

# AMBULANCE FOR DENSELY POPULATED METROPOLISIS



PROGRAMME



# Royal Academy of Design

Ambulance For Densely Populated Metropolis

## **MA - Industrial Design 4. Semester 2021**

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## The Faster Way to Better Health Care

I think we all hope to never need an ambulance. Not for ourselves - and not for the people around us. But if we do, I think a most of us have certain expectations to the service. We have expectations to the paramedics, the condition of the ambulance and its equipment, and for the time it takes for the ambulance to arrive to us and get to the hospital. Luckily, I live in Denmark and I know that the quality of the danish ambulance service is great. But the ambulance service varies around the world.

### **6 seconds = 10 minutes = 1 life**

While going through different subjects to work within my final thesis, I tried to think of situation in my past, where I have wondered. One memory came to mind - very vivid and clear. After I finished high school, I travelled for a full year around SE Asia. And I remembered an ambulance caught in heavy traffic in a growing metropolis. Not once, not twice - but often.

While the equation might seem flawed it is very much real. It takes as little as six seconds to pull your car to the side for an ambulance. If enough motorists choose to do so, an ambulance can easily save ten minutes - and ten minutes can easily make the difference between life and death in severe situations.

## Abstract

This project is focused on improving the health infrastructure in densely populated metropolises by a small and cheap ambulance that easily can navigate in dense traffic, reaching patients faster than a traditional ambulance. This can help more patients, faster and cheaper – benefitting the poorest in the community. The content of the ambulance is carefully chosen, making room for driver, paramedic, patient and all necessary equipment.

## Methodology

With this project I present my master's in industrial design, where I design, build and try to understand how an ambulance for densely populated metropolises could look. First, I present a brief historic summary of the ambulance and give a short insight in how the ambulance look today and how it - maybe - will look in ten years. I describe the stakeholders involved in the use of an ambulance and map their importance and make a timeline of when they encounter the ambulance. Then I look at what elements an ambulance contains to better understand where the ambulance can be improved and to understand what key elements is needed to give good healthcare. Before defining my problem specification, I describe my target group - I examine statistics of ambulance dispatch times in India and compare them to countries in Europe - this will be followed up by statistics on population growth and a study of infrastructure. Then I describe my framing, holding up dispatch times against size of the ambulance and therefore amount of medical equipment. Finding the balance between these two will be a key factor in this project. I present how I gain my empirical background through field studies and expert interviews with Jan Nilsson from Taastrup Falck Station, where I get a thorough presentation of the ambulance, paramedic job and have a talk about my project. I study Indian traffic behavior in ambulance encounters after a brief presentation of the UN goals affecting my project. After a small aesthetical mood board of Indian design history, I begin the creative process.

I go through different vehicles to use as a base for my ambulance and asses them on size, price and potential as ambulance. I make several packaging studies to define what vehicle best serves the purpose. I make an aesthetic analysis of different ambulances and autorickshaws to get inspiration to my own ambulance. To make a holistic project I work on the gurney and jump bags. After a tear down of the rickshaw I start building it up again using all my empirical knowledge gained through the process. Here I focus a lot on the apex of the ambulance and makes different design proposals. Trying to merge the aesthetics of the existing vehicles design, with my vision of a new ambulance, trying different graphic themes to achieve this.

Lastly, I present my final design and describe my choices and solution to my problem specification, before reflecting on how my ambulance could be a part of the solutions to improve a slow health care infrastructure in densely populated metropolises and acknowledge and describe other solutions to the same problem.

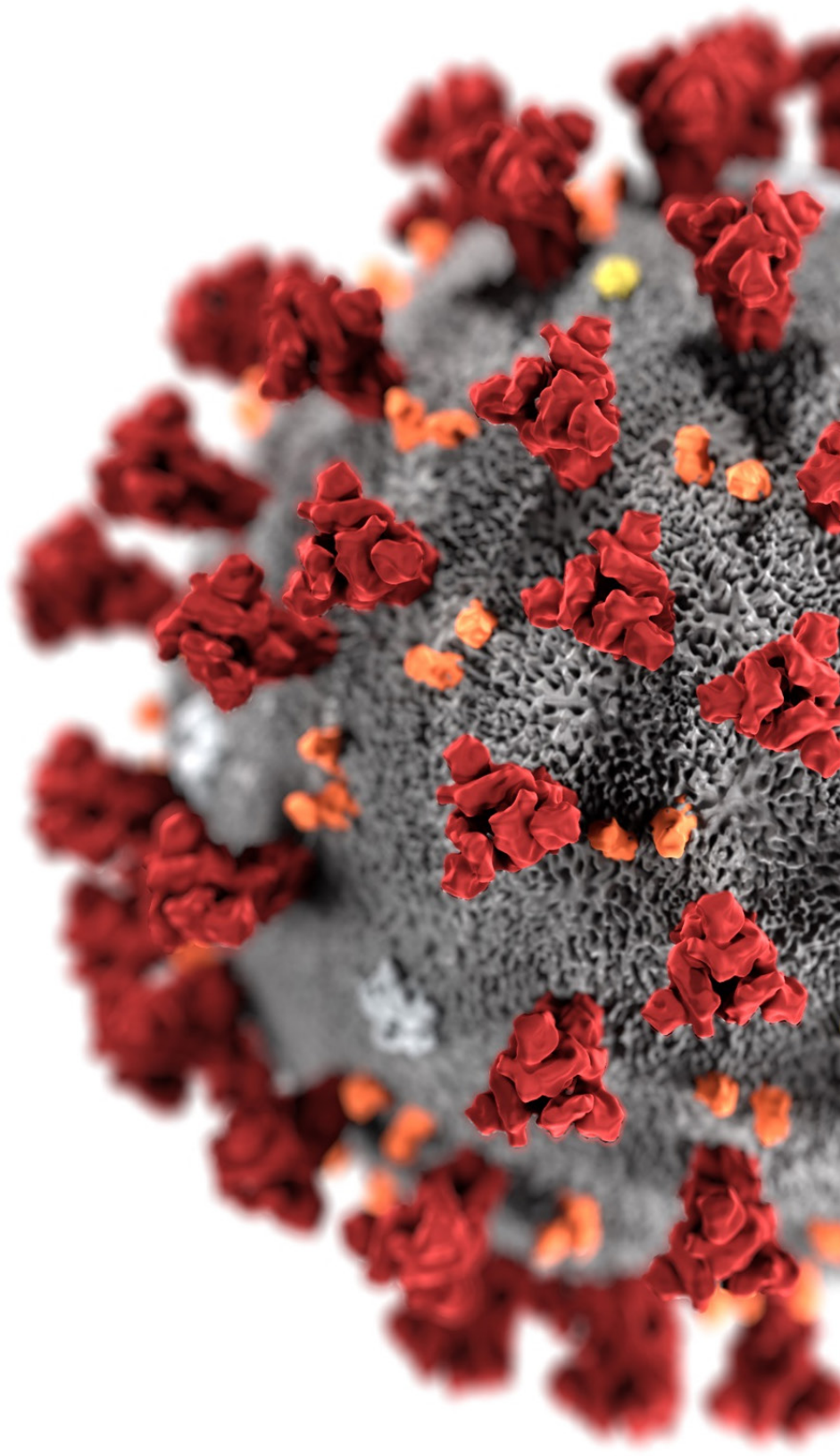
## COVID-19

### **Covid's influence on my master thesis**

Due to covid I, like many others, have been forced to work at home, losing the vital study environment I am used to, together with my fellow students - libraries, wood and metal workshop, including CNC mills, laser cutters and the highly skilled workshop leaders have been replaced with my own 3D printer and the internet. Inspiration, sparing, knowledge and social breaks have been replaced with a small children's room in my apartment. Even after the partial opening of the school, sporadic close downs of my son's kindergarten have made it difficult to leave the house. Trying out proportions in 1:1 could have made the process of making the interior layout more fluent and holistic.

But more defecting the virus have impaired my field research to a high degree. Countless mails and phone calls to Hovedstadens Beredskab and Falck eventually led to a very rewarding field trip to Taastrup Falck Station. But many hours were spent in the process. Also, inquiries to India, traffic and population experts and scholars, designers and automotive manufactures, never gave me any insights to my project. This means that in some places in the process I have made assumptions - in some regards making it more conceptual.





## The Ambulance

### A brief historic summary

An ambulance is a vehicle equipped with medical gear. The two key factors are bringing medical care to a patient and/or transporting patients to and from hospitals. In Spain 1487 during the Siege of Malaga the first ambulances were used to transport wounded soldiers but were first implemented for civilian use in the 1830s (Barkley, 1990). Both the aesthetics, content and the vehicle itself has changed significantly since, and today's ambulances are well equipped technological marvels compared to its predecessors (Vogt, 1976). But in large parts of the world the ambulance shares more resemblance with its older counterparts. In large parts of the African continents medical transportation is often handled with horse and carts, as in the time pre motorized transportation. And many urban areas - developing as well as developed countries - uses motorcycles for health transportation as they did in the first world war (Dickson, 2018).

### State of the art and future technology

Today's ambulances are full of equipment that were not even available in prolific and well-equipped hospitals seventy years ago. EKGs, defibrillators, ventilators, suction units as well as an array of medical preparations gives ambulance personnel the possibility to assist, help and save patients with a wide variety of injuries (Tan, 2021).

Like everything else it can be difficult to guess exactly how ambulances will look in the future. Drones seems to be a returning element in one way or another. This can be as an aiding factor to monitor the area, guiding traffic and warn people around the place of accident (Schafft, 2018). Drones can also serve as a quick response with defibrillators, glucagon or thrombolytics and can shave of precious seconds when treating, heart failures, diabetic chocks and blood clots (Nieljs, 2014). But some companies also work on human sized drones (technically not drones) to response to deadly injuries and can work in a fraction of the cost of manned helicopters and much quicker than any on ground vehicles (Chung, 2021). Back on the ground one of the big areas of development is in on board diagnosing through 5G - so called Smart Ambulances. This way a central placed group of doctors can aid multiple patients (Euronews, 2020). Smaller equipment and planning also gives way to add more gear like ultrasound and x-ray. In the long run, off site controlled operating robots, could even further enhance the ambulances' ability to be a mobile hospital instead of transportation (Tesser, 2020).

As presented, today's ambulances are full of technology, and are in an ever-growing development focused on one simple goal - giving better and faster treatment. But what about cheaper? As most of the progress comes from developed countries, cost is not a goal in itself, but merely a factor (Tesser, 2020).



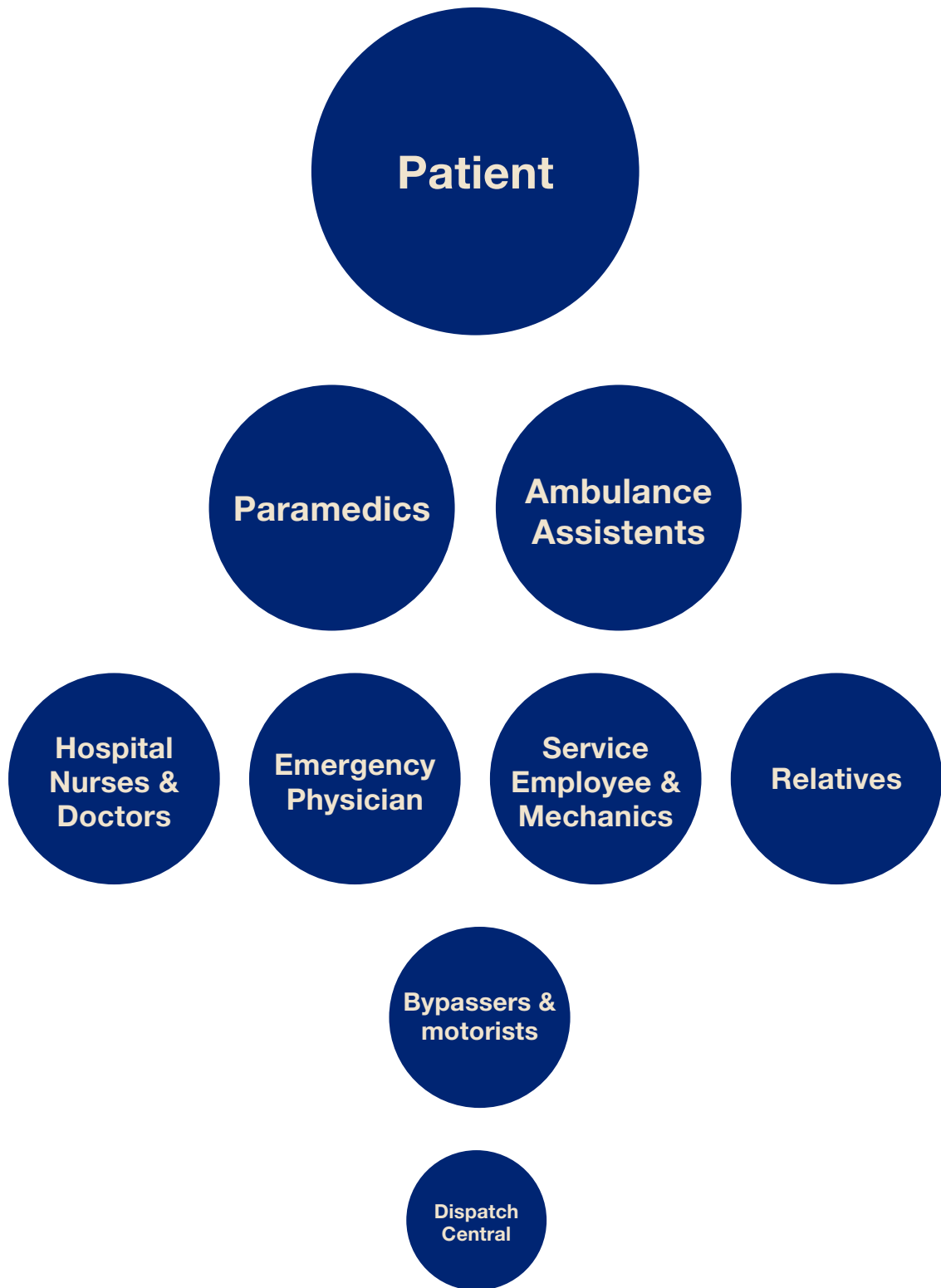
## Actor Network

Actor-network theory (ANT) is an important tool for a holistic design process. As objects, according to ANT are created to mold and influence activities, actions and decisions. In this way the design of objects can impact and even change our morality and ethics by convey human relations (Yaneva, 2009).

### Stakeholders

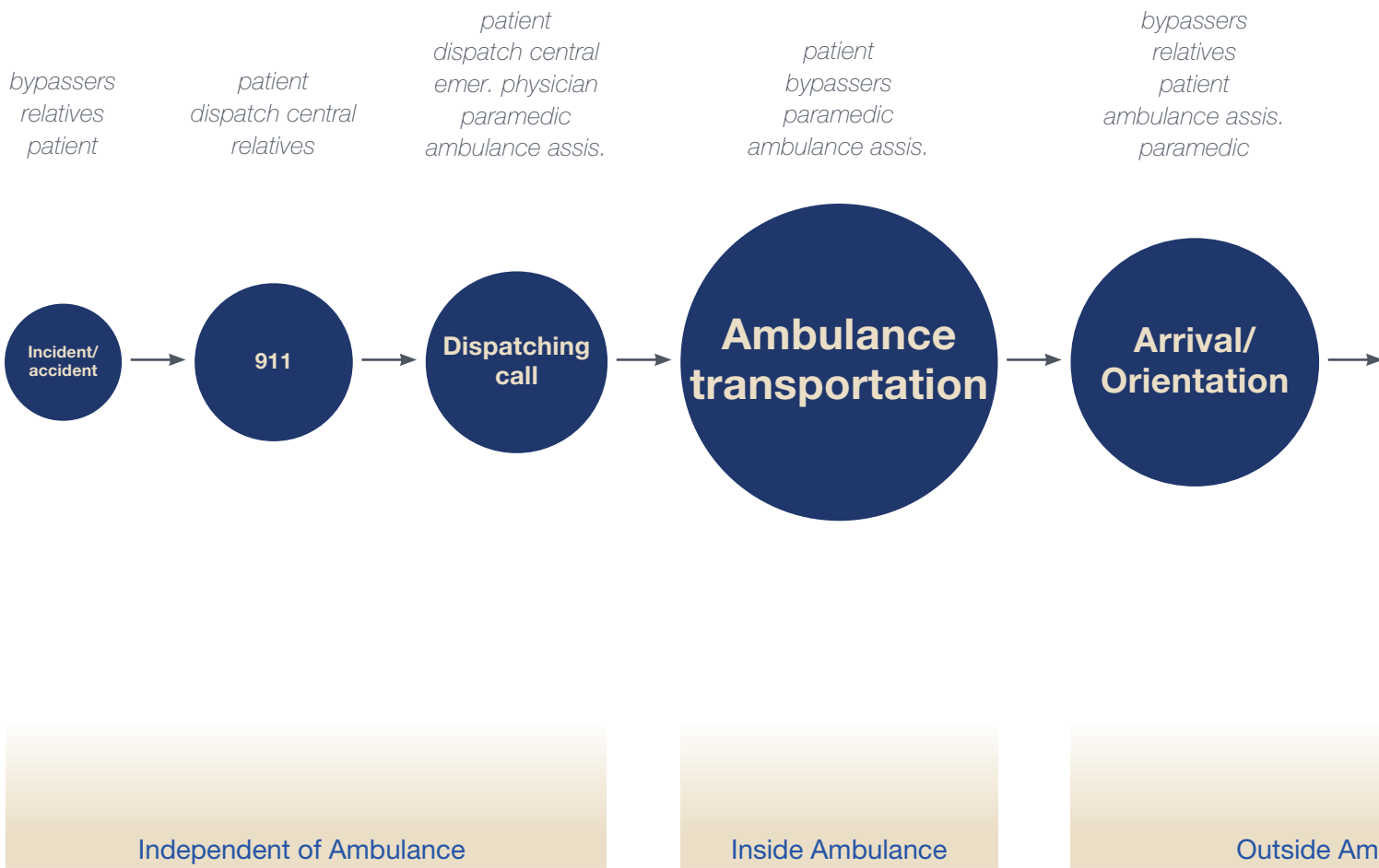
There is a line of relevant stakeholders in the day to day use of an ambulance - all in a different order of priority. Even though the ambulance assistant and the paramedic use the ambulance every day, for a long time, the patient is at the top of my hierarchy. The key requirement of an ambulance is to give the patient, as fast, lifesaving and comfortable treatment as possible. All interventions should be with the patient in mind. The patient should feel secure, relaxed and important (O'Hara, 2015). But to fulfill those requirements the paramedics and ambulance assistants should have the tools they need. The interior design of the ambulance should support the paramedics role of caretaker, authority but first and foremost as a treater. The paramedic should be able to have eye contact with the patient and access to patient for treatment - and should have easy access to all the tools and equipment in the ambulance. The paramedic should be safe and secure, in case of hard brakes, sharp turns or accidents (O'Hara, 2015). Hospital personnel will be relevant in the transition from ambulance to hospital as well as the emergency physician will be relevant in severe accidents. Relatives might travel with the patient in the ambulance - and be able to talk and look at the patient. This can help calm the patient down in stressful situations (O'Hara, 2015). Service personnel take care of the stocking and condition of the ambulance and its equipment. Motorists' perception and awareness of the ambulance is a key factor in fast transportation. The motorists should be able to hear and see the ambulance very clearly - while giving stubborn road users and incitement to clear the road (Saunders, 2003). A goal for the ambulance assistant is to use the sirens as little as possible to avoid unwanted sound pollution, while never down grading the response time

