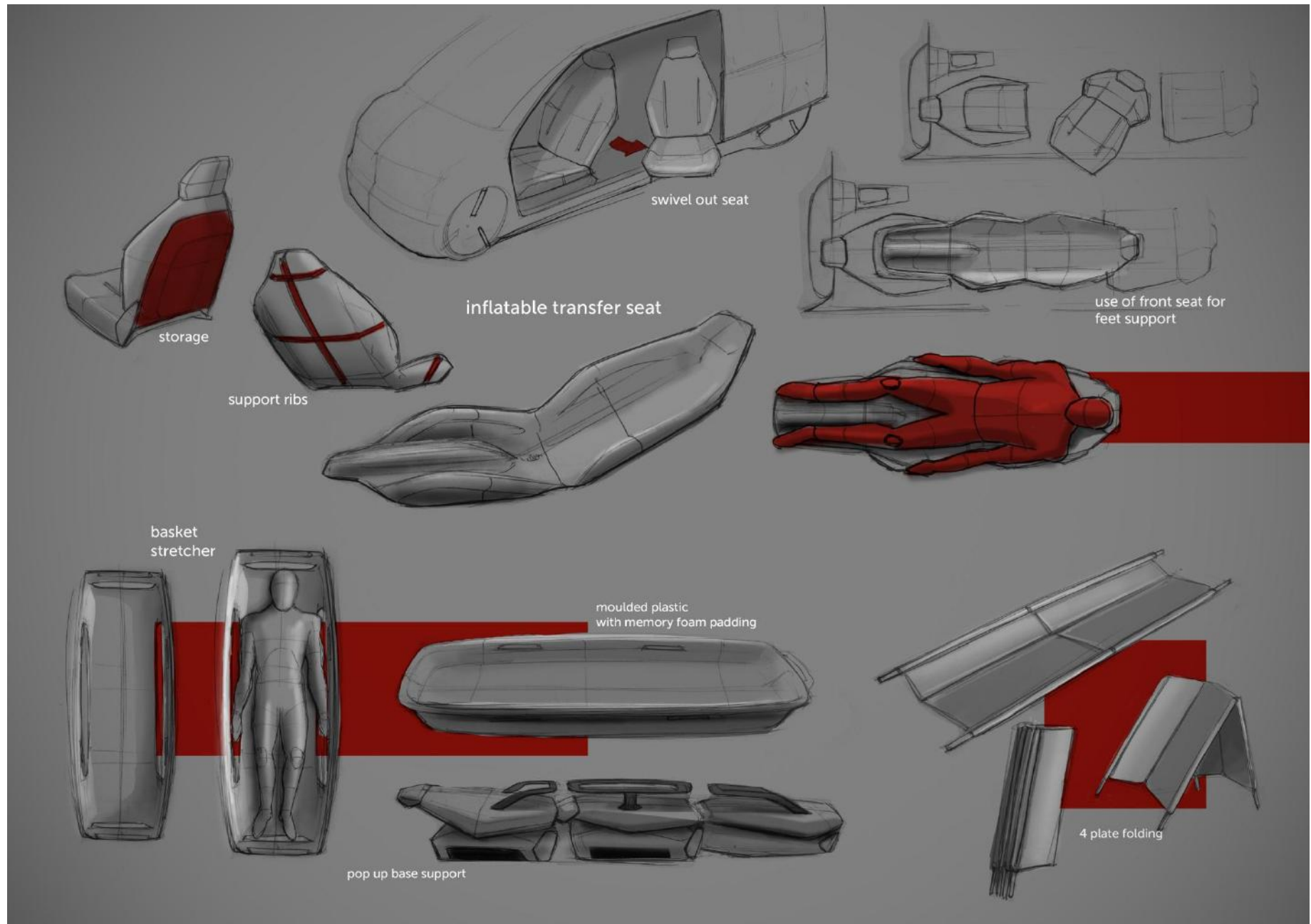
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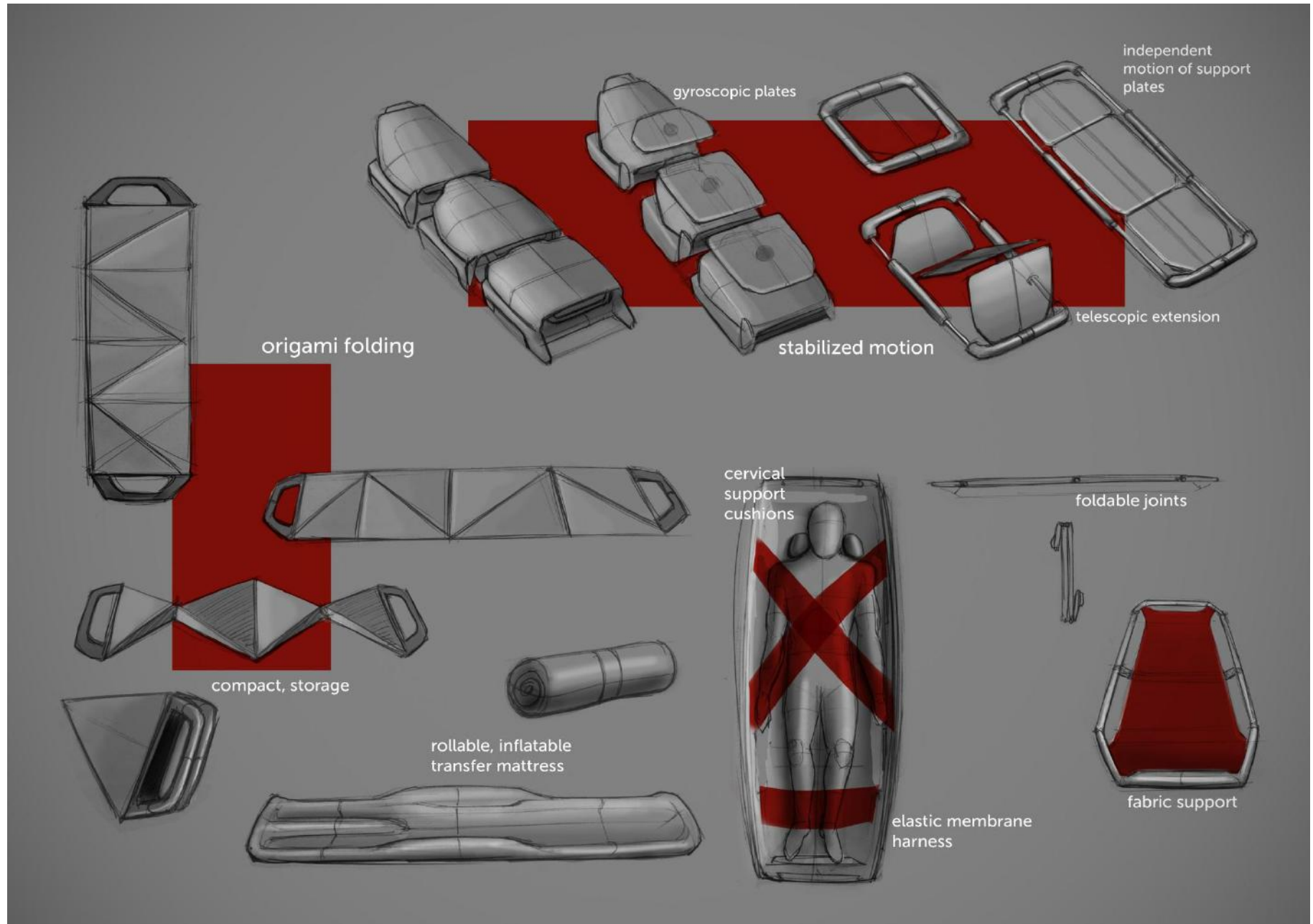
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