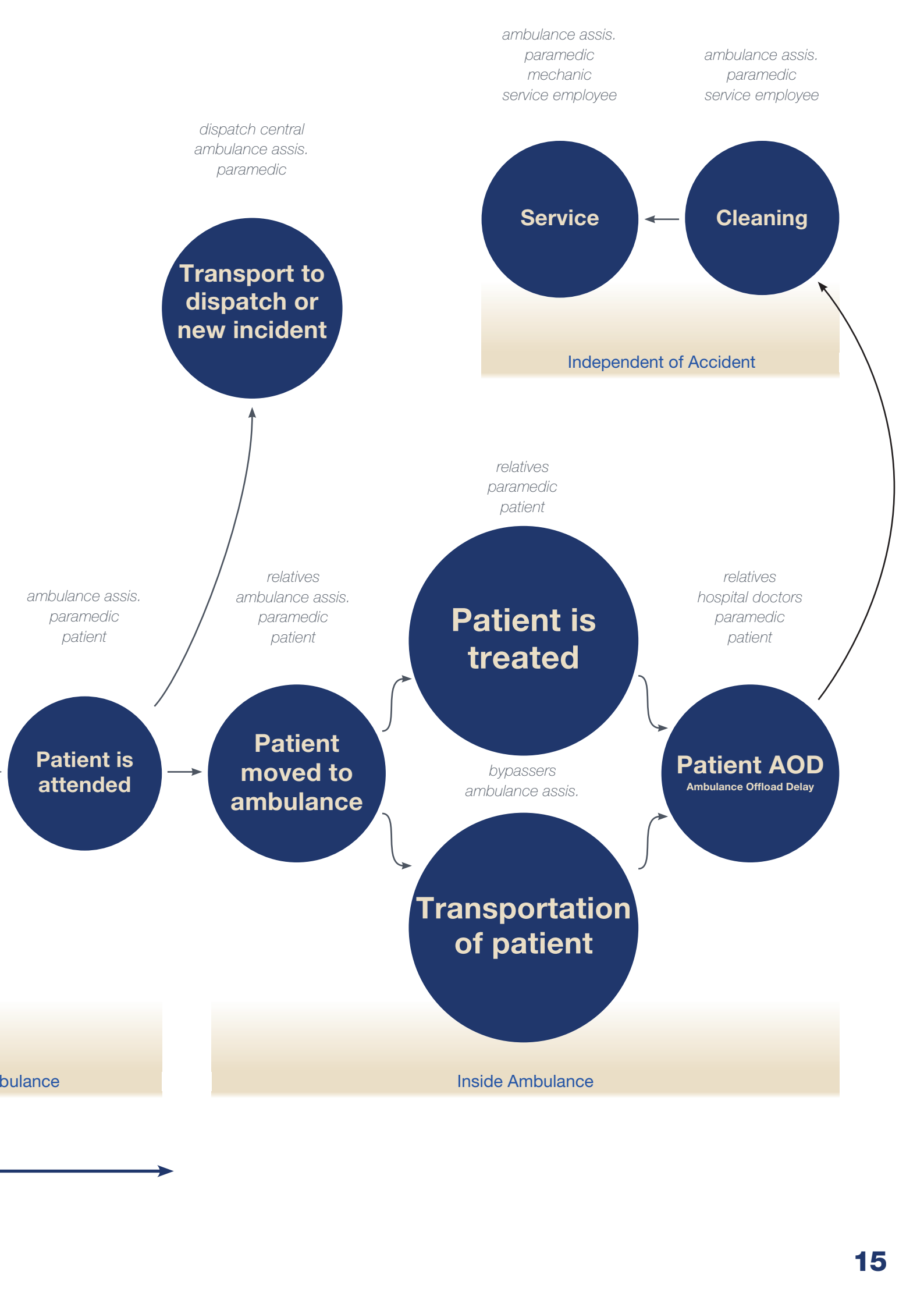
high priority  
low priority



## Timeline

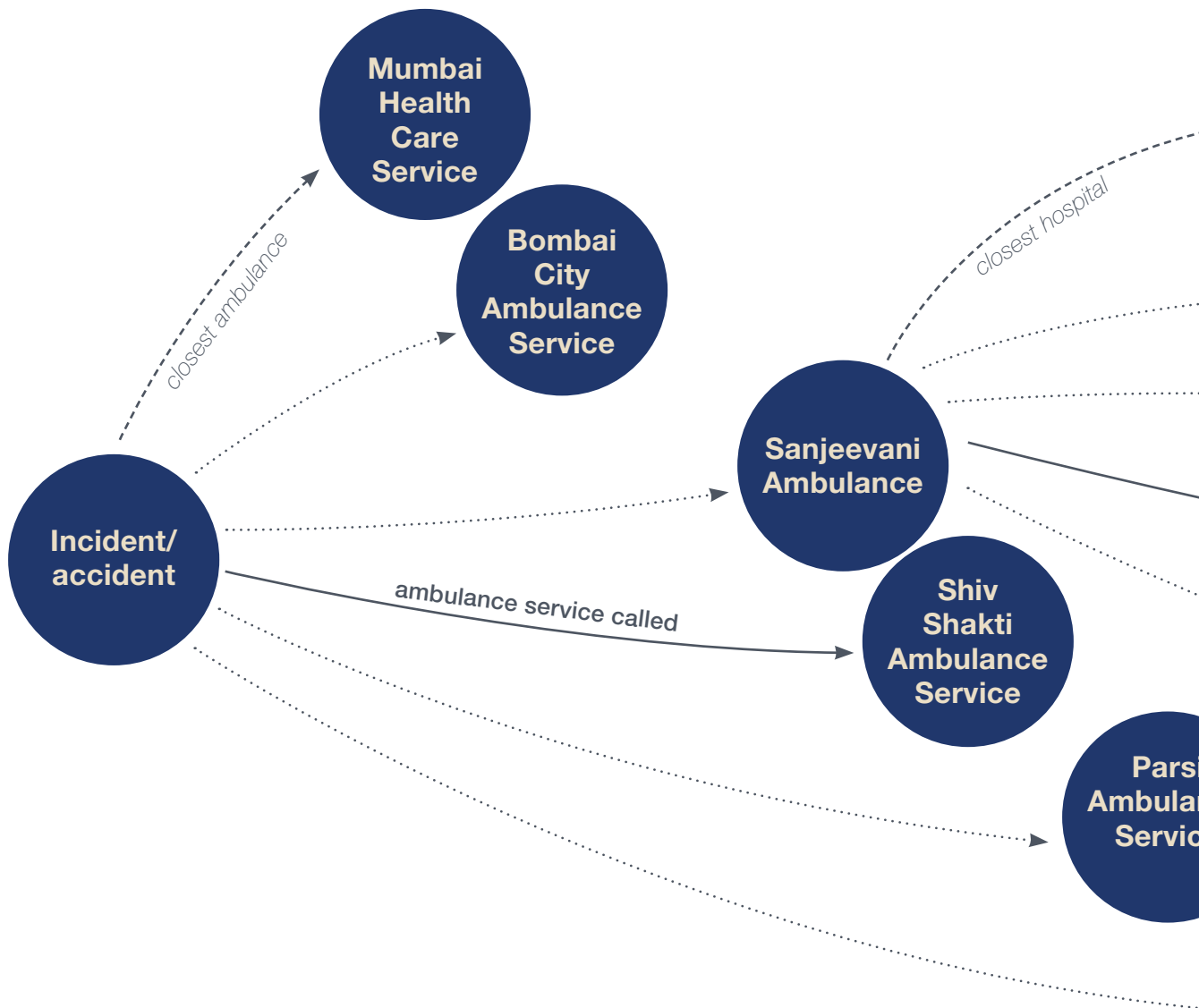
The timeline is defined to better understand order and magnitude of each steps in an emergency call. Above each steps the relevant stakeholders are defined listed after relevance. Even though the patient is not present in all steps he/she is always relevant.



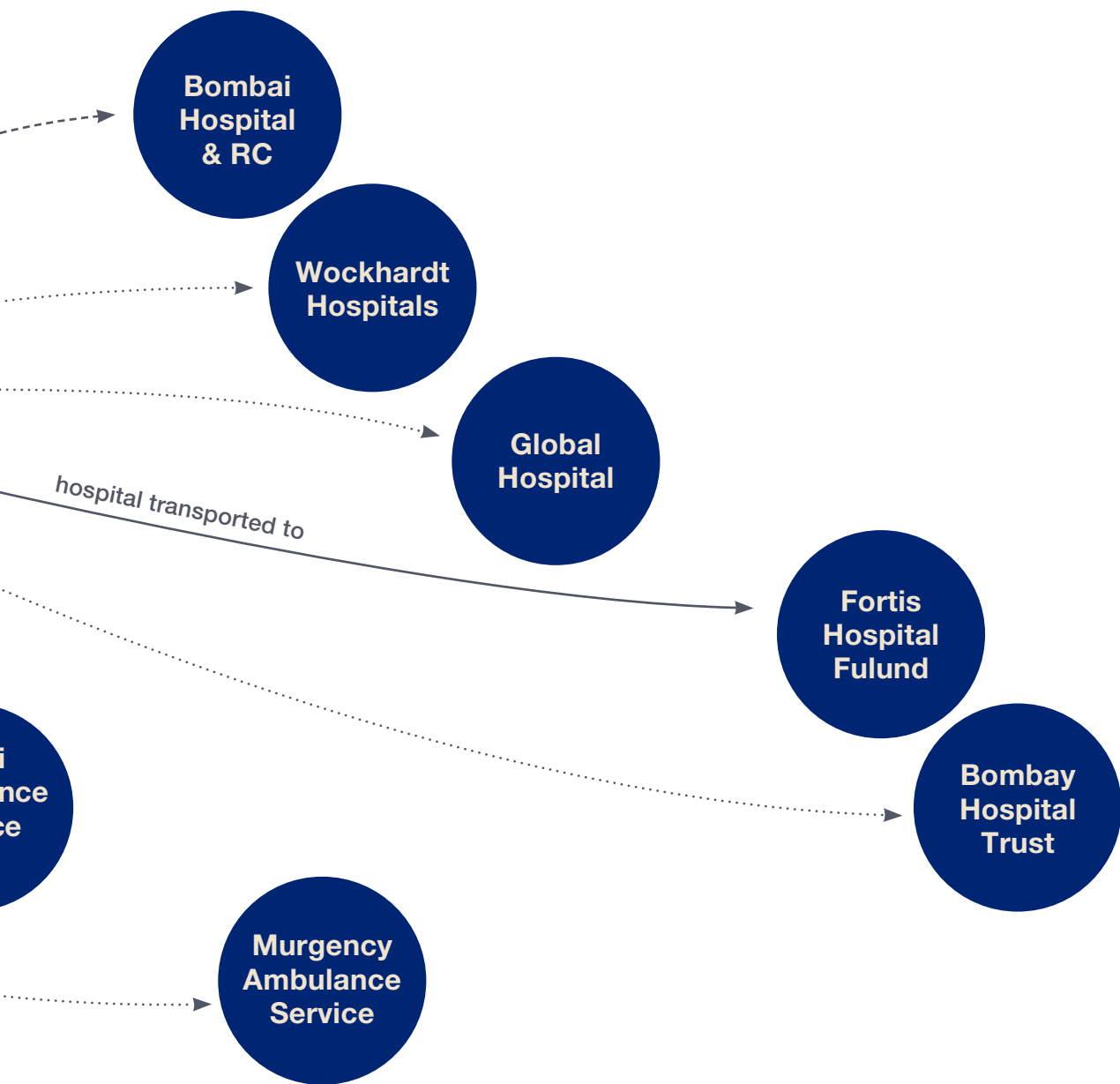


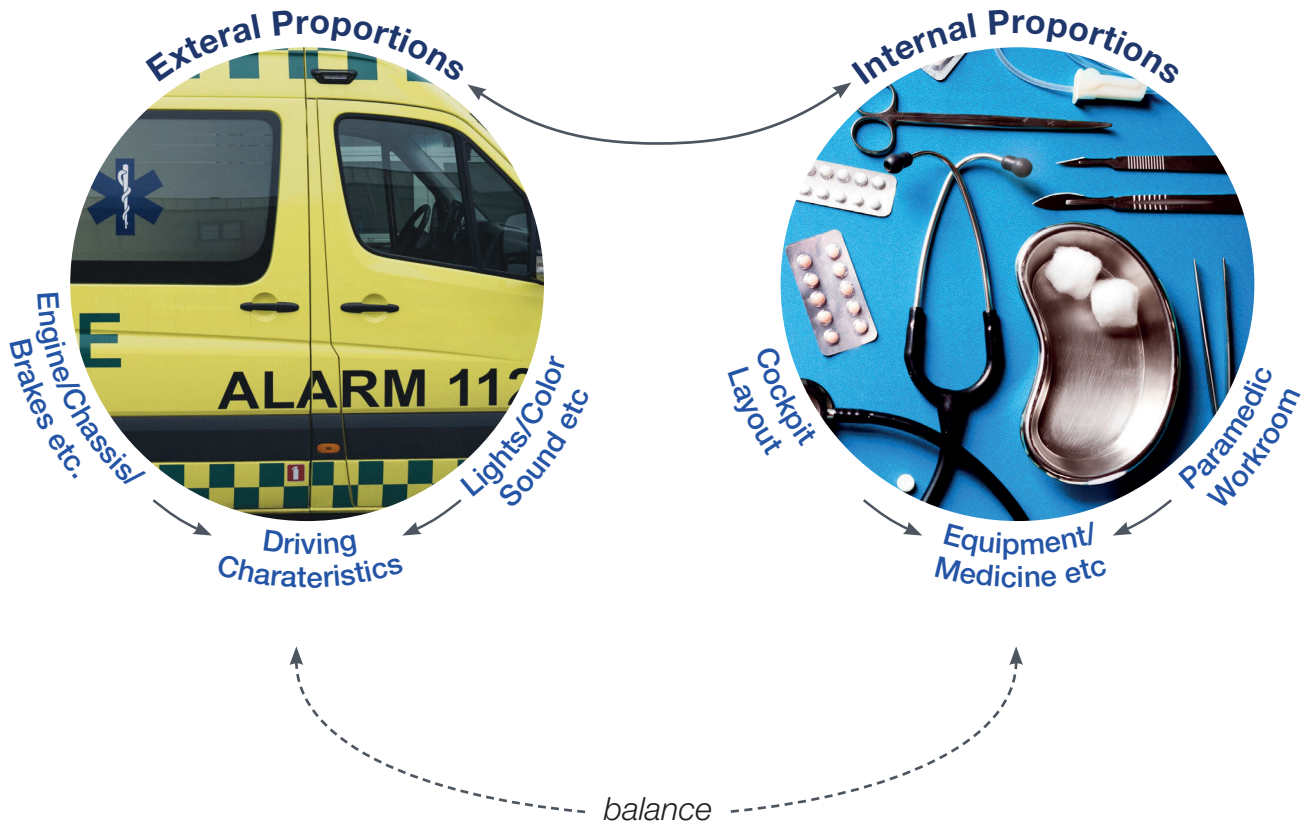
## Indias Ambulance Infrastructure

India's ambulance service is driven by multiple private companies. This means that the patient or relative will have to assess which company to call, based on location, price etc. The problem is that you rarely know which company have the closest ambulance dispatched, and this gives a longer dispatch time. Also, some of the companies have agreements with different hospitals, and therefore take you to a specific hospital even though it is not the nearest. In Mumbai there are at least 20 different ambulance services scattered over the city.









## Elements

To better understand where innovation could be needed, I have divided the ambulance into elements. The two main groups internal proportions and external proportions affects each other. The internal proportions effect the cockpit, the workroom for the paramedic and the equipment in the ambulance. The external proportions effect the mechanics (engine/chassis etc.) and lights/color/sound which all effect the driving characteristics. The key to a faster dispatch time could be by finding the right balance between the driving characteristics and the equipment. If the ambulance contains less equipment the ambulance can be smaller and therefore travel faster in congested traffic. To be able to find this balance I have studied the environment the ambulance is going to be used in, and what equipment there are in an ambulance and their importance.



*Bag Valve Mask*



*ECG w Defibrillator*



*Ventilator*



*Jump Bag*



*Suction Unit*



*Wheeled Gurney*



*M Data Terminal*



*Oxygen*



*Medicine Bag*



*Cervical Collar*



*Two way Radio*



*Spinal Board*

## Equipment

There are a lot of variation in ambulances equipment depending on the country of origin. Two-way radios and mobile data terminals are key for the communication between the ambulance, dispatch central and the hospital. Bag valve mask, ventilator and suction units are used for aiding and clearing air paths and the ECG monitors the patient's vitals and are vital in the case of heart failures. Cervical collar and spinal board are used to clamp the patients where the patients neck or back are in danger. But one of the most important tools is the Jump bag containing all health care essential including a well-equipped medicine bag, Haemoglucometer (HGT), cold packs, gaze, coban (tape), tourniquet (blood loss), saline washing, stethoscope, blood pressure cuff, Rad measure (oxygen saturation, pulse etc.), nebulizer (drug delivery), Co2 monitor, needle decompression, bone drill, catheter and incubation kit (PrepMedic, 2018) (Tan, 2018).

## Designing For

### Densely populated cities

Today in 2021 there are more than 80 cities with +5M inhabitants and in 2030, 60% of the world's population will live in cities 500.000 inhabitants or more (World Urbanization Prospects, 2018). As we move towards 2050 the world's population will grow, and of them more and more will live in urban settlements. This means that the problems we see in densely populated cities today will become bigger and new problems will arise. And India is the country in the world contributing the most to urban population growth. (Chee, 2018). Furthermore, the standard of living is increasing and more and more rises to the middle class and therefore more will use the ambulance services while the traffic will increase (India Datasheet, 2018).

### Traffic congestions and the cost

The most densely populated cities have well more than 30.000 people pr square kilometer which cause several problems - traffic congestions being one of them. In only four mayor cities in India (Delhi, Mumbai, Bengaluru and Kolkata), traffic jams cost more than \$60M - a day! (Tandon, 2018). But more importantly the congestions slow down essential infrastructure including ambulances. Distances that should be covered in 15 minutes takes up to an hour. In India over 40.000 dies annually in ambulances due to traffic jams, over 30% of all ambulance deaths - this means that 1% of all patients dies on ambulance rides (TOI, 2019), compared to under 0,1% Denmark (Petersen, 1997).

### Time: From accident to help

But how does the traffic affect the dispatch times. In Copenhagen and most western capitals the average dispatch times of category A (most urgent cases with sirens and lights) are around 6 minutes and 90% percentile of 13 minutes (Akutberedskabet, 2018). This is generally accepted times and fulfill the danish governments own goals for dispatch times. But how is this compared to giant, heavily congested Indian metropolises? In Delhi, the average time for ambulances are 25 minutes and this is even though the ambulance fleet is larger than ever. A big reason for this is because of ineffective dispatching routines, but traffic congestions are a key factor as well.

### The price is right

In the UK, the average price of a fully equipped ambulance is around \$350.000 (Hammond, 2004) and the salary of an ambulance team is around \$285.000 yearly (4 shifts pr week) (AGCAS, 2020). With a depreciation on 10 years for the ambulance the value of the ambulance itself is only responsible for only 10% of the annual cost (simplified calculation). Therefore, upgrades in ambulances and its equipment to make the ambulance more effective, is a great investment. In India, the ambulance costs around \$220.000 (Frazer, 2019), and an average ambulance team earns \$12.000 yearly (3 shifts pr week) (payscale, 2021). With a depreciation on 10 years for the ambulance the value of the ambulance itself is responsible for 65% of the annual cost (simplified calculation). Therefore, it makes more sense to have cheaper ambulances and more of them to cover a larger population and area.

## Why India then?

- India has the second most million cities.
- India is contributing the most to urban population growth
- India's ambulances have very slow ambulance dispatches,
- and high death count due to traffic jams
- India's economy is on the rise and more and more people have economy to pay for ambulance services
- Low wages and expensive ambulances give incentive to cut down on the cost of the ambulance



## Problem Specification

How will an ambulance look specified to high density cities like Mumbai and Delhi, India?

### Follow up questions:

How to compromise between size and speed of ambulance, to arrive as fast as possible with the right tools?

How can design thinking tools make the ambulance in use more cost effective?

How can future technologies in the health field, influence the design of ambulances in lower income countries?



## Framing

As presented in the Elements chapter, one of the biggest challenges with this project was to find the balance between the size of the ambulance and the amount and type of equipment.

### Size

In Denmark and in the western world the size of the ambulance has increased during the years. In the 40s the ambulance was the size of a hearse - in the 90's the ambulance was a small van - and today a larger van (looked through picture references). In India, the ambulance is today like a small van. This could be because of the ambulance cost relative to the paramedic wages - and the cost of the ambulance and health care relative to the average wages (as presented in the chapter Designing For)

But in addition to the larger ambulances, many densely populated cities have a fleet of motorcycle ambulances (Tesser, 2020). These are used as first responders if traffic congestions keep the ambulance from arriving on time. The motorcycles are equipped with a reduced equipment package and are not able to transport the patient back to the hospital.

### Content

These considerations are held up against the health care possible with the given amount of medical equipment. To evaluate what equipment to keep, what to leave and what to change it is important to understand what equipment is used for lethal and to unlethal injuries - but also how often the equipment is used. But to evaluate these compromises I have strengthen my empirical foundation. In the following chapter I will describe how this is achieved.

### Today, tomorrow, to the future

This project is not focused for our world in 50 years but for our world tomorrow. In this way I can make relevant solutions to problems as they are now and with tools and production tools that exists today. And not add to the dozens of drone projects that might or might not make its way to our world in the future.



**More equipment =  
More thorough health care**



**Less equipment =  
Smaller ambulance**

**More equipment =  
Bigger ambulance**



**Smaller ambulance =  
Faster dispatch**

**Bigger ambulance =  
Slower dispatch**



**Faster dispatch =  
Urgent health care**

*Balance*



## Gaining Empirical Foundation

As described in the Framing section I wanted to base my choices on empirical knowledge. I wanted to achieve this knowledge by different areas of Field Research. I had a wish to make direct observations by following an ambulance in its daily routine of picking transportation, attending patients, cleaning etc. I wanted to make a short participant observation by putting myself in both the patients and the paramedics place - noting the access to the patient and the equipment. In the “Actor Network” I have made a case study on the ambulance itself mapping the actors and when and how they interact with the ambulance - and in the Elements section I focused on the physical elements of the ambulance. I wanted to make qualitative interviews with relevant personnel. Lastly, I have made short ethnographic studies on the behavior of motorists in an emergency response, through videos on the internet. In this way i have included all levels of field research theory (Stiffman, 2009).

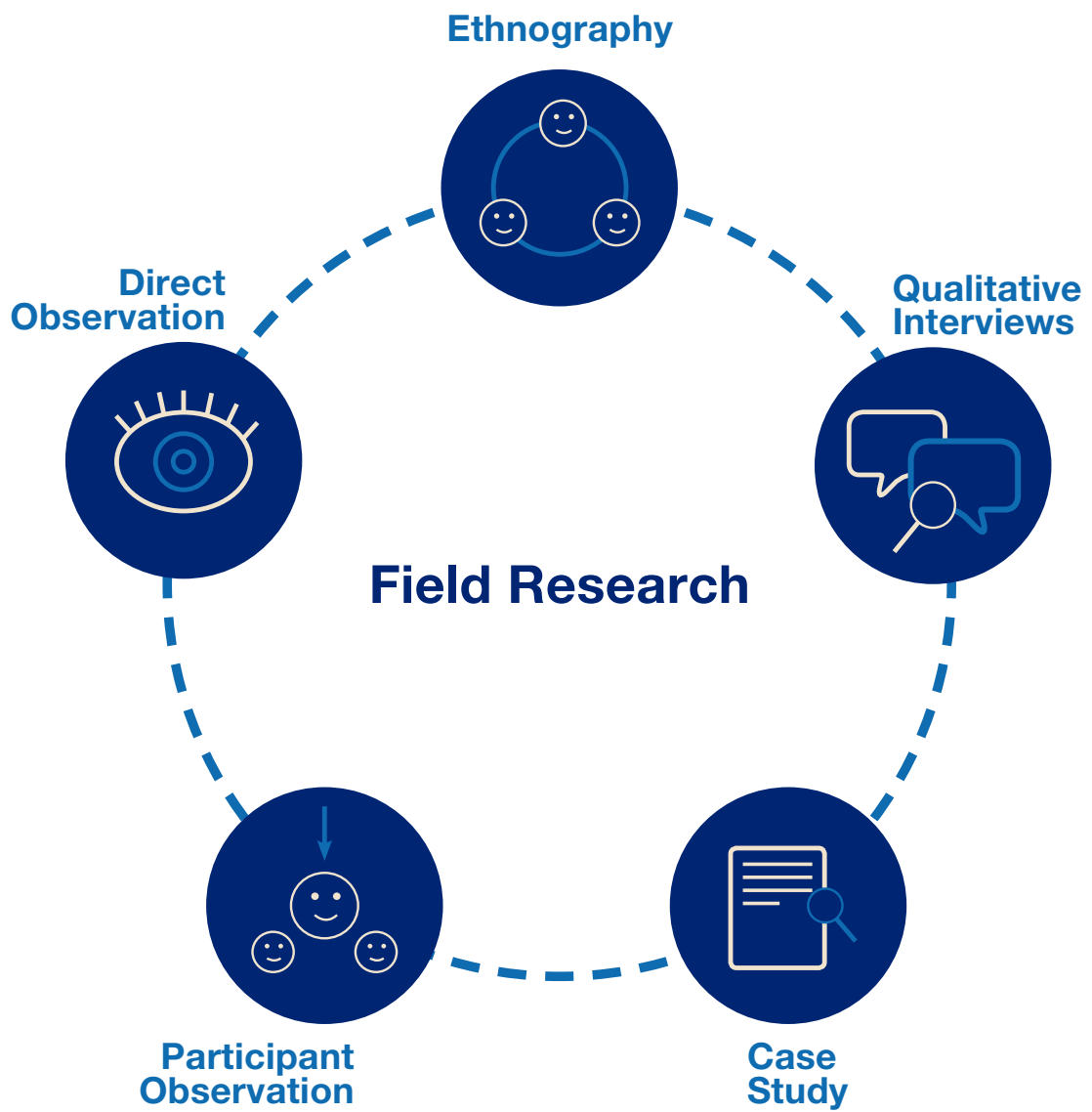
### Field Research

I gained my empirical knowledge by performing following action:

- Participated in actions related with ambulance work
- Studying motorist’s behavior in emergency responses
- Making a case study of the ambulance and its elements
- Interviewing paramedics on their experience with the ambulance understanding hurdles, getting advice and knowledge from the personnel working with the ambulance daily

I wanted to, but didn’t succeed in:

- Attending paramedics for a day
- Interviewing emergency physicians to help me prioritize the equipment of the ambulance against the size, and getting insights
- Interviewing service employees to understand what elements need additional maintenance, and getting insights
- Interviewing traffic and population researcher to get additional knowledge of traffic in the future



## Scope

### Concept

I have defined the concept of an ambulance for the fast-growing metropolises. As described in Framing section the primary goal was to find the balance between size and the content of the ambulance.

### Interior Layout

As the ambulance gets smaller the layout of the ambulance's interior will be more important. An important task was to define the inside space of the ambulance to maximize the amount of medical equipment, but also to give a paramedic the best amount of workroom.

### Interior Design (draft)

Giving the new layout of the ambulance equipment, I have also designed the equipment storage. Here I have focused on the storage of the equipment and not the equipment itself.

### Exterior Design

An ambulance has to stand out in the cityscape. An ambulance must be heard - but also be seen. I have designed the exterior of the ambulance to be seen even though it is smaller.

**Concept** →



**Interior Layout** →



**Interior Design** →



**Exterior Design** →



## UN goals

### Goal 03

is about securing good health and improve the wellbeing of all age groups. Faster ambulance service will improve greatly on this goal in general and especially on sub goal 3.6, about decreasing amount of the deaths from traffic accidents. This is because most patients dying from slow ambulance infrastructure comes from traffic accidents (TOI, 2016)

### Goal 09

is about building robust infrastructure and support innovation. Faster ambulance service could help fulfill sub goal 9.a and 9b about focusing innovation and infrastructure in developing countries. Even though India is not a developing country, some areas are and some of the infrastructural problems they are facing, can soon be relevant in other third world countries.

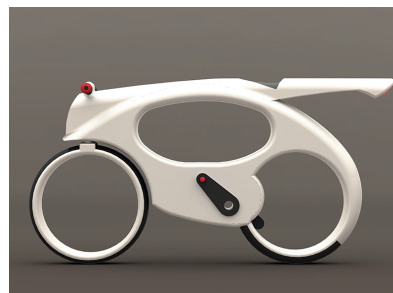
### Goal 10

is about reducing inequalities in and between countries. Building a faster, but more important, cheaper ambulance service, health care can be provided for a greater range of citizens.



## Indian Design Tradition

I have looked at elements of Indian design tradition, making a mood board serving as inspiration to the design. It has been difficult to incorporate aesthetics to the design of an ambulance. But one key insight is how the very ornamental aesthetic from the past in some ways have lived on today. Indians love technology and its aesthetics - as it somehow gives the product a sense of importance (Vaishali, 2020)







## Analysing Motorists Response to Ambulance

To better understand the infrastructural problems Indian ambulances faces every day I have watched multiple ambulance videos on YouTube. Even though it is not as good as experience the situation firsthand or talking to the local ambulance drivers it has given two main insights to the Indian traffic, and why the response times of ambulances are so poor.

### Problem #1

*Ambulance has a hard time navigating the congested traffic, due to it's size.*



## Problem #2

*Motorists doesn't give way to the ambulance, even though there is room for it.*



## Color & Layout

### **Dansk Standard - European Guidelines**

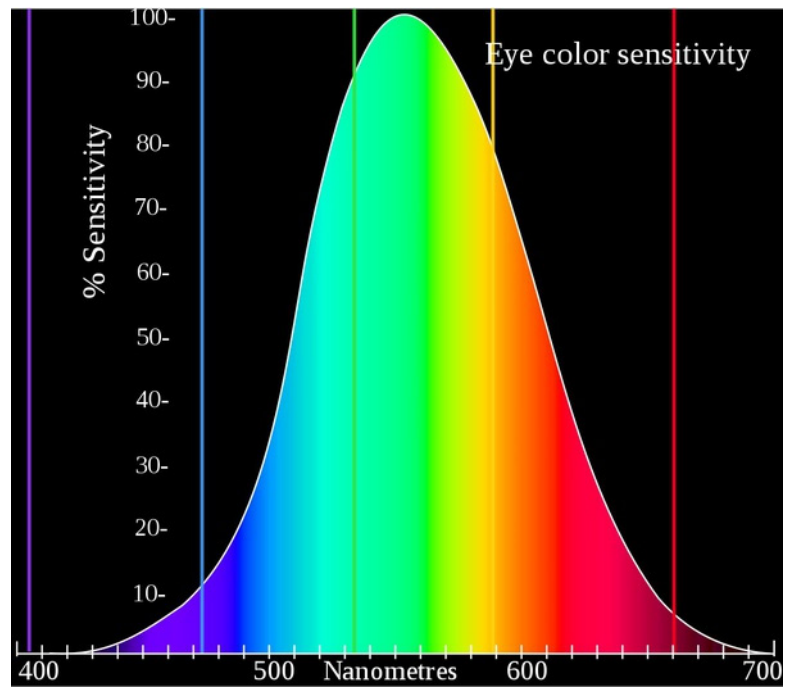
To enhance the recognition and visibility of the vehicle in daylight the base body colour should be yellow (RAL 1016)11) or white.

Where the white body option is selected additional fluorescent yellow or yellow (RAL 1016)11) or fluorescent red (RAL 3024) 11) should be used on the external surface of the vehicles.

For night time visibility micro-prismatic reflective material should be applied.

With the exception of Red Cross societies or where the "Star of life" is locally registered, a blue reflective "Star of life" emblem (minimum size 500 mm) together with reflective letters, numerals or a symbol identifying the organization and the vehicle, should be applied to the roof of the ambulance. The word "ambulance" or equivalent national translation should be applied in reflective upper case letters, a minimum of 100 mm high, in a colour contrasting with the background, to the side and rear of the ambulance and if possible on the front.

*Dansk Indeks for akuthjælp. 2020 - Laerdal*



## Loading & Unloading Ambulance

### Unloading

#1 Fairly slow action in an emergency

#2 Tricky lifts and movements

#3 Very big gurney for miniambulance



*Pulling gurney out of ambulance*



*Attachment locks the gurney in place*



*Wheels are pulled down*



*Gurney is tilted out of the lock*



*And are pulled away from ambulance*

## Loading

#1 Fairly slow action in an emergency

#2 Tricky lifts and movements

#3 Very big gurney for miniambulance



*Patient placed on gurney*



*And lifted by two persons*



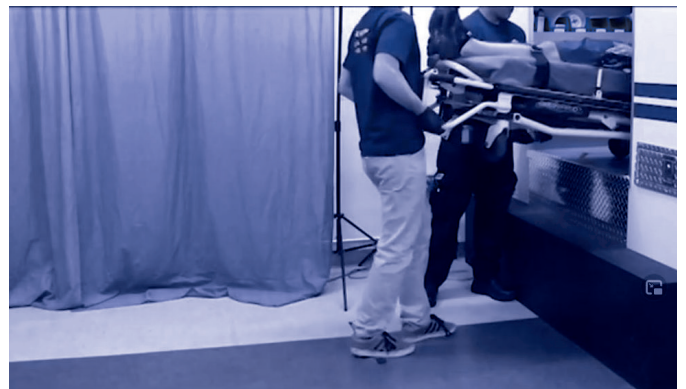
*Gurney is tilted over the locking mechanism*



*One person is lifting the gurney*



*The other is pulling up the wheelbase*



*And the gurney are pushed inside the ambulancex*



## Company Visit

After several attempts to get in touch with an ambulancem, I was suddenly contacted by Jan Nilsson from Falck Station in Taastrup. He invited me to their station on the 15th of march 7pm. Here we had a long talk about the ambulance, paramedic job and the equipment in the ambulance. Following is the insight gained from my visit at the station. I documented all the equipment in the ambulance and lastly, through dialogue with Jan, defined the bare essentials to do proper paramedic treatment.

This field trip was essential to understand what is needed in an ambulance and he agreed on my hypothesis about limiting equipment to improve response time.



## Insights



15 march 7pm - Welcome to Falck Station Taastrup



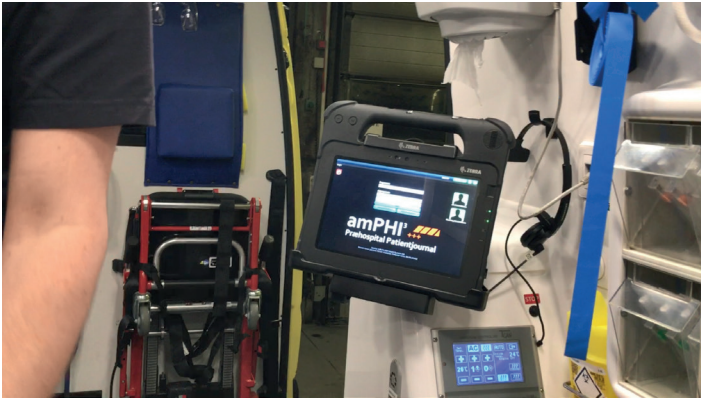
Paramedic Jan Nilsson presented the ambulance and talked about equipment and use of the ambulance



Full navigation system prepare personnel for specific injury. This means they can prepare medical equipment and/or medicine. Also response type is informed.



Only way to improve Danish response times is more ambulances. Emergency call, response and dispatch is very effective. Traffic is rarely an issue. Or have a more effective indexing system to diagnose patients.



*Ambulance personnel must answer call and leave station before 90 seconds.  
Before GPS/navigation system all information was giving with radio.*



*For most injuries two personnel is needed. Heart failure and most deadly injuries can not be treated by only one person.*



*The ambulance is their office. Even though it is necessary to work on the streets, apartments, houses etc, it is always preferable to work in the ambulance.*



*There are two of everything in the ambulance plus two of everything in the jumpbags*



*The communication between different groups of the pre-hospital unit is very effective and detrimental to a good treatment*



*Injuries among ambulance personnel is common when doing heavy lifting - specifically when lifting the gurney*

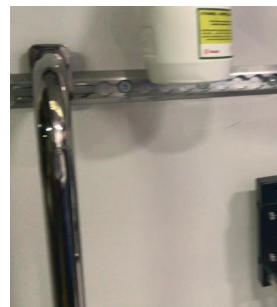
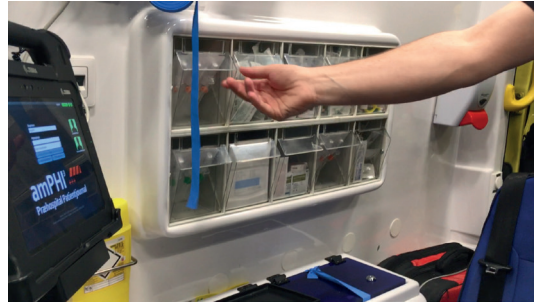


*Spineboard and Neck collar is almost never used*



*It will be difficult to reduce the amount of equipment in the jump bags*

## Content in Danish Ambulances



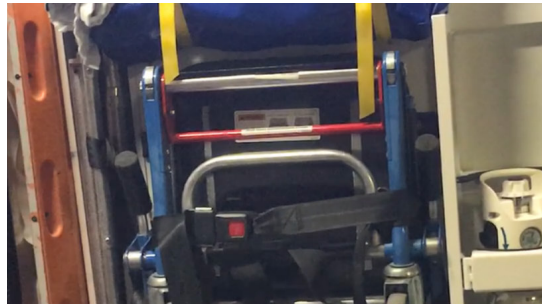
**Communications system** - Contact to alarm central and hospital, and possibly emergency paramedics.  
**Handheld Radios** - Internal contact



**ECG** - (Measures saturation, respiratory, incidental co2, EKG) - in heart failures - 50% hospital & cardiologist



**Various Compartments** - For all medicine and small equipment which is also available in jump bags

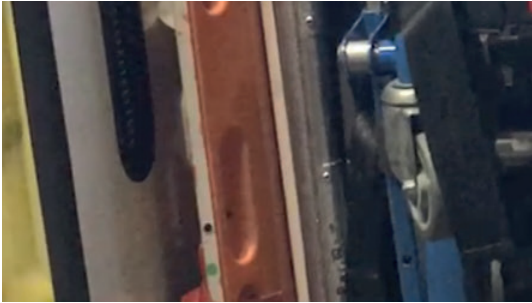


**Oxygen Flask** - *Small Flask also available in jump bags*

**Stair Chair** - *Special chair for transportation on stairs*



blood pressure,  
oxygen frequency,  
Gives shock  
connected to  
regist



**Seats** - Seats for passengers and relatives. This is the primary workplace



**Spine board, Cervical collar, Vacuum mattress & Scoop board** - Stiff boards and fastening equipment for possible fractures on spine and neck

**Gurney** - For most transportation of patient, and patients place when ambulance is driving.



paramedics and  
the paramedics



**AB & CDE Jump Bags** - These two bags contain almost all essentials for treating patients, including:  
- Sam splint, tape tourniquets, coban, gaze, gauze pads, cold packs saline washing, stethoscope, blood pressure cuff, nebulizer, king tube, incubation kit, catheter needle compression, oxygen flask.

## Essentials - Requirements for Paramedic Work

In my conversation with paramedic Jan Nilsson, he was very clear about what equipment is essential to doing proper prehospital treatment.

### **Jump Bags**

Jump bags are the single most important tool for paramedics. Mostly because it is not a single tool but multiple. These bags contain an array of medical equipment. All the equipment in the bag is also in the ambulance in various compartments.

### **ECG**

Next are the ECG. These comes in many different versions. The ECG in danish ambulances can monitor all the patient's vitals, communicate with hospitals and give electrical shocks in case of heart failures. The ECG is used in almost all injuries.

### **Gurney or Board/Bed**

The patient needs to be transported in three ways. From the place of incident to the ambulance, in the ambulance to the hospital and from the ambulance to the hospital personnel.

### **Communication System**

The communication gives the ambulance the next task while informing place of incident, name of patient, type of injury and if it is A, B or C driving. The system can also be used to communicate internally at the place of injury. Lastly the system is used to communicate with the hospital giving information about the patient.

### **Chairs for paramedic and driver**

The driver and paramedic obviously need a chair to work from.





**Jump Bags** - 580 x 400 x 200mm & 500 x 400 x 300mm



**ECG** - max 640 x 240 x 200mm



**Gurney** - 2000 x 500 x 300mm

## Updated Goals & Requirements

After my field trip I updated my requirements for the project

### **Rethink Jump Bags**

All equipment in the ambulance is in the jump bags as well. So, if the jump bags are designed to be both removable and stationary, the paramedic can have access to all equipment in the jump bags while sitting in the ambulance.

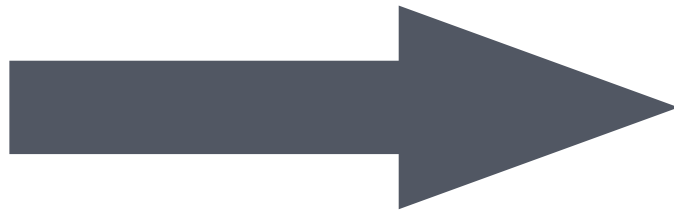
### **Rethink Gurney System**

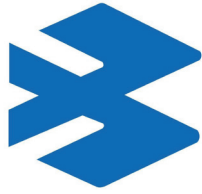
The gurney needs to be small to not take up as much space in the ambulance and still give enough room to the patient. Maybe looking at existing products for inspiration.

Still with focus on

**Smaller Ambulance = Faster Response Time**

**Cheaper Ambulance = More Ambulances**





**BAJAJ**

## Company Profile

**Bajaj Auto Limited** is an Indian multinational two-wheeler and three-wheeler manufacturing company based in Pune, Maharashtra. It manufactures motorcycles, scooters and auto rickshaws. Bajaj Auto is a part of the Bajaj Group. It was founded by Jamnalal Bajaj in Rajasthan in the 1940s. Bajaj Auto is the world's third-largest manufacturer of motorcycles and the second largest in India. Bajaj is the world's largest manufacturer of auto rickshaws and accounts for almost 84% of India's three-wheeler exports ([https://en.wikipedia.org/wiki/Bajaj\\_Auto](https://en.wikipedia.org/wiki/Bajaj_Auto))



### **Bajaj Auto Limited**

Founded	1945
Founders	Jamnalal Bajaj
Area Served	India, Nepal, Bangladesh etc
CEO	Rajiv Bajaj
Revenue	\$4.2 Billions
Parent Group	Bajaj Group
Products	Motorcycles Three-wheelers Scooters Cars

## Current Models



*Chetak Scooter*



*Bajaj Maxima C*



*Bajaj RE*



*KTM 390 Duke*



*Bajaj Domina 400*



*Bajaj Qute*

## Small Cargo Transportation





ize →

## Small Cargo Transportation

I wished to use a base vehicle to build my ambulance upon. In my research I have not come across an ambulance build from the bottom, only for this use. In Denmark we mostly use the Mercedes Sprinter. It would be very expensive to build the ambulance from scratch, and therefore I look at existing vehicles to serve as a foundation for my ambulance.