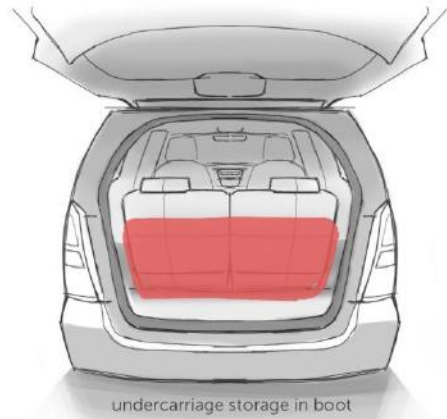
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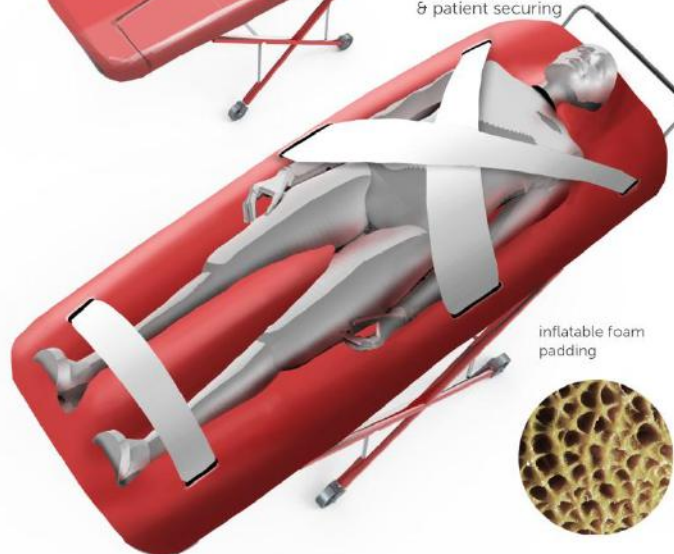
INITIAL STRETCHER CONCEPT