<b>Name</b>	<i>Luoyang Sanling Cargo</i>	\$700	<b>Price</b>
<b>Speed</b>	60km/h	N/A	<b>Range</b>
<b>Width</b>	100cm	1.000 kg	<b>Storage</b>



<b>Name</b>	<i>Tripl Delivery</i>	N/A	<b>Price</b>
<b>Speed</b>	45km/h	100km	<b>Range</b>
<b>Width</b>	127cm	200kg	<b>Storage</b>





<b>Name</b>	<i>The Carver Cargo</i>	\$12,000	<b>Price</b>
<b>Speed</b>	45km/h	100km	<b>Range</b>
<b>Width</b>	98cm	500 l	<b>Storage</b>



<b>Name</b>	<i>Ningbo Electric Cargo</i>	\$1,800	<b>Price</b>
<b>Speed</b>	40km/h	40km	<b>Range</b>
<b>Width</b>	110cm	250 l	<b>Storage</b>



<b>Name</b>	<i>Balaj Auto Rickshaw</i>	\$2,750	<b>Price</b>
<b>Speed</b>	60km/h	130km	<b>Range</b>
<b>Width</b>	130cm	400 kgs	<b>Storage</b>



<b>Name</b>	<i>Tata Ace Gold</i>	\$7,000	<b>Price</b>
<b>Speed</b>	60km/h	N/A	<b>Range</b>
<b>Width</b>	210cm	750 kg	<b>Storage</b>



<b>Name</b>	<i>Royal Enfield</i>	\$2,400	<b>Price</b>
<b>Speed</b>	130km/h	500km	<b>Range</b>
<b>Width</b>	80cm	200kg	<b>Storage</b>

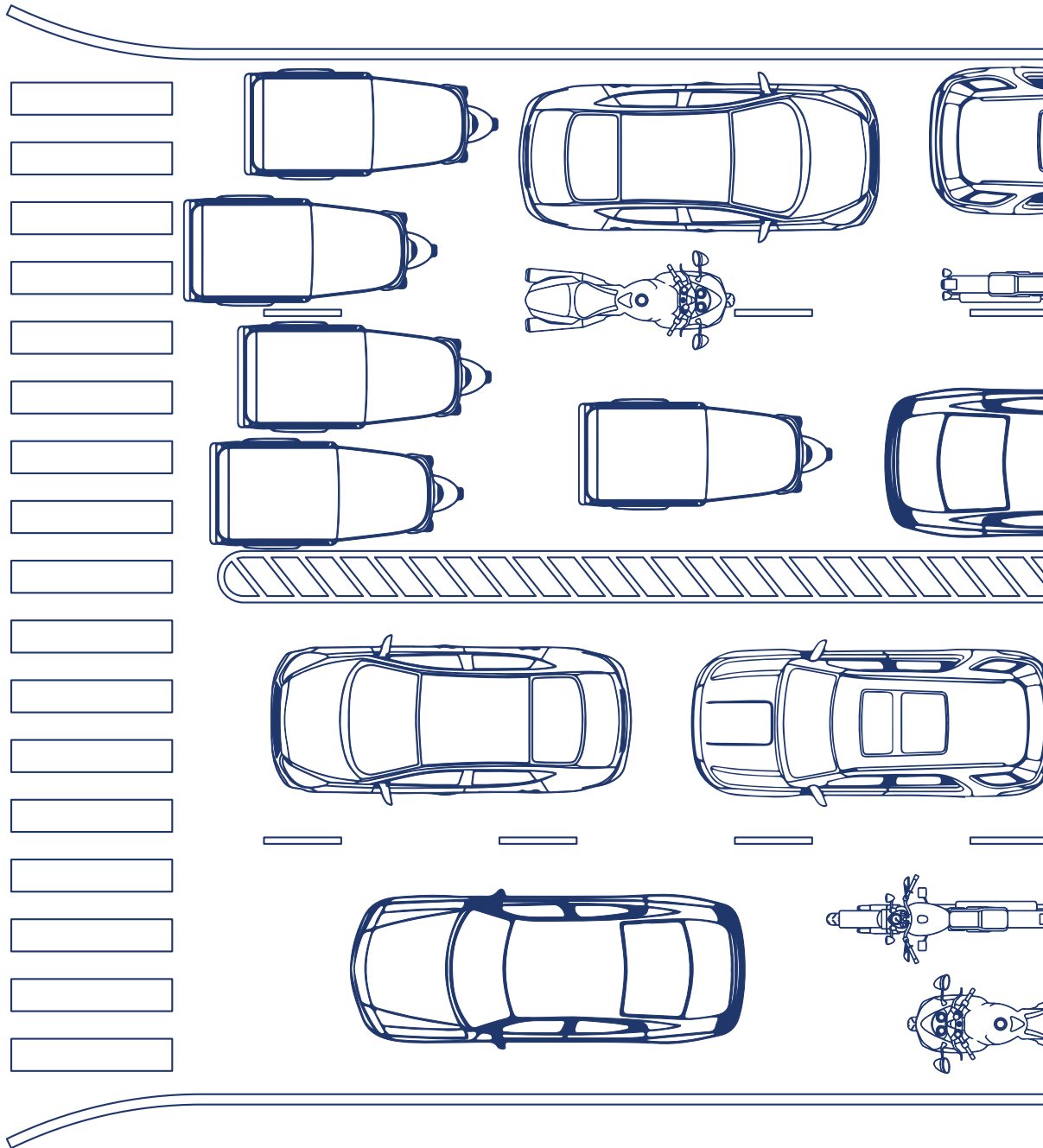


<b>Name</b>	<i>Balaj RE EV</i>	\$4,400	<b>Price</b>
<b>Speed</b>	45km/h	120km	<b>Range</b>
<b>Width</b>	130cm	400kg	<b>Storage</b>

## Vehicle Sizes

Rickshaws or motorcycles fits twice as many as vehicles

Rickshaws or motorcycles fits between two of two lane road



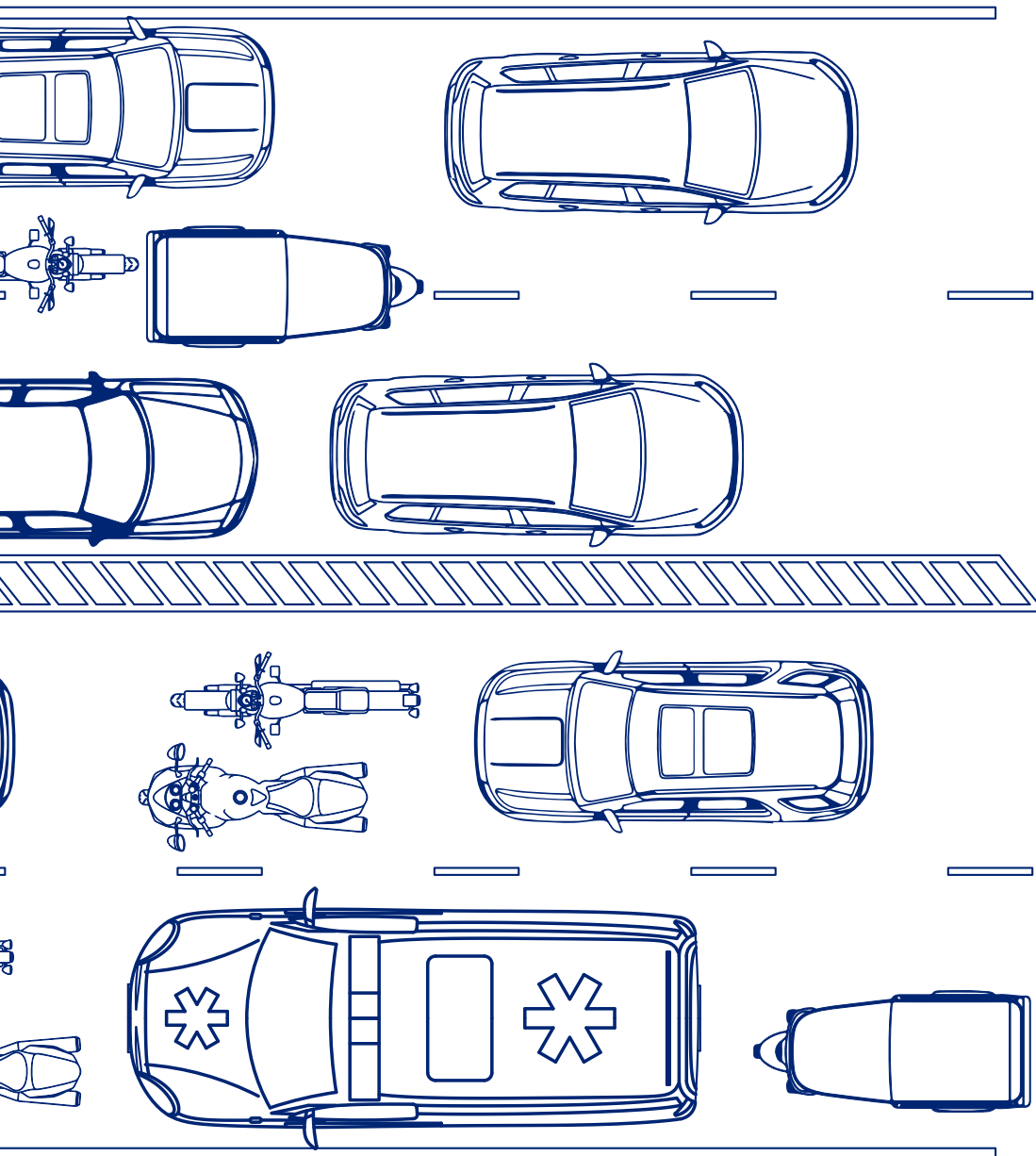
## Recommended Carriageway Widths Delhi

Single Lane	3.50m
Double Lane	7.00m
Triple Lane	10.50m

Government of Delhi Urban Roads 2014

Motorcycles  
fits in a

Rickshaws or  
motorcycles fits besides  
one car in a one lane road



## Choice of Base Vehicle

### Packaging Studies

To decide on the base vehicle I have made package studies of the four different vehicles. The goal was to fit in the patient, paramedic and driver in the best way possible without making the vehicle wider, and leaving as much room as possible for medical equipment.

### European - Electric



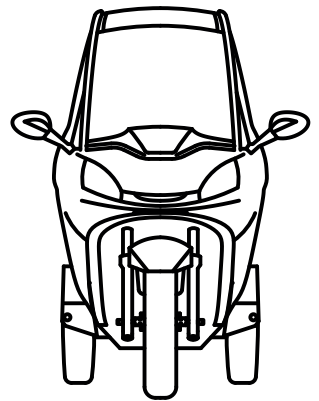
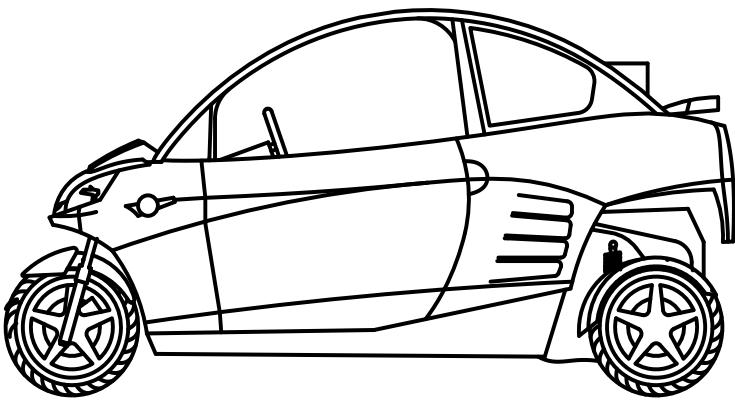
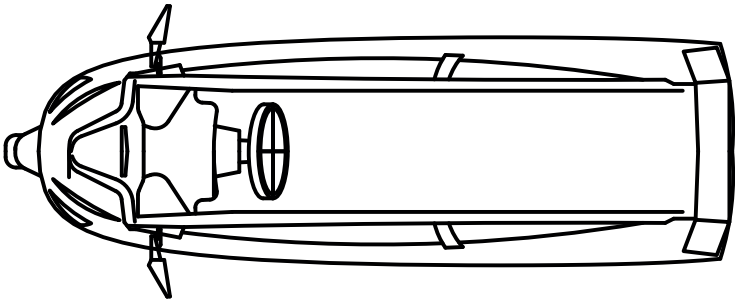
**Indian - Gasoline**



## Base Vehicle 01 - Carver NTV



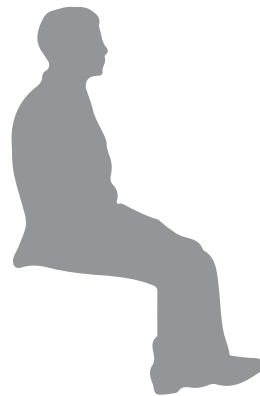
<b>Speed</b>	45 km/h	<b>Length</b>	289cm
<b>Accel.</b>	45km/h in 8 sec	<b>Width</b>	98cm
<b>Range</b>	100km	<b>Height</b>	149cm
<b>Battery</b>	Lithium Ion	<b>Weight</b>	300KG
<b>Capacity</b>	5,4 kWu	<b>Capacity</b>	600l
<b>Charging</b>	80% - 4hr	<b>Power</b>	2 x 2kw



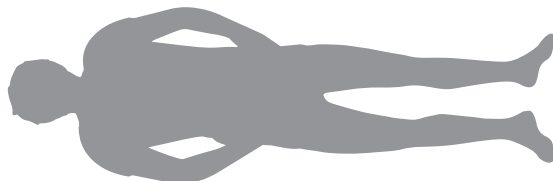
**Driver**



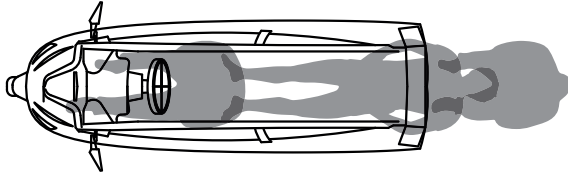
**Paramedic**



**Patient**

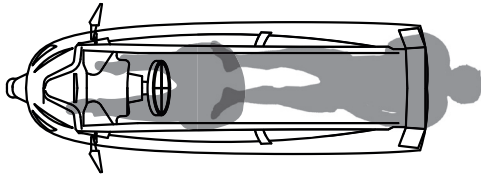
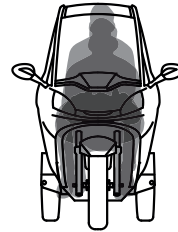
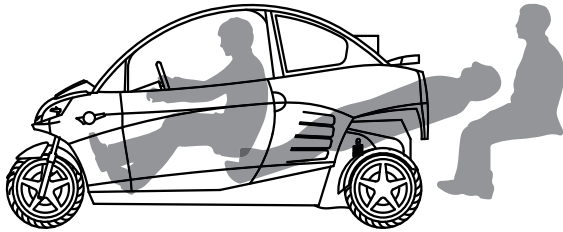


## Carver NTV - Concepts



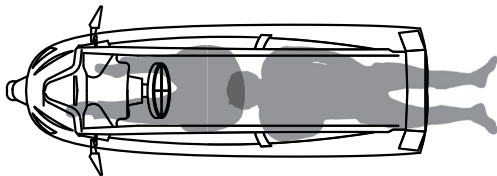
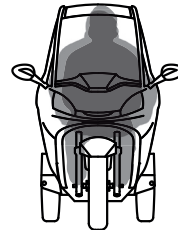
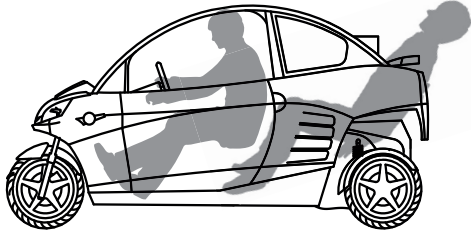
### Concept 1

Package concept 1 fitting paramedic, patient and driver. The vehicle have to be increased in length and not much room for equipment.



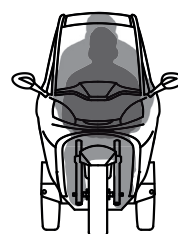
### Concept 2

Package concept 2 fitting only paramedic and patient. The vehicle doesn't have not much room for equipment.

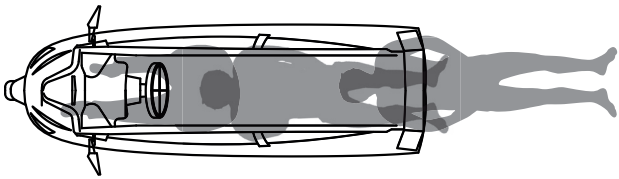


### Concept 3

Package concept 3 fitting only paramedic and patient. The vehicle doesn't have not much room for equipment.

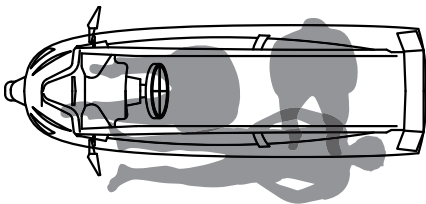
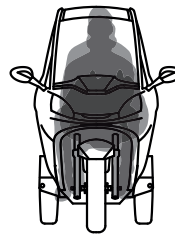
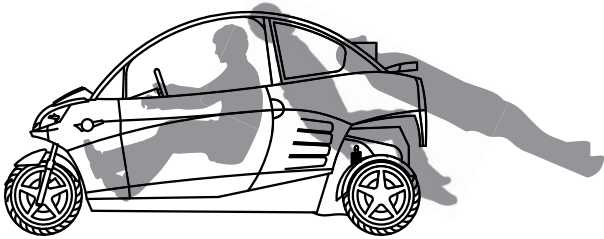






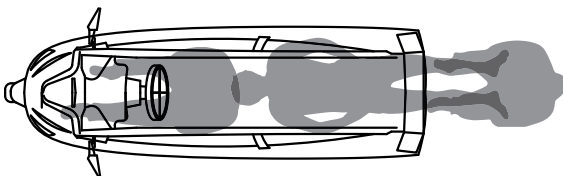
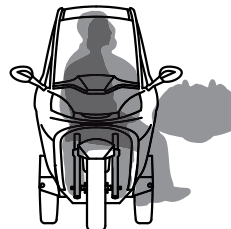
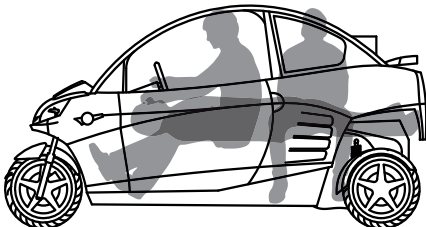
#### Concept 4

Package concept 4 fitting paramedic, patient and driver. The vehicle have to be increased in length and not much room for equipment.



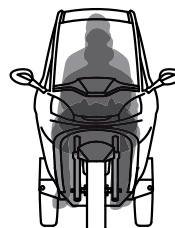
#### Concept 5

Package concept 5 fitting paramedic, patient and driver. The vehicle have to be increased in width and not much room for equipment.



#### Concept 6

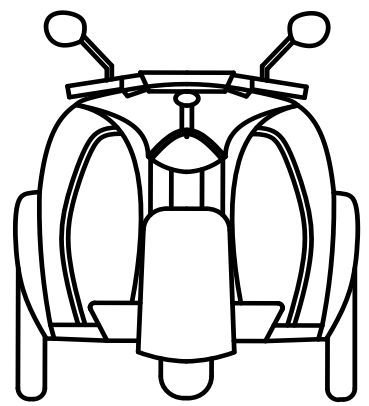
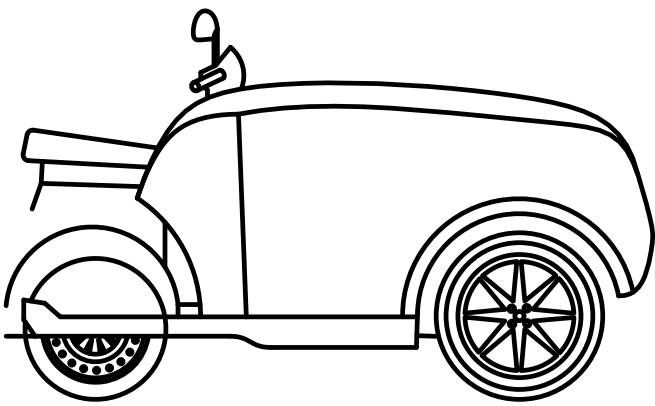
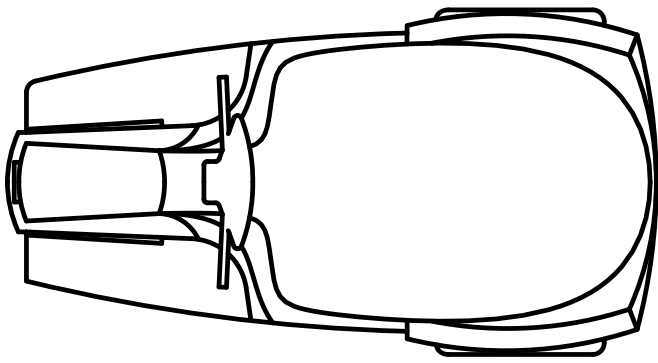
Package concept 6 fitting paramedic, patient and driver. The vehicle have to be increased in length and not much room for equipment.



## Base Vehicle 02 - Tripl Electric Scooter



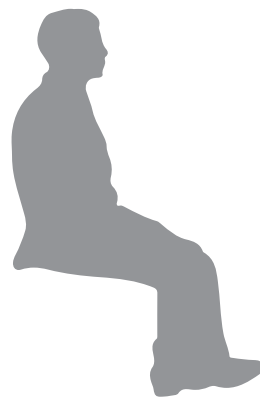
<b>Speed</b>	45 km/h	<b>Length</b>	241cm
<b>Accel.</b>	45km/h in 7 sec	<b>Width</b>	127cm
<b>Range</b>	100km	<b>Height</b>	117cm
<b>Battery</b>	Lithium Ion	<b>Weight</b>	234kg
<b>Capacity</b>	7,2 kWu	<b>Capacity</b>	750l
<b>Charging</b>	80% - 5hr	<b>Power</b>	2 x 3,4kw



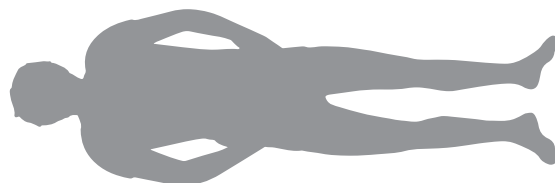
**Driver**

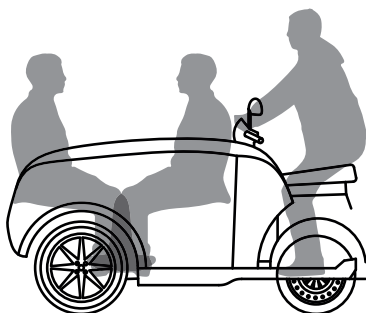
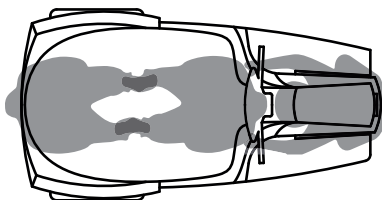
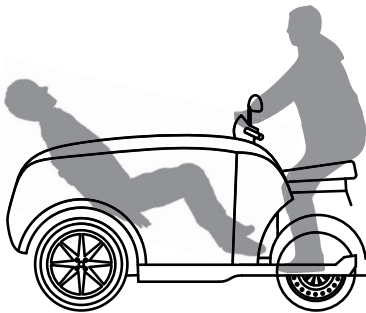
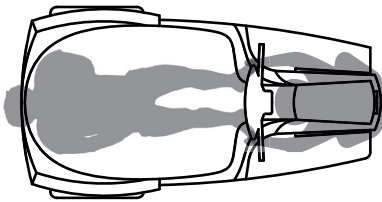
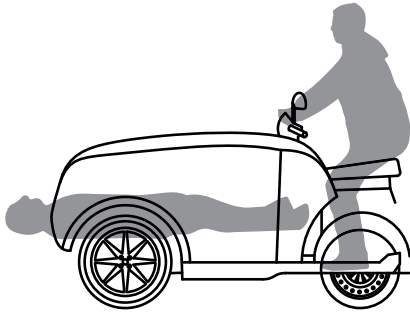
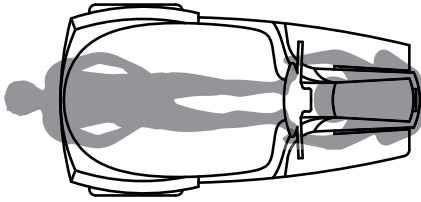


**Paramedic**



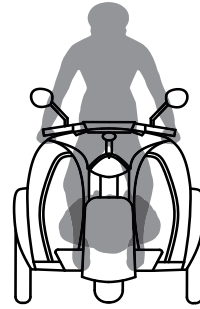
**Patient**





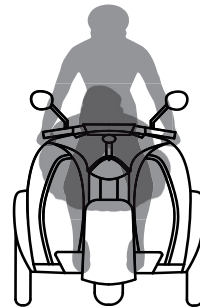
### Concept 1

Package concept 1 fitting only paramedic and patient. The vehicle doesn't have much room for equipment.



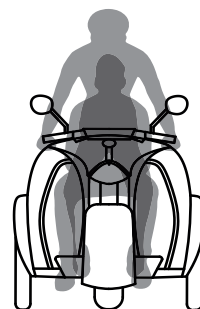
### Concept 2

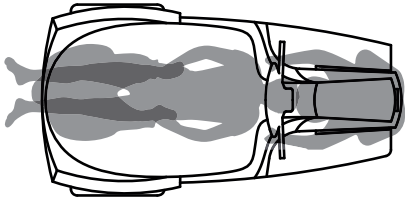
Package concept 2 fitting only paramedic and patient. The vehicle doesn't have much room for equipment.



### Concept 3

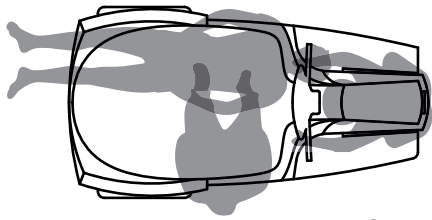
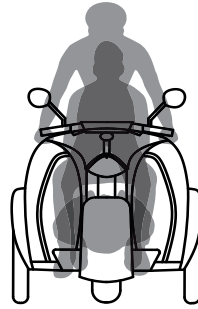
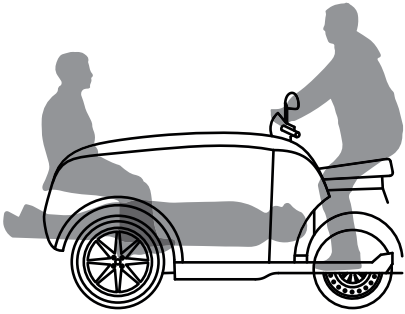
Package concept 3 fitting paramedic, patient and driver. The vehicle doesn't have much room for equipment and patient have to sit.





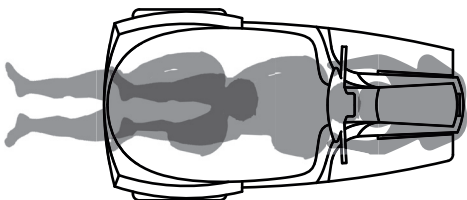
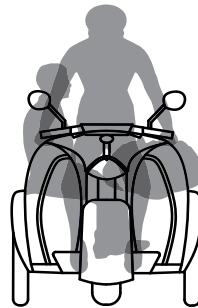
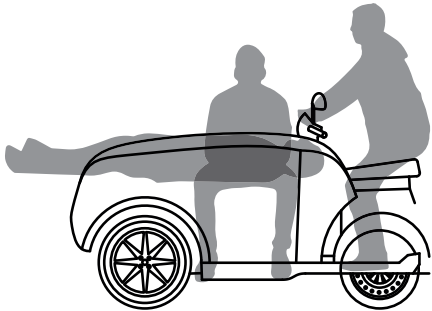
#### Concept 4

Package concept 4 fitting paramedic, patient and driver. Bad working position for paramedic.



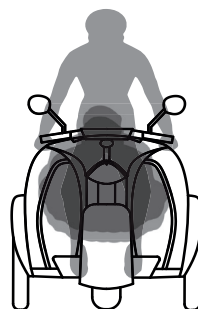
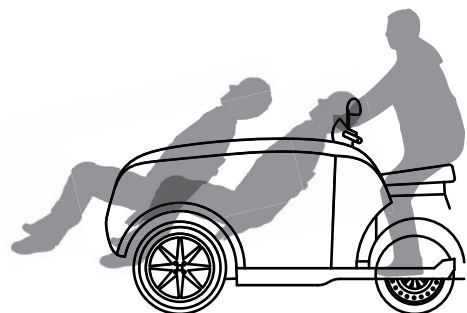
#### Concept 5

Package concept 4 fitting paramedic, patient and driver. Over all good solution



#### Concept 6

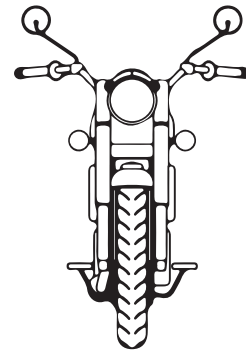
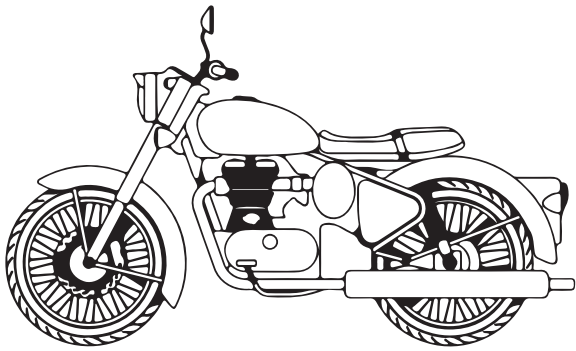
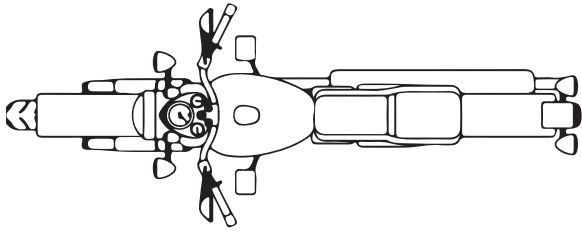
Package concept 4 fitting paramedic, patient and driver. Bad working position for paramedic.



## Base Vehicle 03 - Royal Enfield



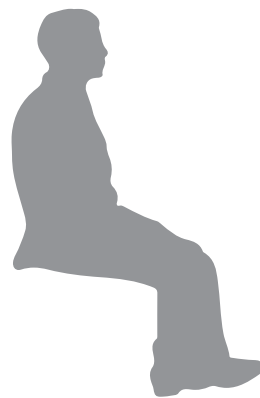
<b>Speed</b>	<i>130 km/h</i>	<b>Length</b>	<i>216cm</i>
<b>Accel.</b>	<i>100km/h 1 sec</i>	<b>Width</b>	<i>79cm</i>
<b>Range</b>	<i>630km</i>	<b>Height</b>	<i>109cm</i>
<b>Engine</b>	<i>Gasoline</i>	<b>Weight</b>	<i>195kg</i>
<b>Capacity</b>	<i>13,5 l</i>	<b>Capacity</b>	<i>n/a</i>
<b>Fueling</b>	<i>1 min</i>	<b>Power</b>	<i>356cc</i>



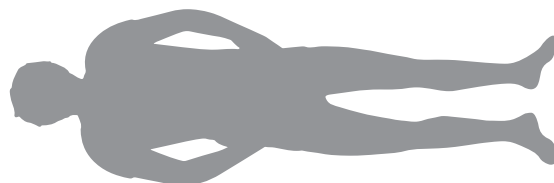
**Driver**

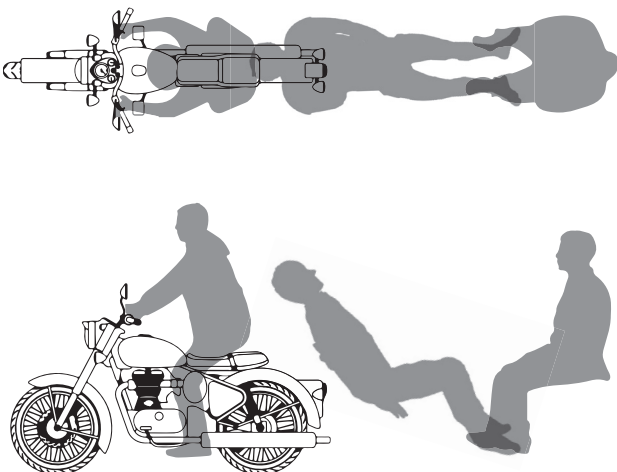
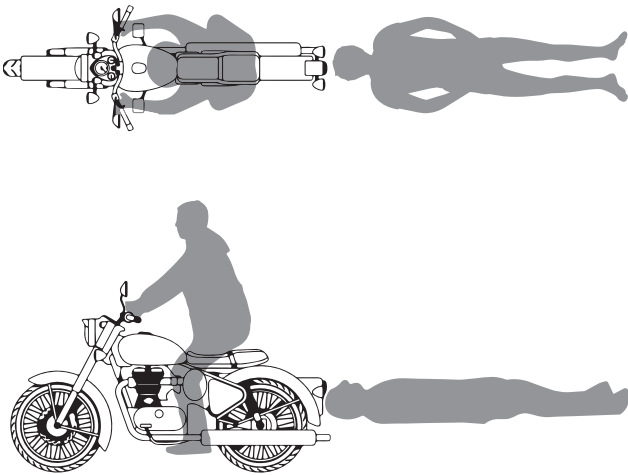
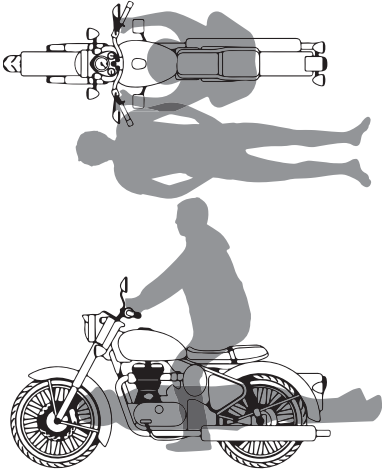


**Paramedic**



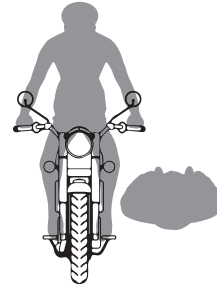
**Patient**





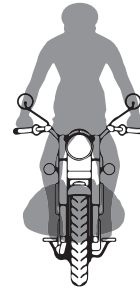
### Concept 1

Package concept 1 fitting only paramedic and patient. The vehicle needs a side car, and can have room for equipment.



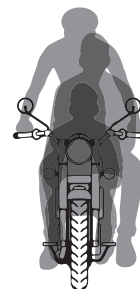
### Concept 2

Package concept 2 fitting only paramedic and patient. The vehicle needs a trailer and can have room for equipment.

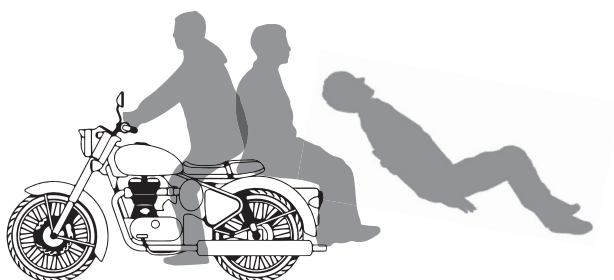
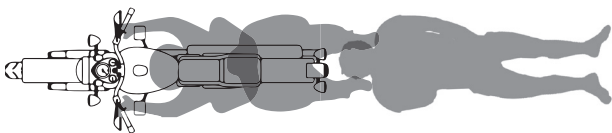
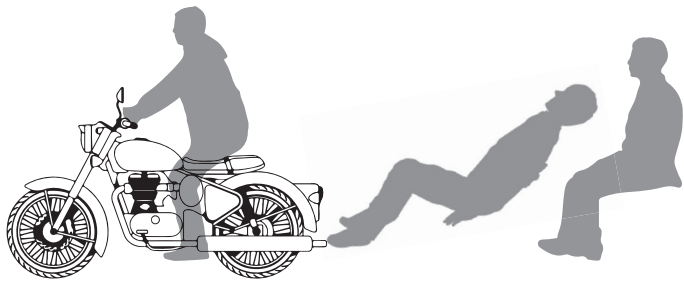
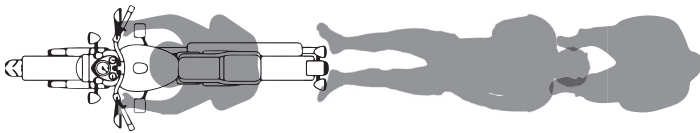
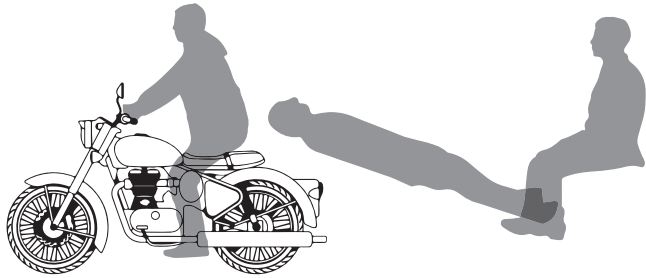
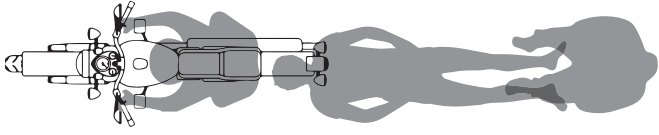


### Concept 3

Package concept 3 fitting paramedic, driver and patient. The vehicle needs a trailer and have some room for equipment.

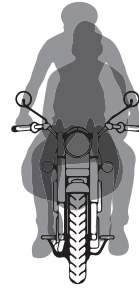






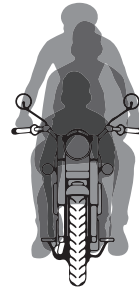
#### Concept 4

Package concept 4 fitting paramedic, driver and patient. The vehicle needs a trailer and have some room for equipment.



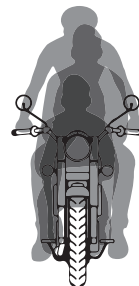
#### Concept 5

Package concept 5 fitting paramedic, driver and patient. The vehicle needs a trailer and have some room for equipment.



#### Concept 6

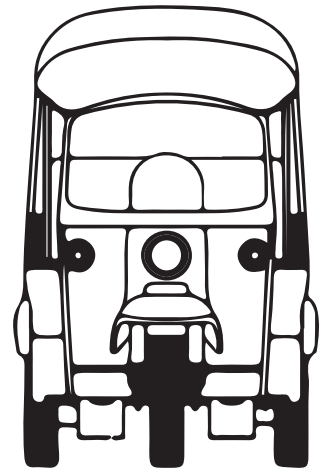
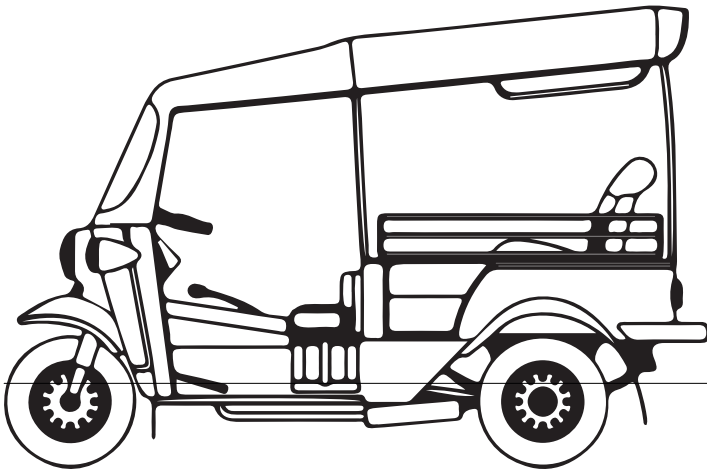
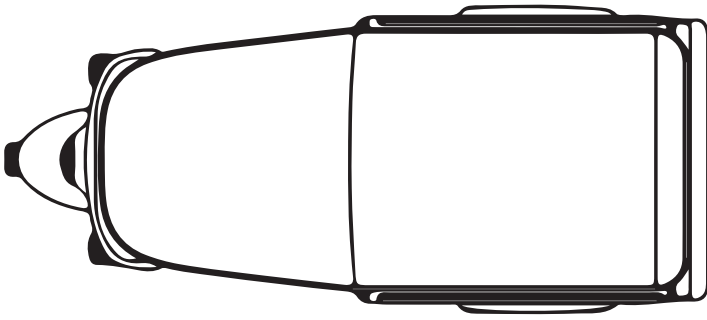
Package concept 6 fitting paramedic, driver and patient. The vehicle needs a trailer and have some room for equipment.



## Base Vehicle 04 - Bajaj RE



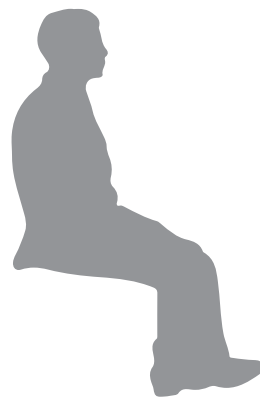
<b>Speed</b>	45 km/h	<b>Length</b>	264cm
<b>Accel.</b>	45km/h 12 sec	<b>Width</b>	130cm
<b>Range</b>	320km	<b>Height</b>	170cm
<b>Engine</b>	Gasoline	<b>Weight</b>	362kg
<b>Capacity</b>	8 l	<b>Capacity</b>	1200l
<b>Fueling</b>	1 min	<b>Power</b>	236cc



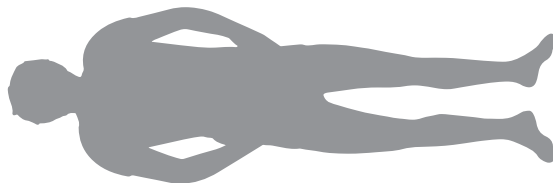
**Driver**

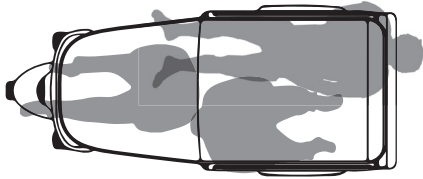


**Paramedic**



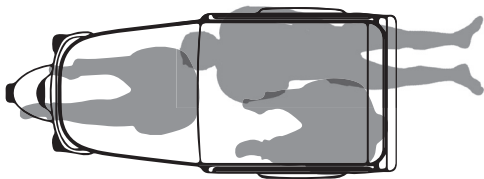
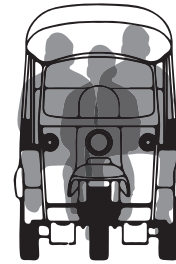
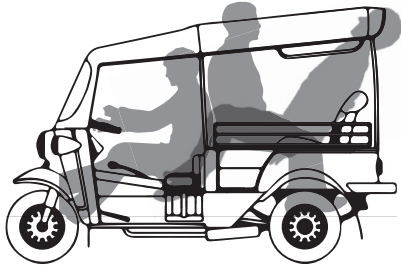
**Patient**





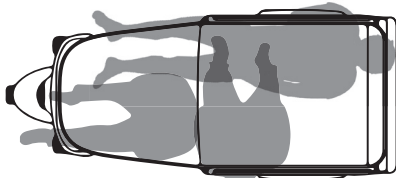
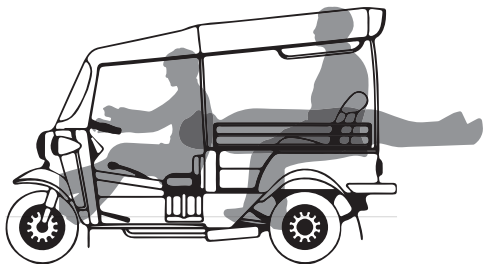
### Concept 1

Package concept 1 fitting paramedic, patient and driver. The patient cant lie down completely, but there are room for equipment and paramedic has a good work position.



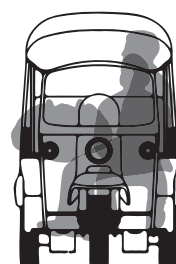
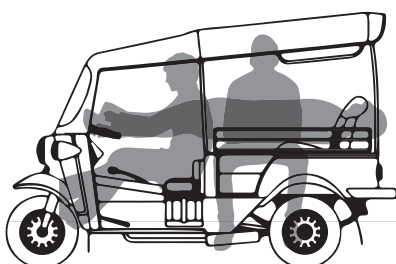
### Concept 2

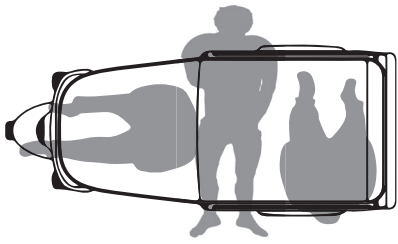
Package concept 2 fitting paramedic, patient and driver. There are room for equipment and paramedic has a good work position. The rickshaw has to be extended.



### Concept 3

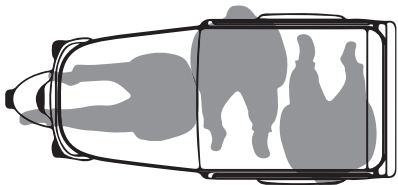
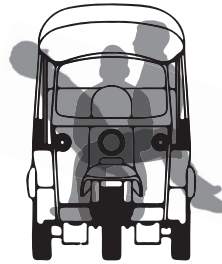
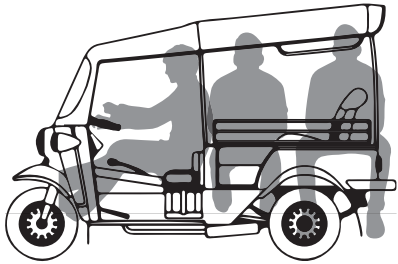
Package concept 1 fitting paramedic, patient and driver. The patient can lie down completely, and there are room for equipment and paramedic has a good work position.





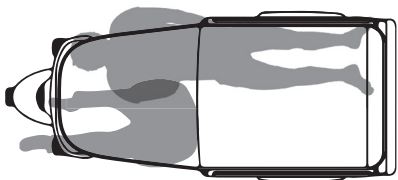
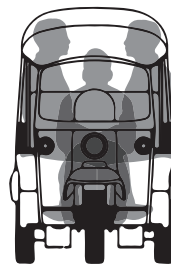
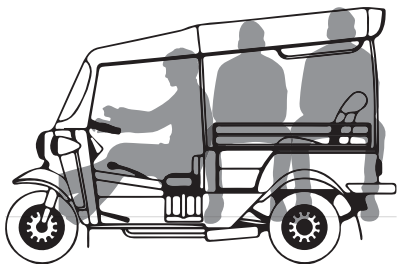
**Concept 4**

Package concept 1 fitting paramedic, patient and driver. The patient cant lie down completely, but there are room for equipment and paramedic has a good work position.