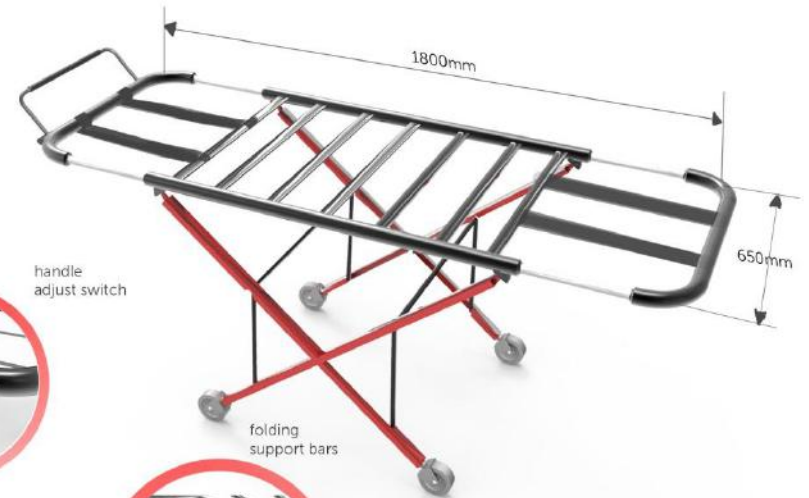
stage 1 inflation



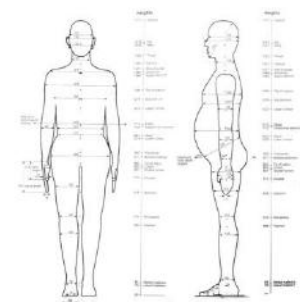
stage 2 inflation
& patient securing



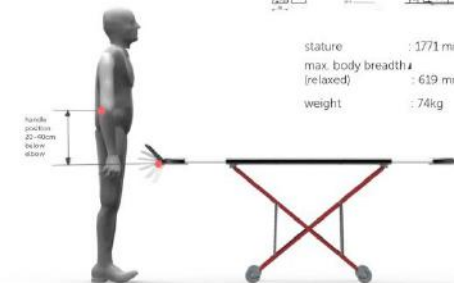
inflatable foam padding



dimensions:
95th percentile human proportions



stature : 1771 mm
max. body breadth (relaxed) : 619 mm
weight : 74 kg



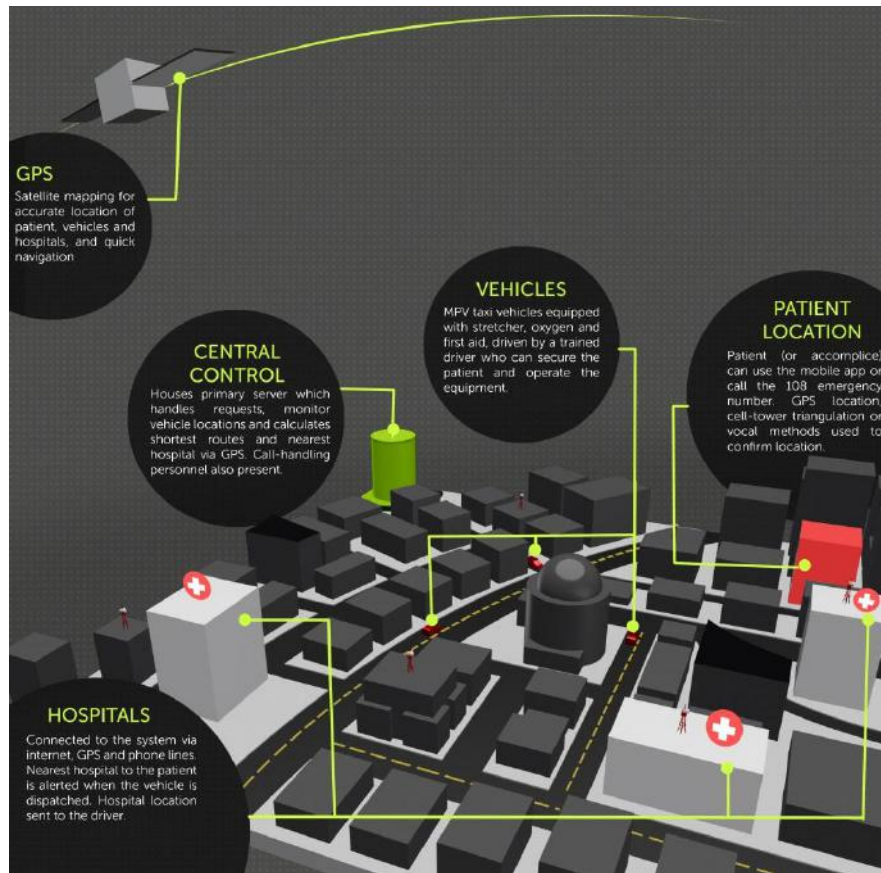
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The stretcher concept here is a collapsible and telescopically