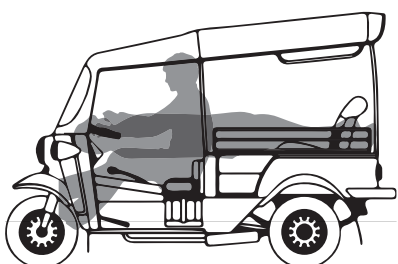
**Concept 5**

Package concept 1 fitting paramedic, patient and driver. The patient cant lie down, but there are room for equipment and paramedic has a good work position.

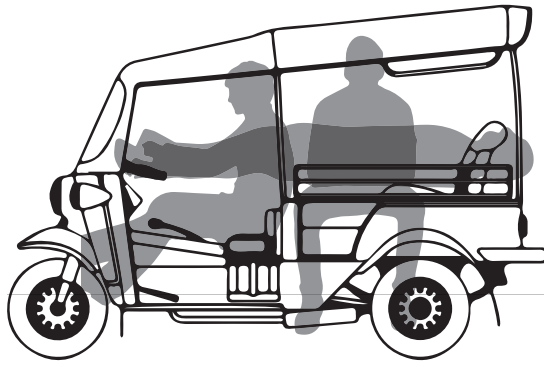
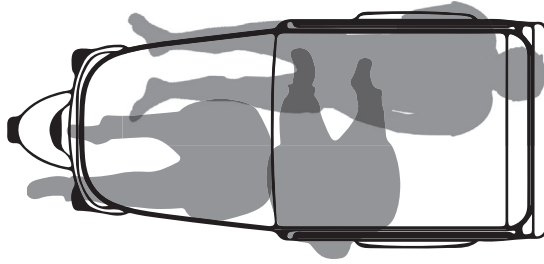


**Concept 6**

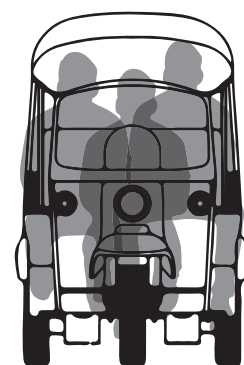
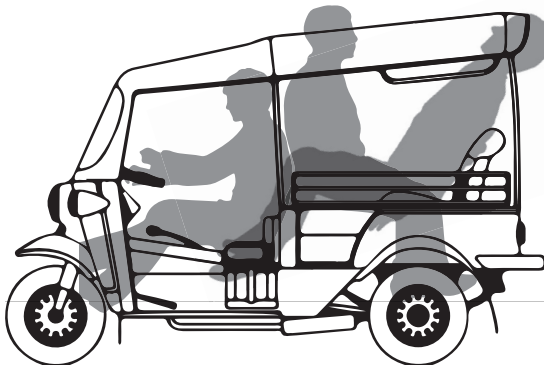
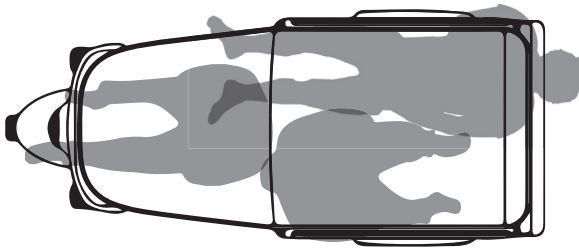
Package concept 6 fitting only paramedic and patient. The vehicle have plenty room for equipment.



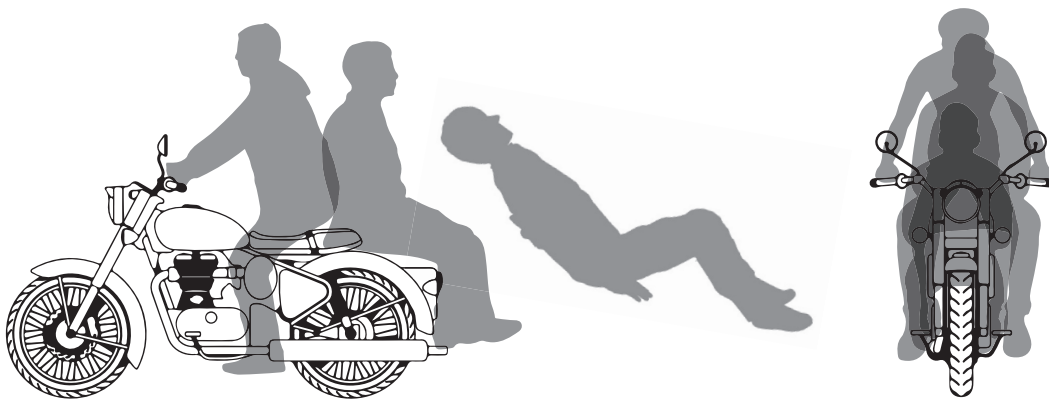
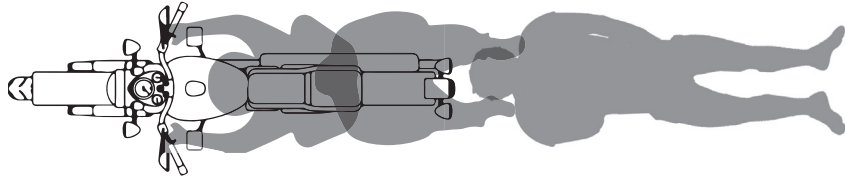
## Four Concepts



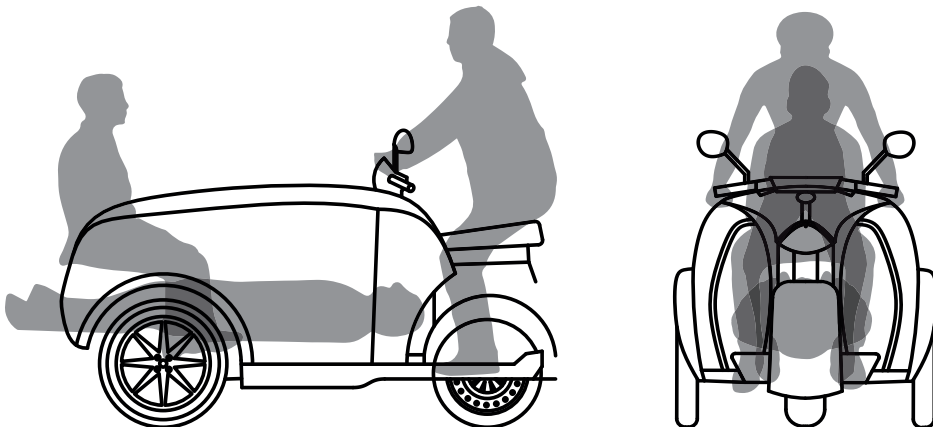
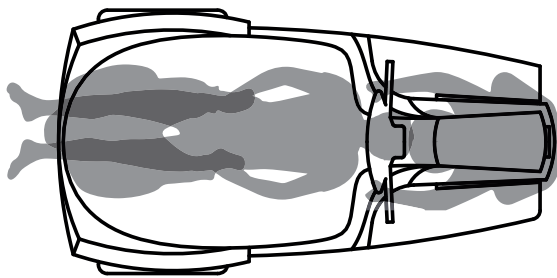
**Auto Rickshaw - Lying Patient**



**Auto Rickshaw - Resting Patient**



**Motorcycle with patient on trailer**



**Electric Scooter - Lying Patient**

## **Adding Essentials**

Through my field trip to Falck Station Taastrup I got key insights. One of them was defining the essential equipment needed to do paramedic treatment. Two jump bags containing all medical equipment, the ECG monitoring the patients vitals and a gurney for transporting the patient to and from the ambulance. I have tested the four concepts by adding this equipment and evaluating how much room it gave for the paramedic to work with the patient.





**Jump Bags** - 580 x 400 x 200mm & 500 x 400 x 300mm



**ECG** - max 640 x 240 x 200mm



**Gurney** - 2000 x 500 x 300mm



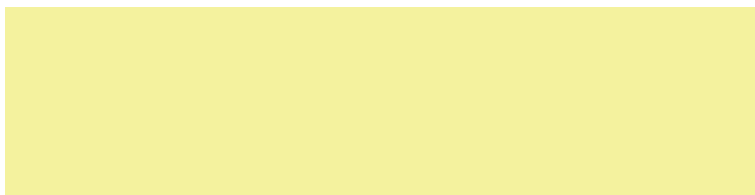
**Jump Bag 1 - AB**



**Jump Bag 1 - CDE**



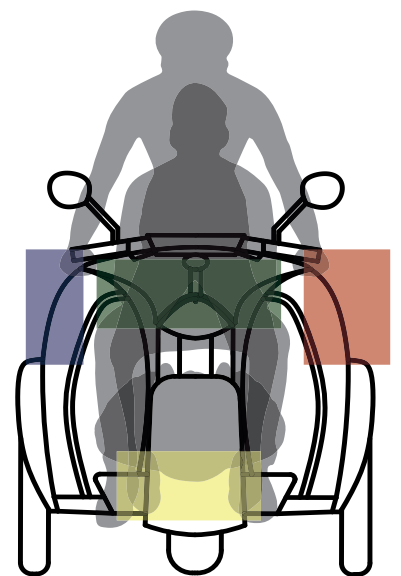
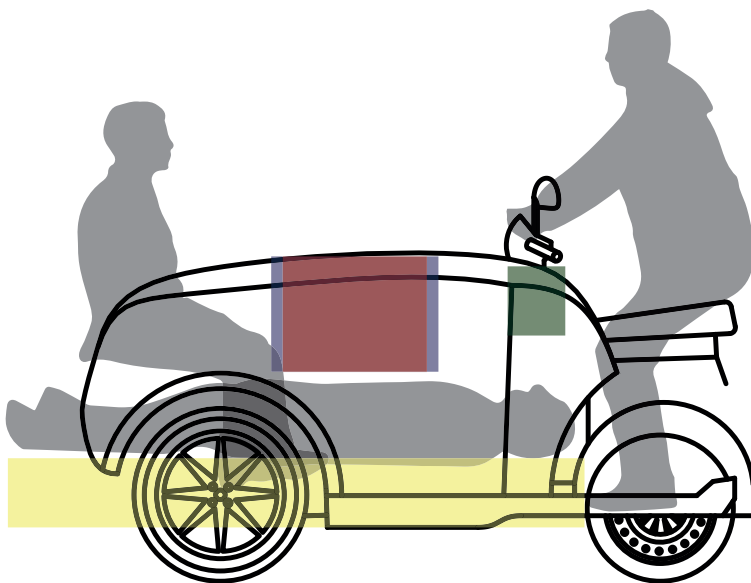
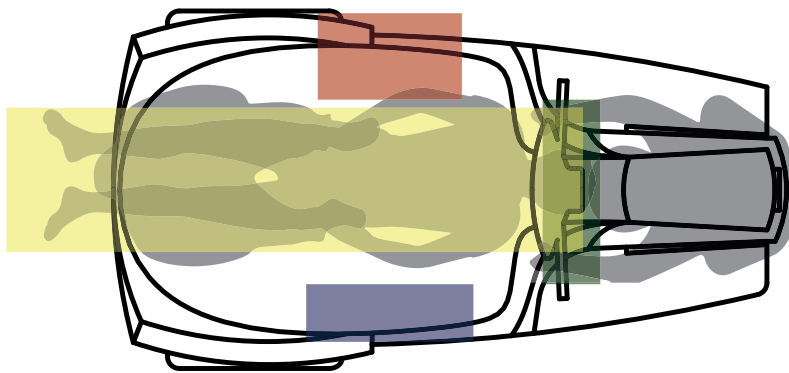
**ECG**



**Gurney**

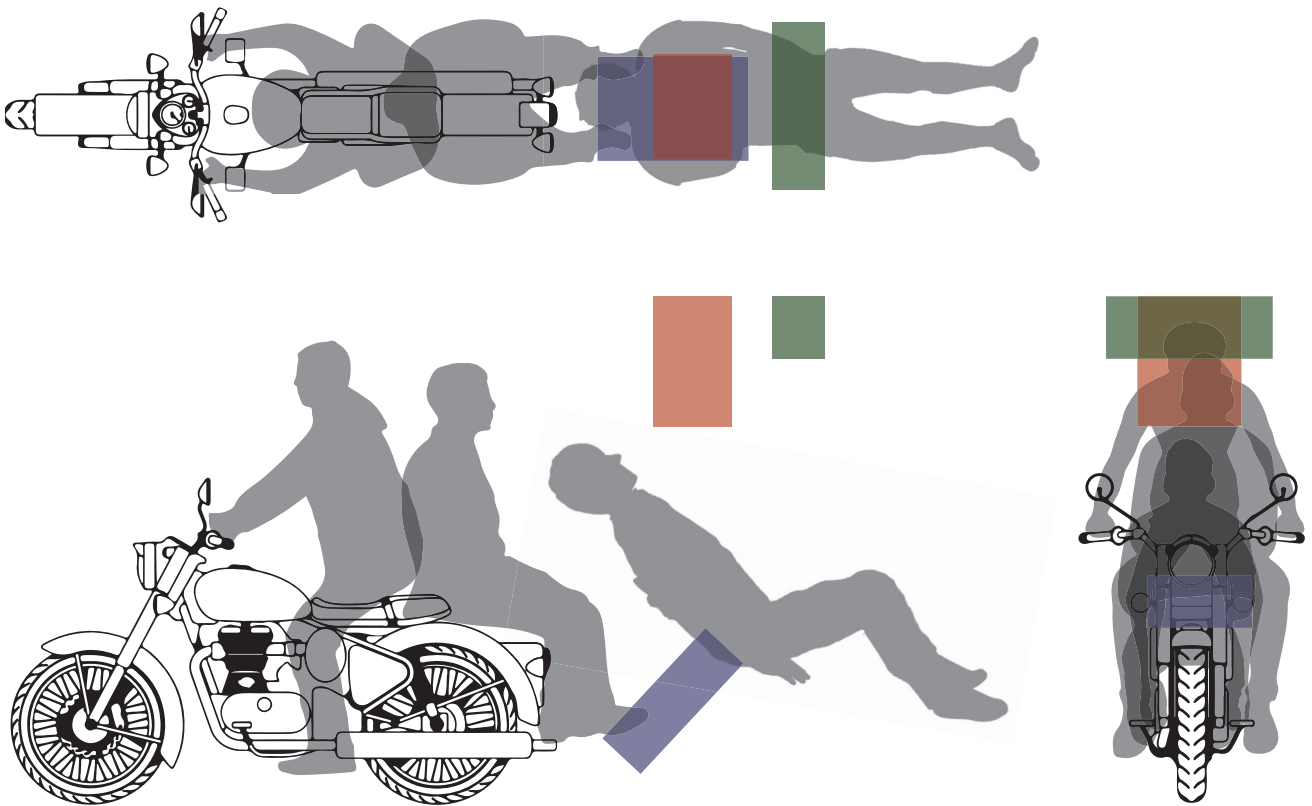
## Electric Scooter - Lying Patient

The Tripl Scooter gives room for both patient, paramedic and driver. There are room for all equipment, and it can be made accessible. The vehicle will only have to increase in length a bit. The driver has a fair view of the traffic - the patient has an acceptable amount of room - but the paramedic has a very poor working position.



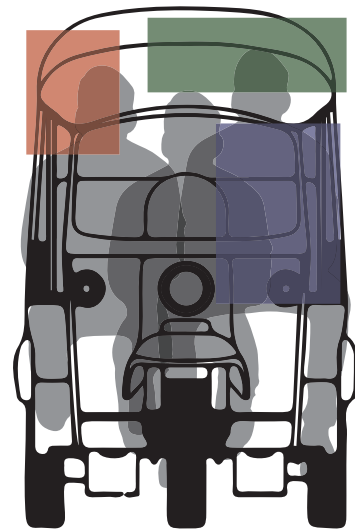
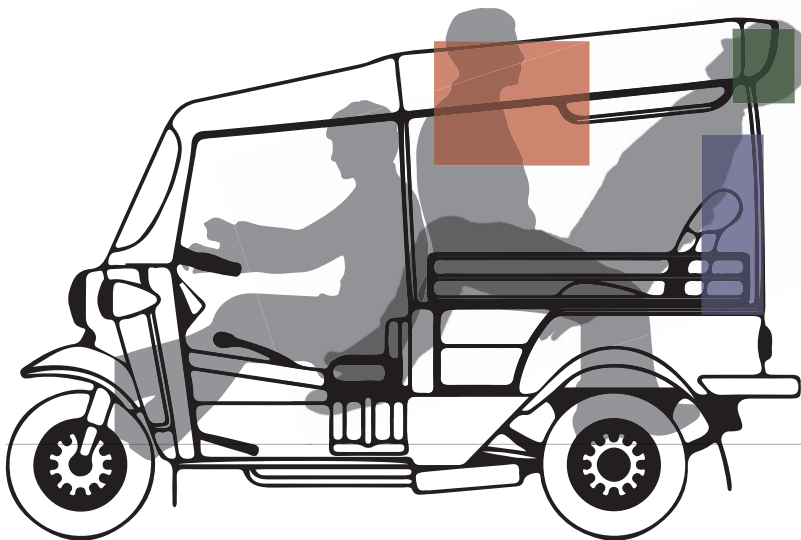
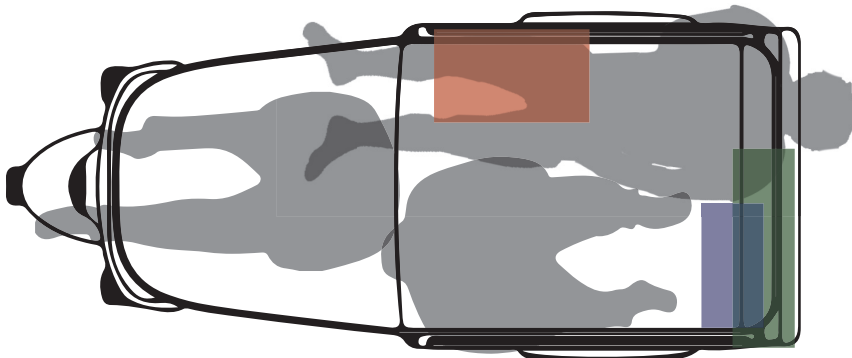
## Motorcycle - Patient on Trailer

The motorcycle gives room for both patient, paramedic and driver. But both patient, equipment and maybe paramedic as well, will have to be located at a separated trailer. In that way there are room for all equipment, but it is not very accessible. The driver has a fair view of the traffic - the patient has a poor lying position - and the paramedic have a very poor working position.



## Auto Rickshaw - Resting Patient

The first auto rickshaw concept gives room for both patient, paramedic and driver. There are room for all equipment, and it can be made accessible. The vehicle will maybe have to increase in length a bit. The driver has a fair view of the traffic - the patient has an acceptable amount of room but are not able to lie down - and the paramedic have an okay working position.