extendible stretcher which is compact enough to be stored in the boot area of the vehicle. Once taken out, it can be stretched out to its full size. The patient area is of a length of 1800mm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

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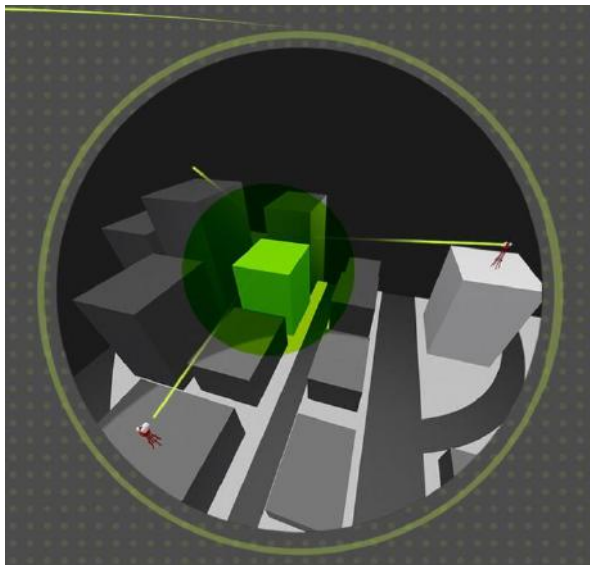
are equipped with a mobile interface which can communicate with the central control as well as the patient to coordinate the operations.