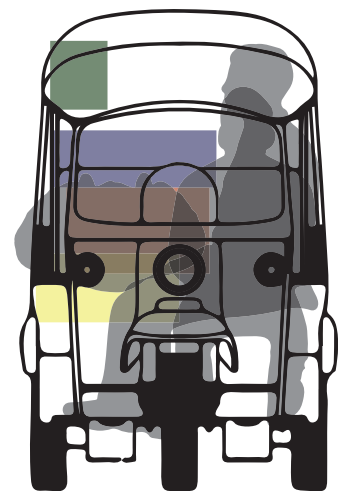
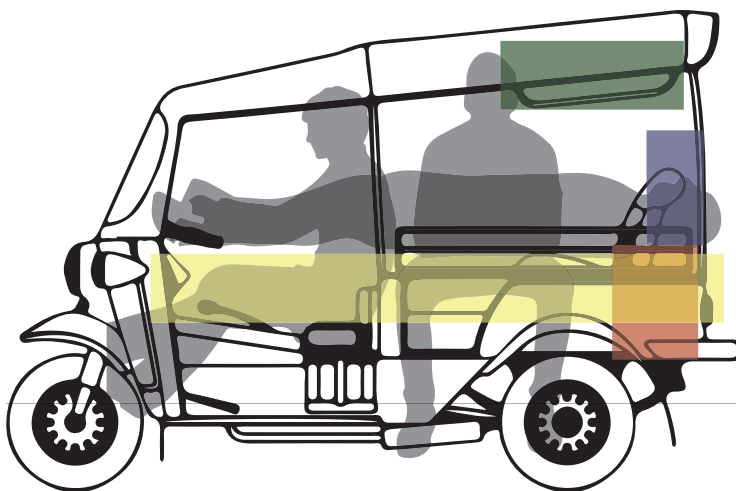
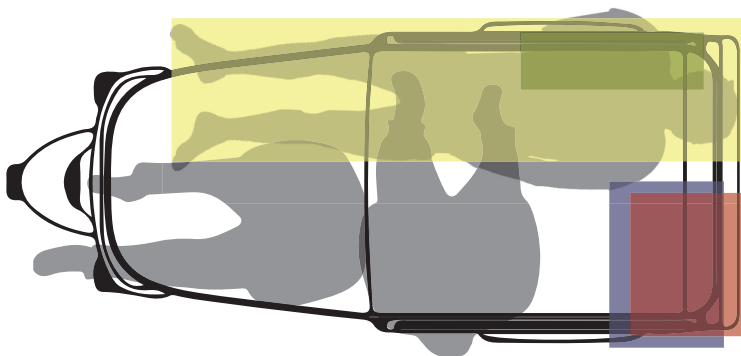


## Auto Rickshaw - Lying Patient

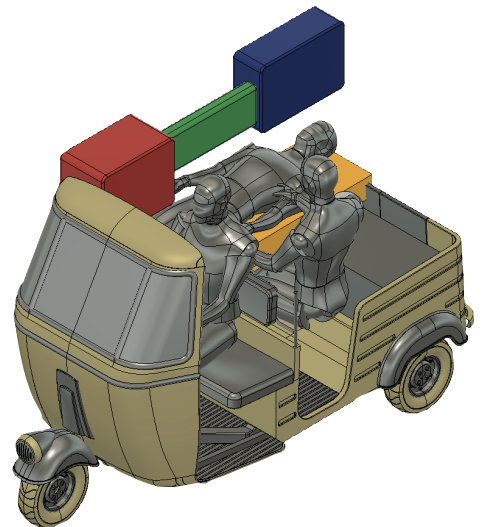
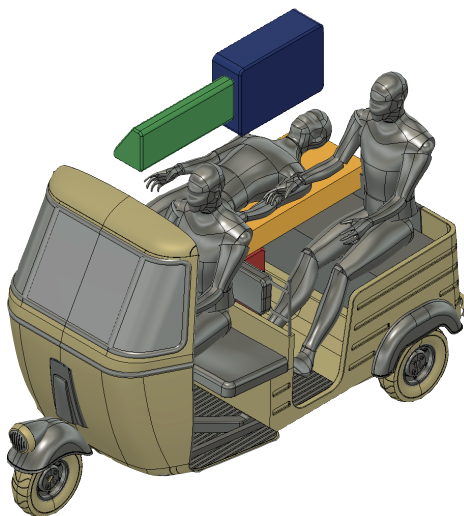
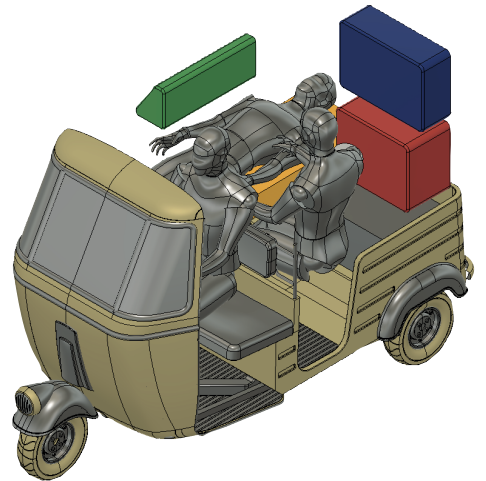
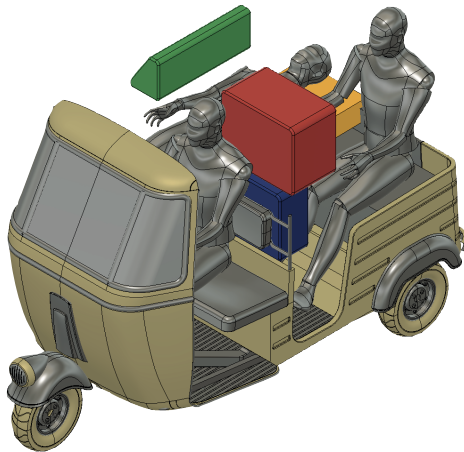
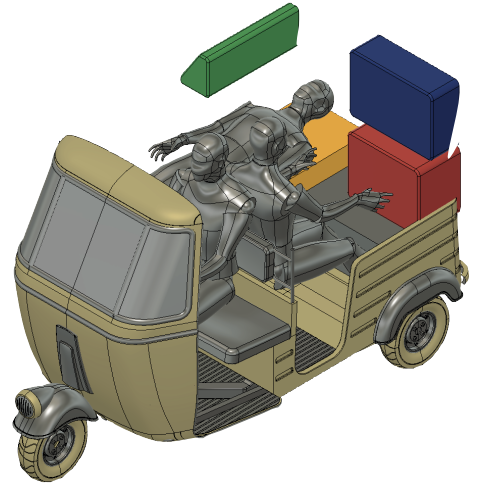
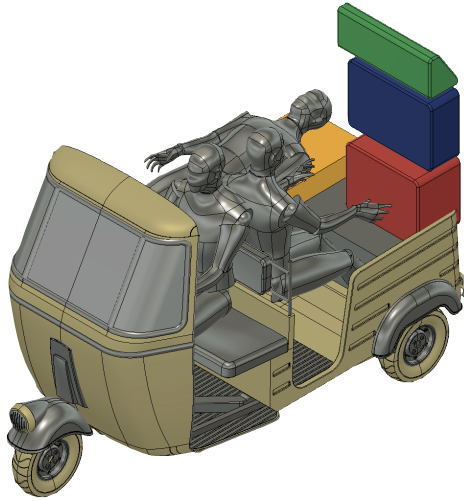
The second auto rickshaw concept gives room for both patient, paramedic and driver. There are room for all equipment, and it can be made accessible. Some of the internal structure of the ambulance will have to be modified. The driver has a fair view of the traffic but will have to move a bit to the left side to give room for the patient - the patient have an acceptable amount of room and are able to lie down - also the paramedic have a fair working position to both work with the patient and access all the equipment.

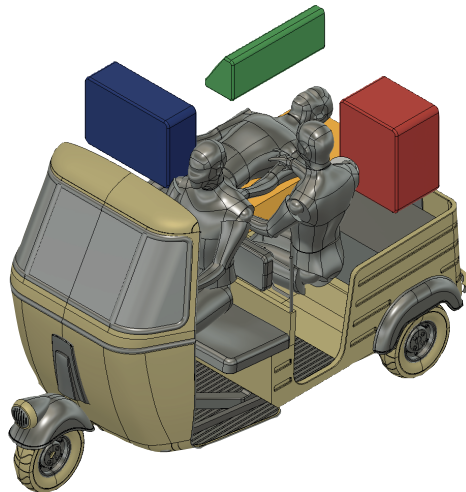
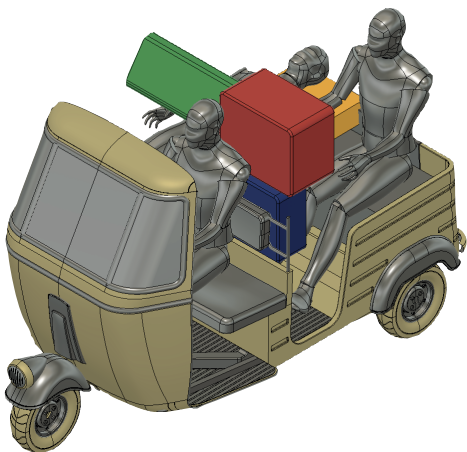
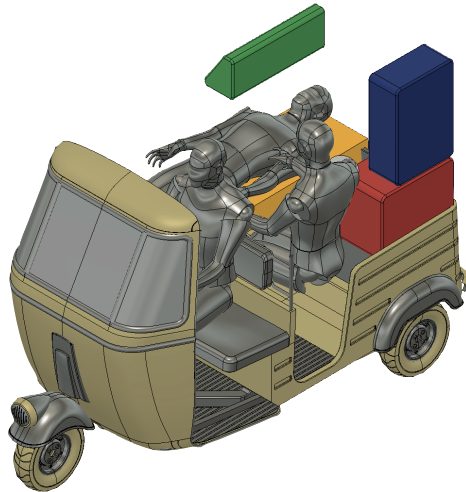
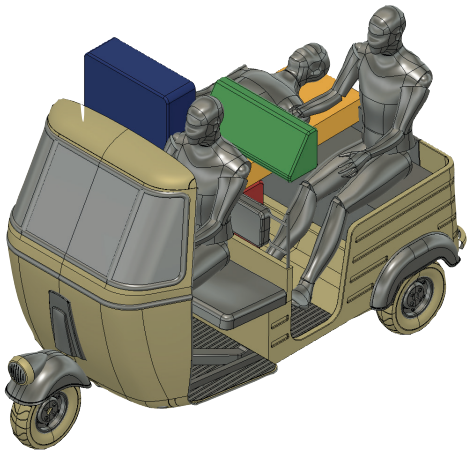
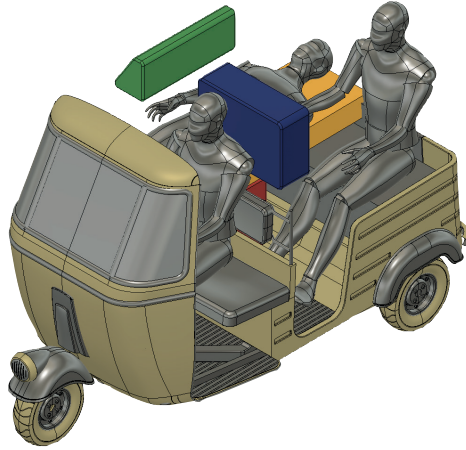
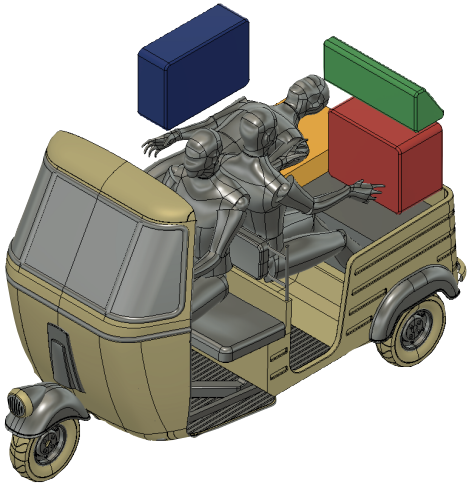
I have chosen to further work with this concept as it shows to be the best solution. Also, Bajaj is soon coming out with their Bajaj RE EV electric auto rickshaw, with a similar construction. A solution can therefore easily be transferred to electric more environmentally friendly vessel.

I have moved the process to 3D to further explore possibilities and problems.



## 3D Packaging - Lying Patient





## Concept - 3D Modelling



**Gurney** - The patient has room to lie down without increasing the footprint of the rickshaw.

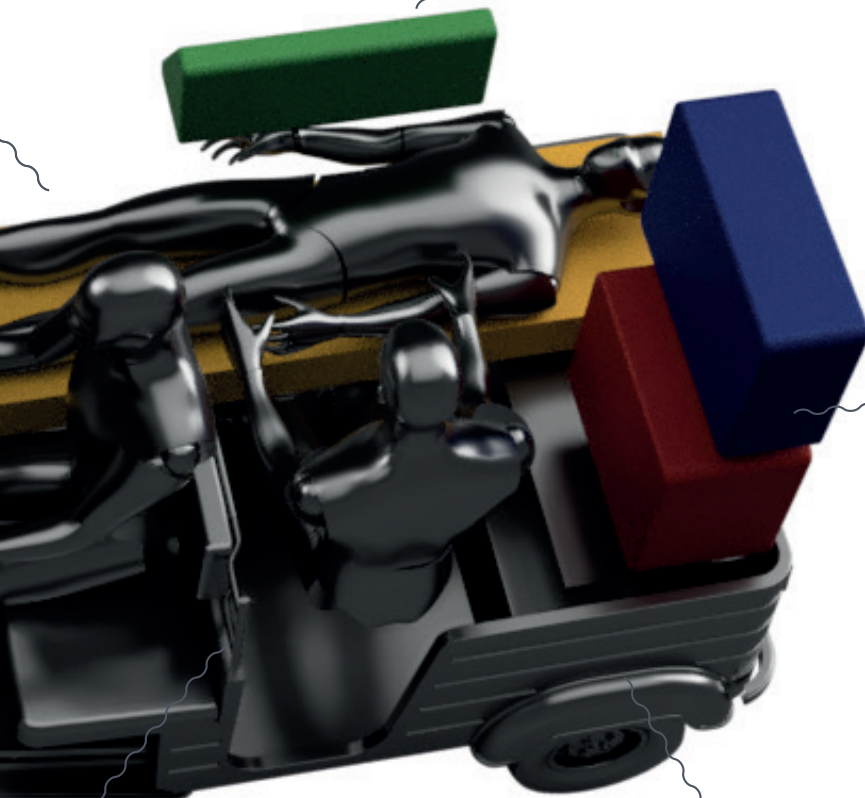


**Seating** - Room for the paramedics in the rickshaw. The paramedics can attend to the patient and the driver.



completely  
aw.

**ECG** - With easy reading for paramedic.  
Paramedic has easy access to accessories



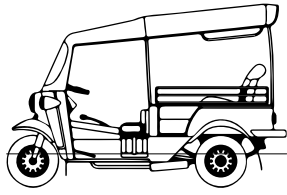
**Jump Bags** - The content  
of the jump bags can be  
accessed by the patient and  
also be reached from outside  
the ambulance.

the driver to steer the  
medic has access to both  
different tools.

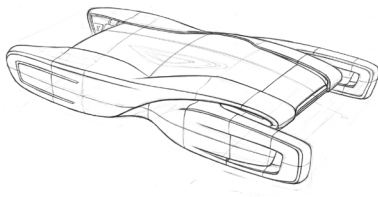
**Size** - The ambulance has room for all  
necessary equipment without increasing  
the footprint of the auto rickshaw

## **Directional Decision - Realism v. Reward**

In this part of the project, I had to make a decision on which direction I wanted the project to take. My initial thought was to make the design of the ambulance very simple and only make layout changes on the auto rickshaw and keep the exterior design. In my view this is the more realistic choice as one of my key goals is to make the ambulance as cheap as possible. But to give the project a higher educational value I have chosen to design a new exterior. Still with end price in mind I will try to design an ambulance that depicts certain expression. I have examined what these expressions could be through an aesthetic analysis of both ambulances and auto rickshaws. I have tried to give form to these expressions through sketching and hand modelling with clay sand.



MY  
COMPROMISE



## Aesthetic Inspiration - Ambulance Concepts



The impression of larger and embracing front window gives the impression of overview. This communicates that the ambulance sees you both for better and for worse!



Slightly bigger wheel base grounds the vehicle and gives an impression of stability.



The big nose indicates a strong ambulance which should be respected and deviated from.



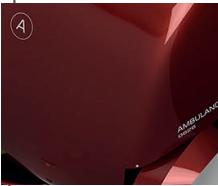
A very simple and monolithic shapes helps to bring out details, here the roof, that finds its way out of the base shape.



Checkers and green/yellow color are a requirement in Europe for reason - it increases visibility significantly.



The graphic lines of the shape of the ambulance almost makes the ambulance appear a bit smaller.



Simple graphic layout makes logos stand out more.



MEGA Electric Ambulance - MEGA1



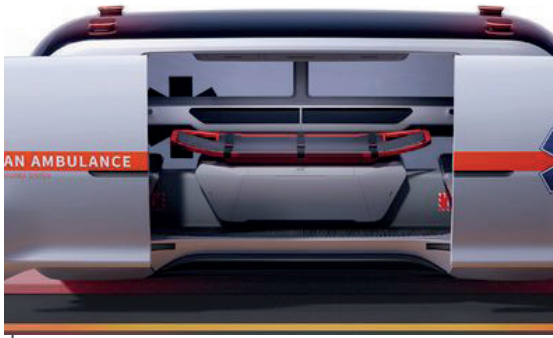
Ambulance 2 - Dmitrir Lecichin.



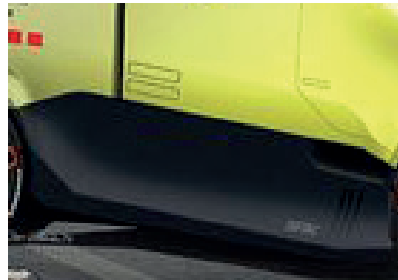
Nembot - Guillermo Callau



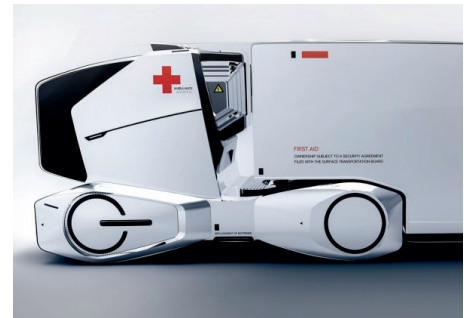
ERKA Autonomo ERKA+



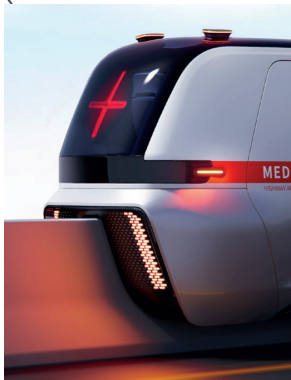
Two large sliding doors give a lot of room for handling the patient but also gives a feeling of openness to the ambulance.



The sharp color contrast between top between the yellow top and asphalt-grey bottom raises the ambulance from the road and gives it floating illusion. This makes the ambulance look more important.



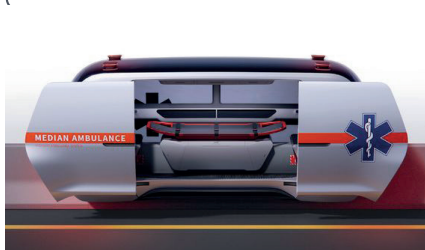
The technical aesthetics gives the ambulance professional and almost futuristic look.



Lights and outside screens help communicate to motorists around the ambulance and increases visibility.



The pointy front end of the ambulance communicate speed but also shows a vehicle that wants to "plow" its way through cars.



us Ambulance - Median AMB - Taek Lee



Renault Ambulance SEM - Daniel Velar De Segura



Mobile Medical Center - Jennifer Tian

## Aesthetic Inspiration - Three Wheeler Concepts



The monolithic bullet shape makes the vehicle appear heavy and dense. In contrast to its size it looks like it could move a bus.



Line in contrast color is framing in the passenger/driver area. Is clearly signaling that something is happening inside it.



Lines that is signalling power torque. It also divides the car in a motor/machine/engine part and a passenger/human part.



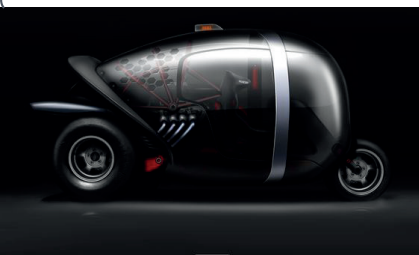
Wider and bigger wheels makes the ambulance more stable, and secure.



Hiding the wheel is giving the impression of the car is flying or hovering.



Subtractive form could function as external equipment.



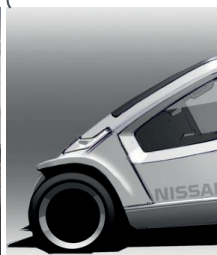
Dragster Tuk Tuk Concept



Muto



Lindo Smart Vehicle



Nissan Flex



*A big integrative form language with subtractive form elements gives the overall design an almost cute look.*



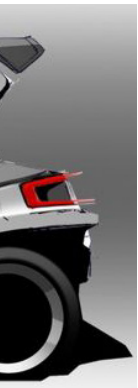
*Letting the body of the car go over the wheels gives more room for interior space.*



*Color contrasts underline form details.*



*Big doors give more room for moving patients in and out of the ambulance.*



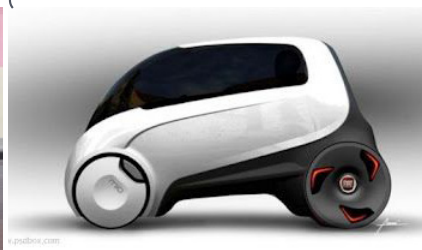
*elements holders for nt.*



*Letting the body of the car go over the wheels gives more room for interior space.*