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.

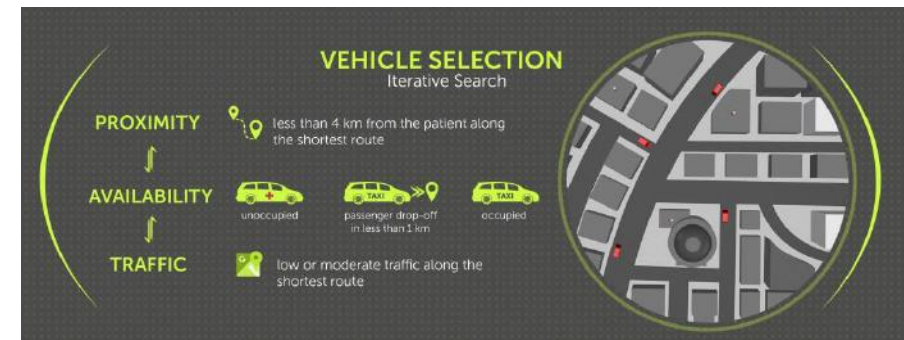
LOCATING THE PATIENT

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

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

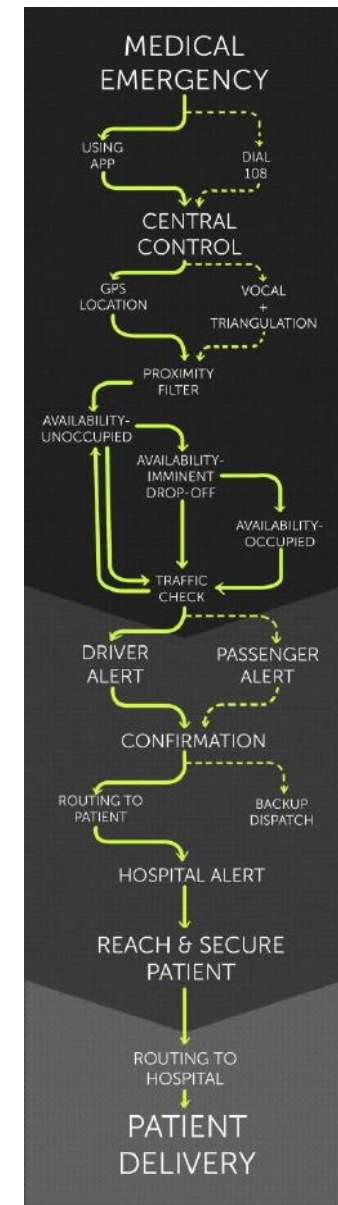
AVAILABILITY: The vehicle to be selected must be available for transporting the patient. There are three levels of priority for selecting an available vehicle:

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.

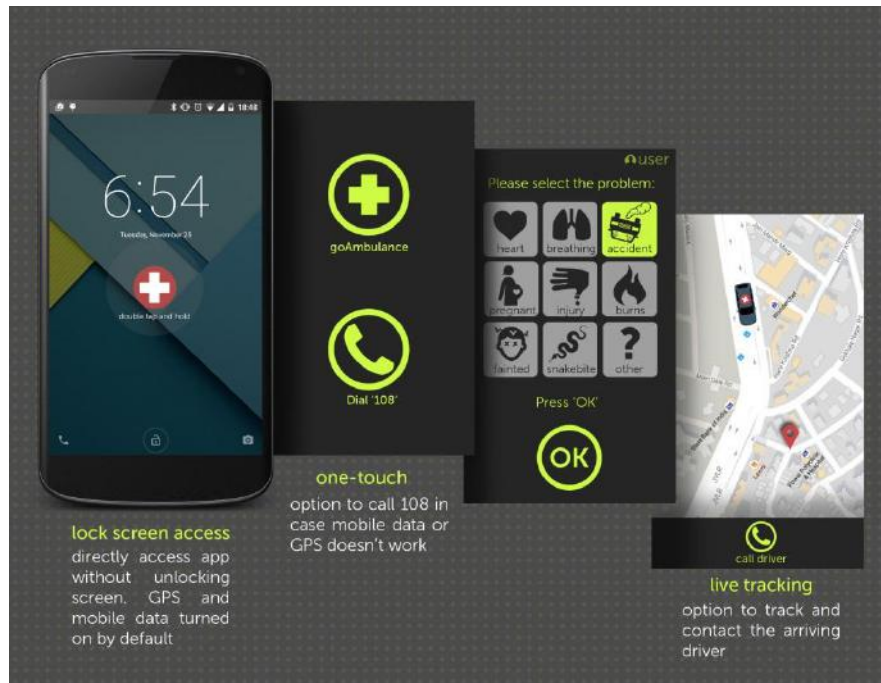
TRAFFIC CONDITIONS: Using live traffic data, it can be estimated whether the vehicle is currently in heavy traffic or not. This factor can overrule the proximity and availability factors if the traffic level is too high. In such a situation, the system goes back to search mode and tries to find a more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

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



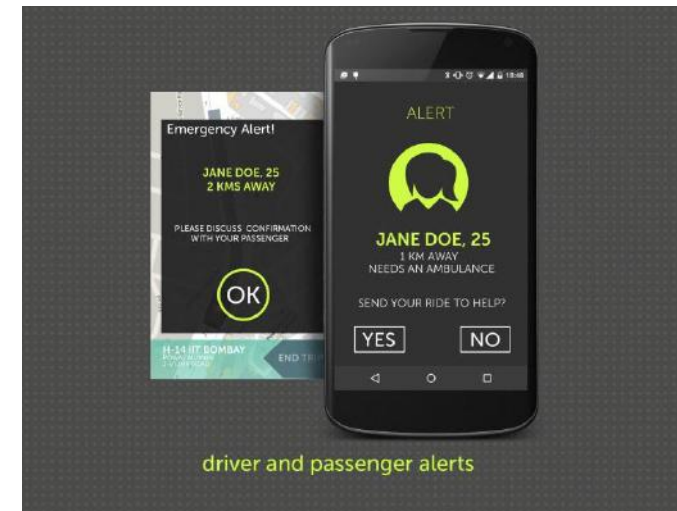
MOBILE INTERFACE

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.



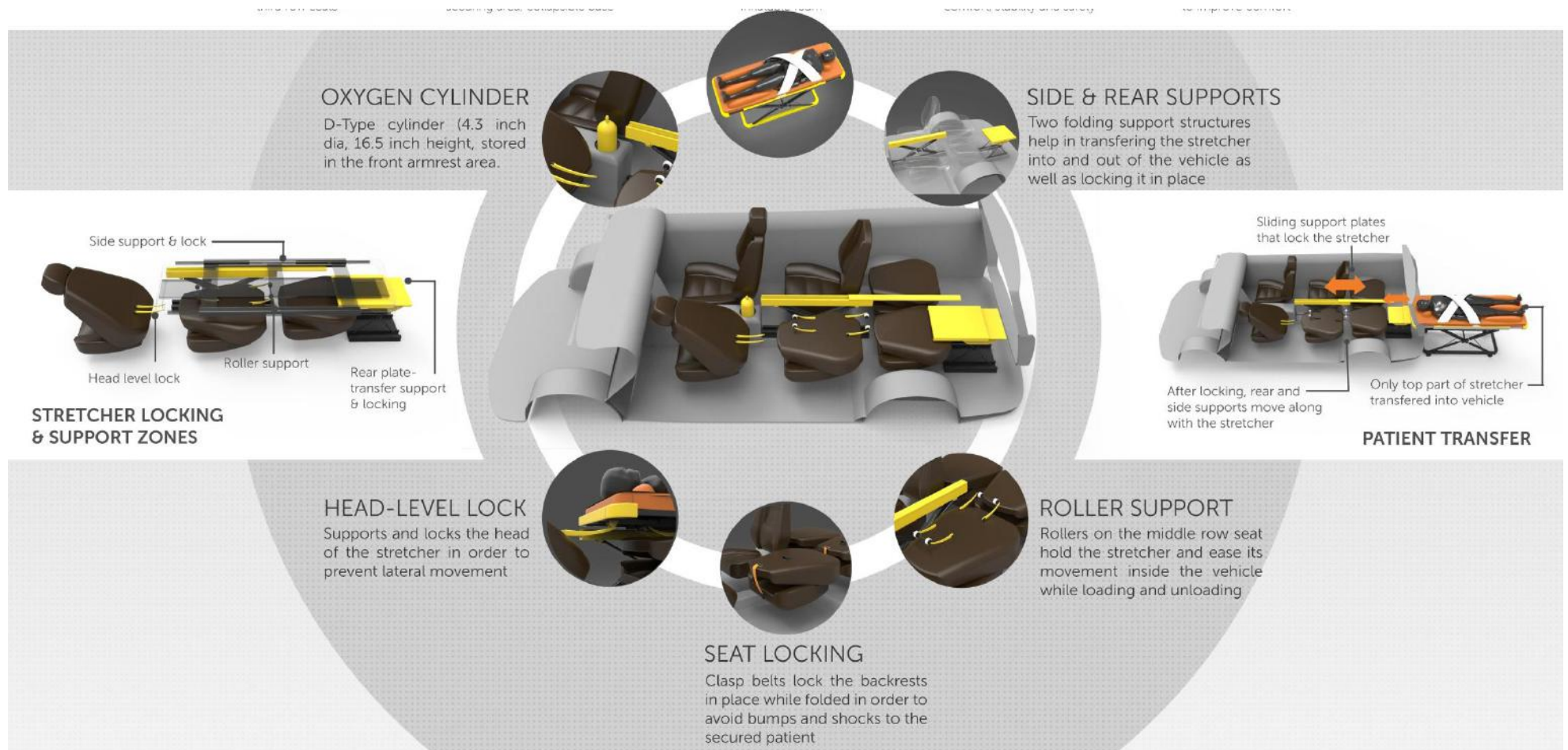
7. CONCEPTS

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.

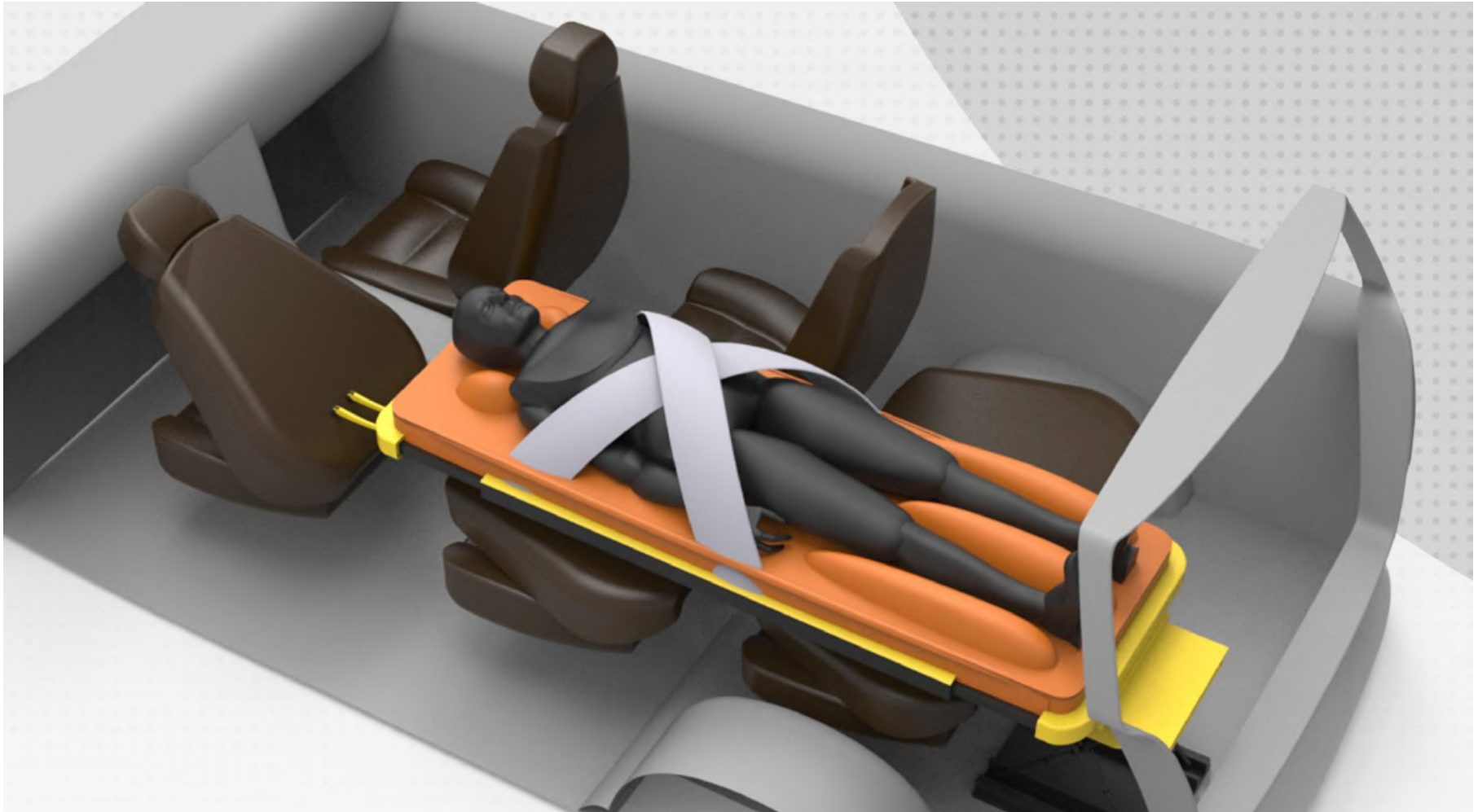
The stretcher is supported on the inside by two primary supports: one at the rear boot area and one between the two middle row seats. Both are electronically collapsible so that they won't interfere with the regular operations of the taxi. These supports have sliding plates which can reach out and helps 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.



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Interior space with the stretcher and patient loaded and secured.

8. SCALE MODEL

9. REFERENCES

1. http://blackwellpublishing.com/content/BPL_Images/Content_store/Sample_chapter/1405135409/1405135409_4_016.pdf
2. http://www.greybook.sgul.ac.uk/grey-book-archives/GREY_BOOK_59th_edition%20Aug2013.pdf
3. <http://www.mascip.co.uk/wp-content/uploads/2015/02/MASCIP-SIA-Guidelines-for-MH-Trainers.pdf>
4. https://en.wikipedia.org/wiki/Nontransporting_EMS_vehicle
5. [https://en.wikipedia.org/wiki/108_\(emergency_telephone_number\)](https://en.wikipedia.org/wiki/108_(emergency_telephone_number))
6. <http://www.delhi.gov.in/DoIT/Health/cat.pdf>
7. <http://www.hydrauliclifts.in/specialized-body-building.html#cardiac-ambulance>
8. <http://www.emsworld.com/directory/patient-handling-immobilization>
9. <http://homeguides.sfgate.com/safely-transport-window-glass-26354.html>
10. <https://web.wpi.edu/Pubs/E-project/Available/E-project-042413-092332/unrestricted/MQFIQP2809.pdf>
11. <http://500sec.com/new-swedishbuilt-mercedes-ambulance/>
12. <http://www.braunambulances.com/models/responder/>