*Havana Cuba - Tuk Tuk*



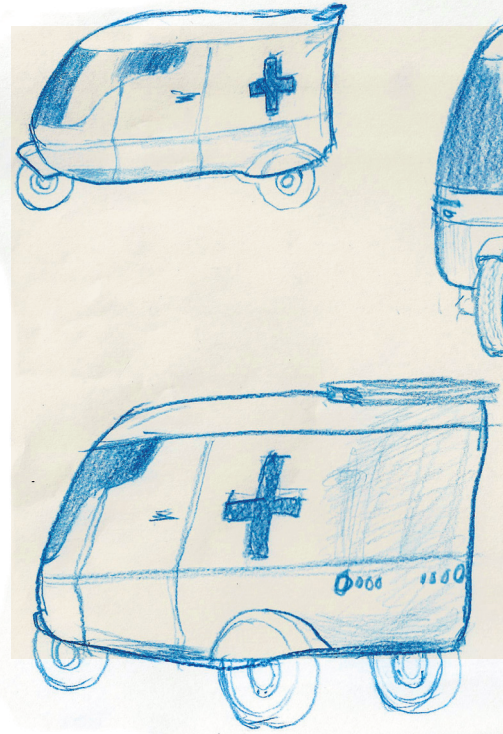
*Kancil EV II*



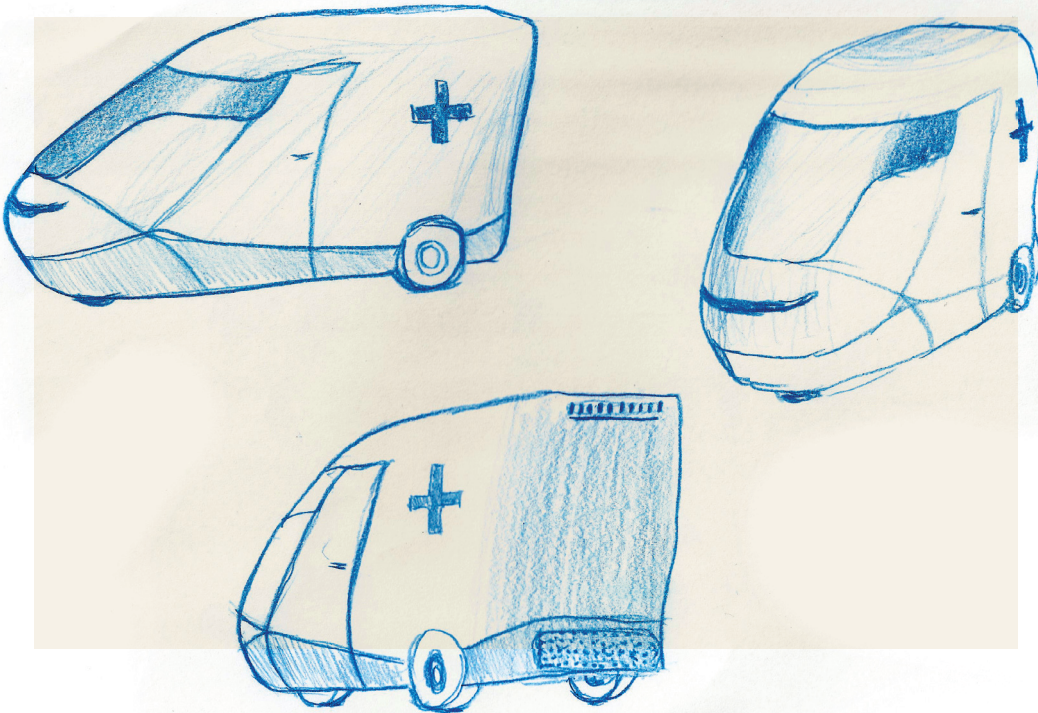
*Cleen Motion Zbee*

## Exploring Aesthetic - Sketching

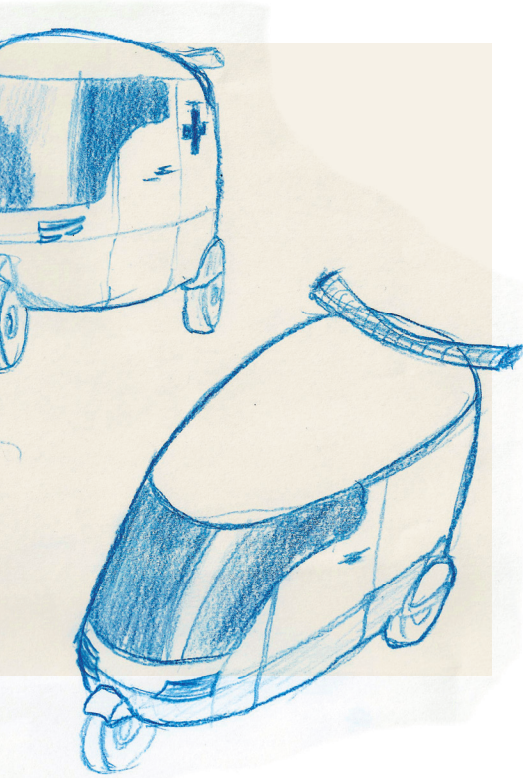
Concept 2



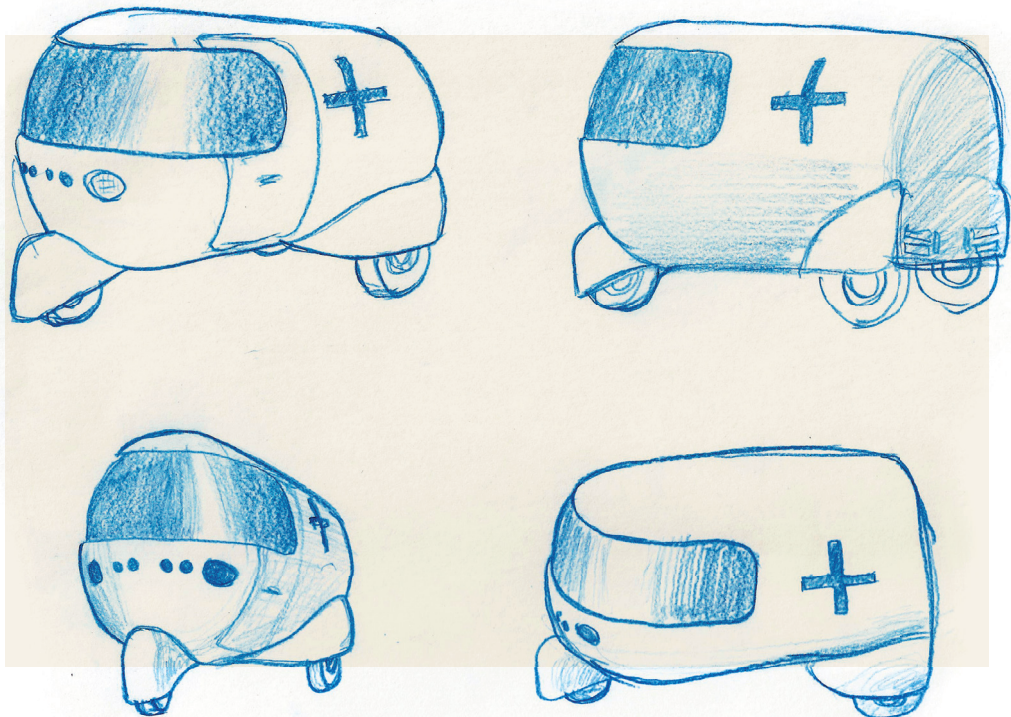
Concept 1



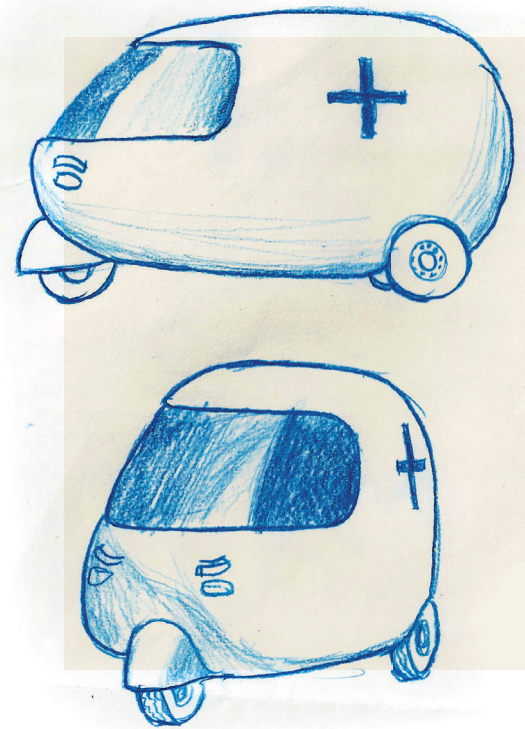




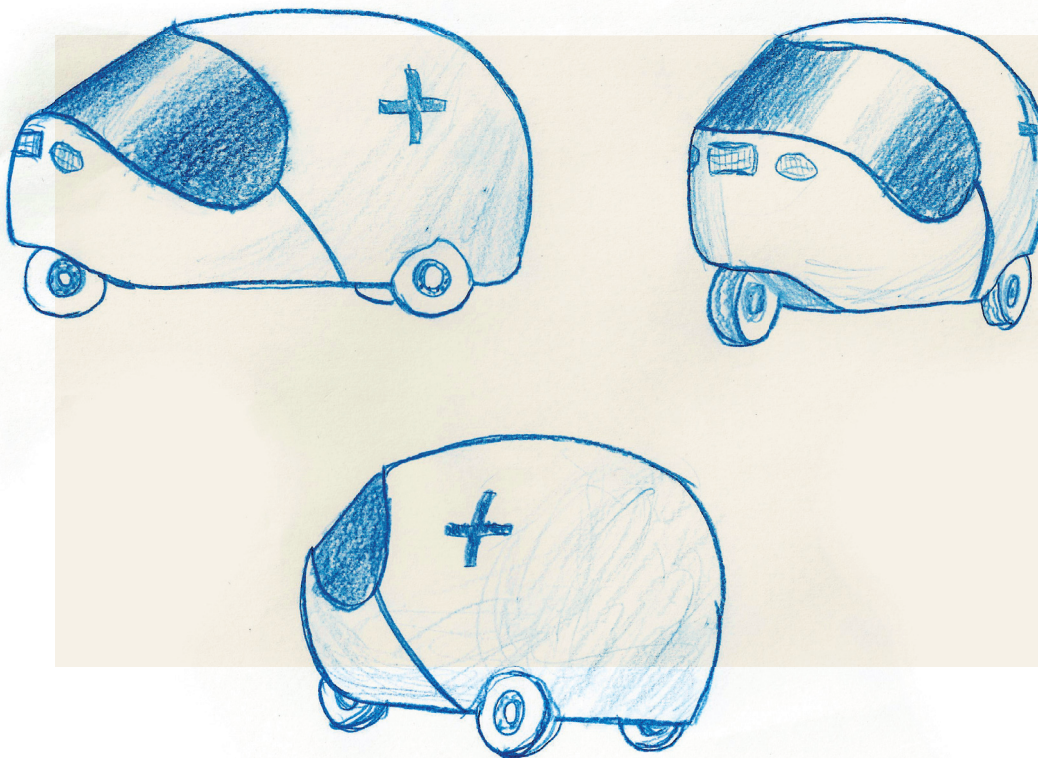
**Concept 3**

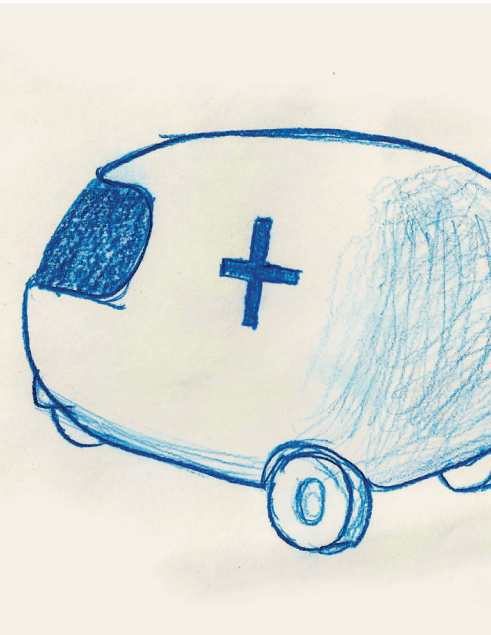


### Concept 5

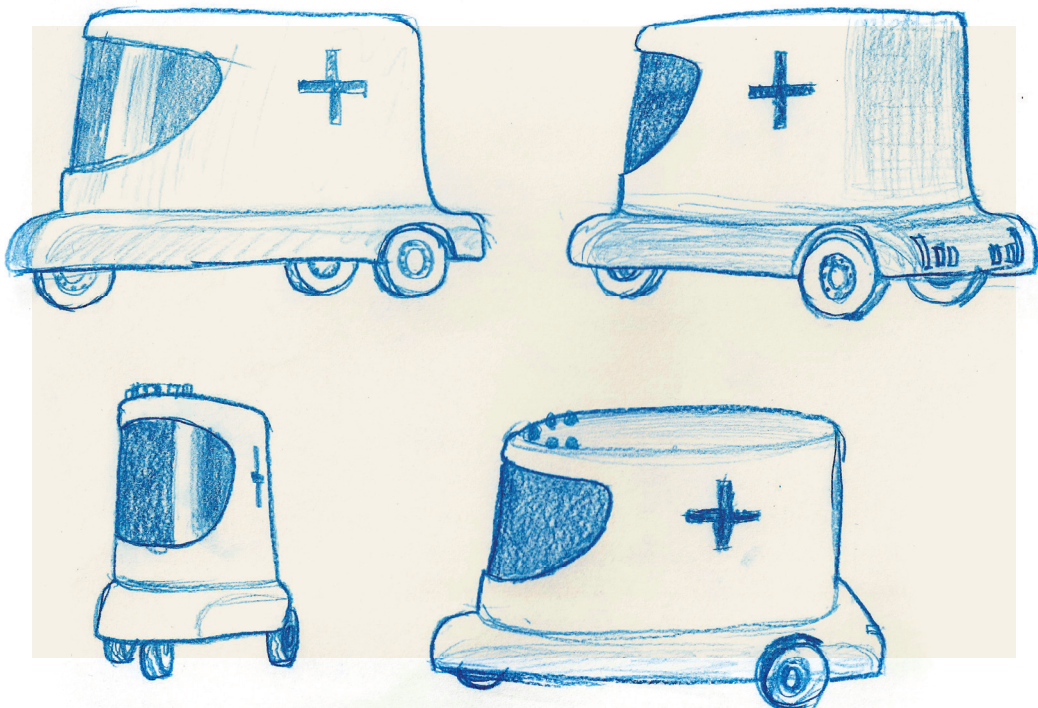


### Concept 4

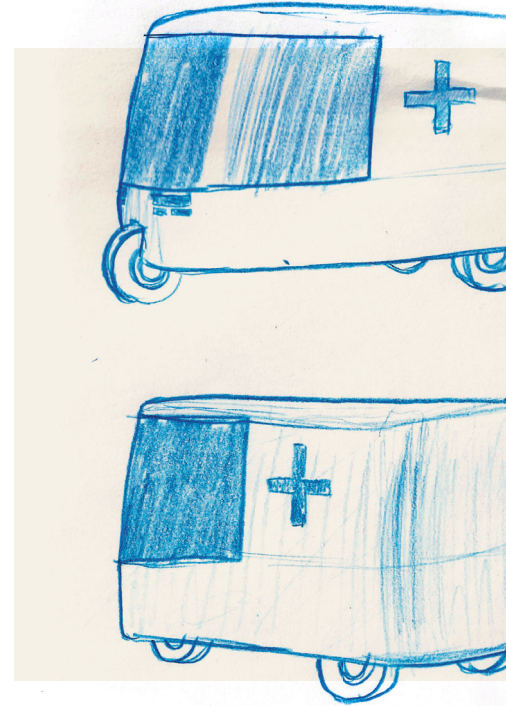




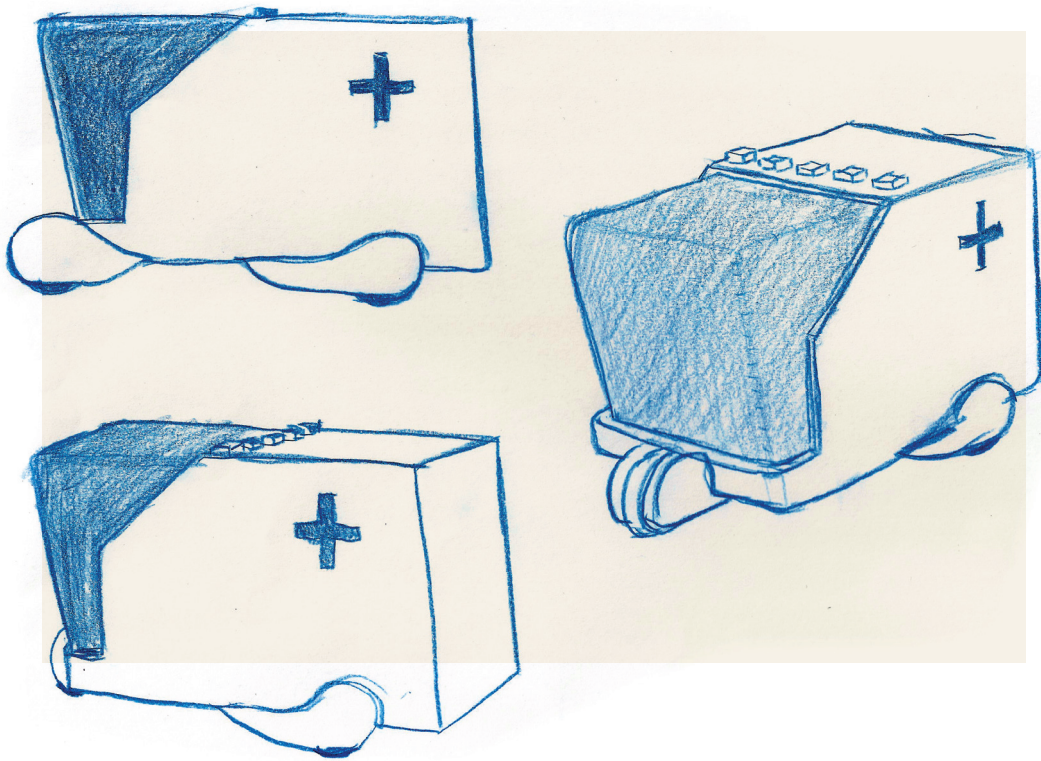
Concept 6

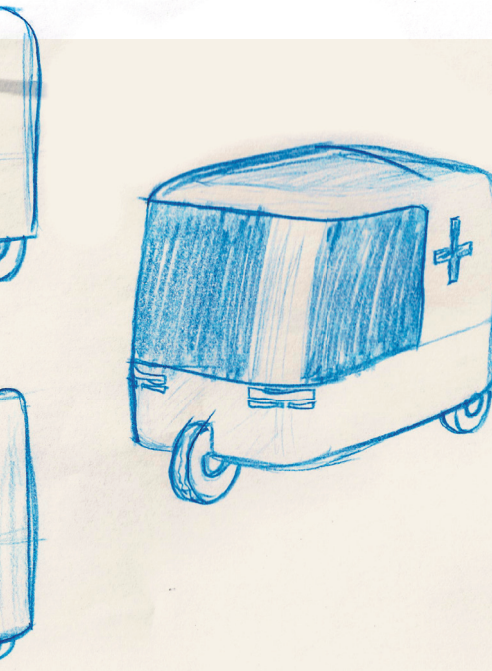


Concept 8

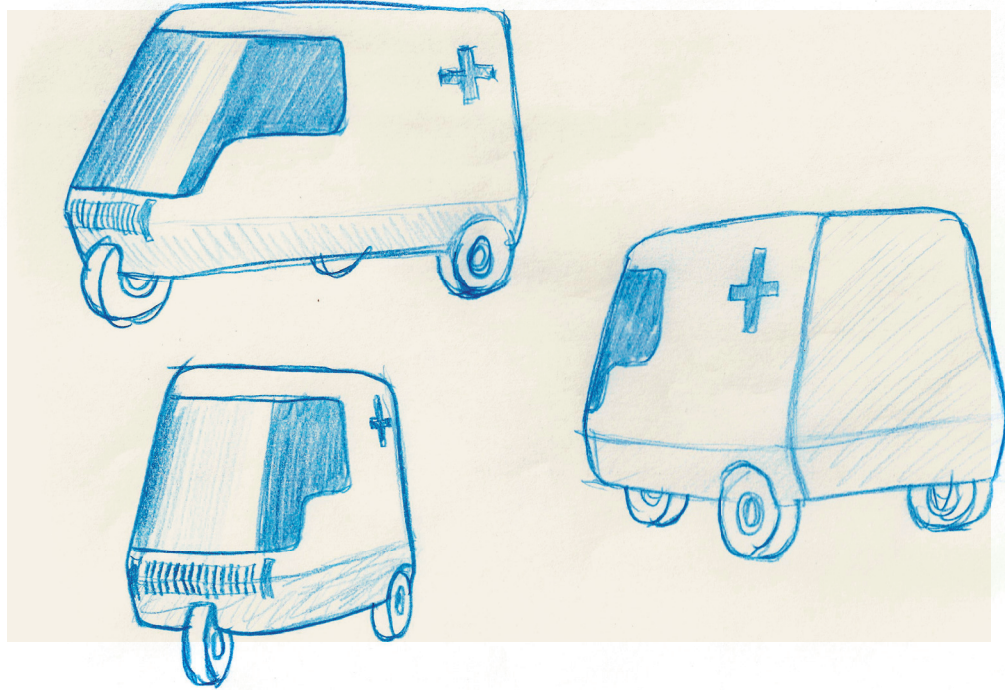


Concept 7



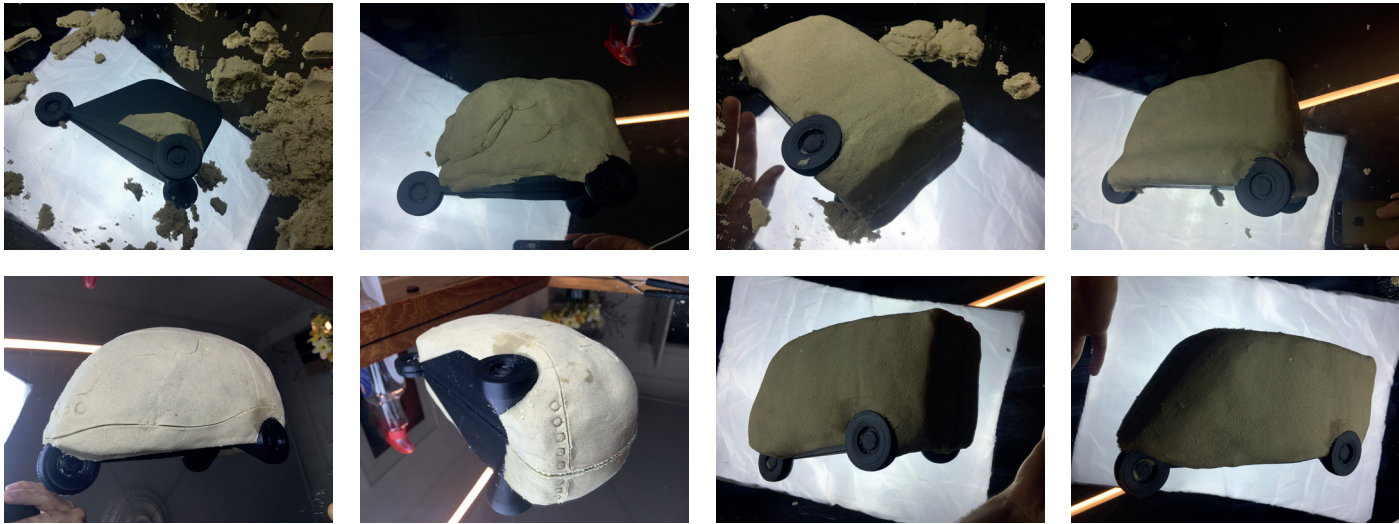


**Concept 9**



## Exploring Aesthetic - Clay Modelling

### Proces



### Concepts





## Exploring Aesthetic - Evaluations

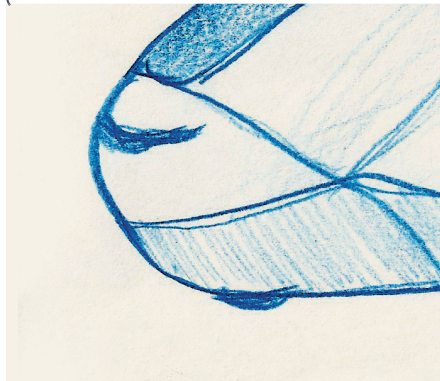
*Big tail gives more room to the insight of the ambulance.*



*A sharp nose is signalling to the other motorist to move out of the way and pierces through the traffic*



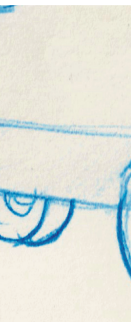
*A nose covering the front wheel protects it while making more room inside the cabin.*



*Slightly bigger wheels increases the stability in rough terrain and potholes, very relevant to cities in India.*



*Large openings for personnel with patients.*

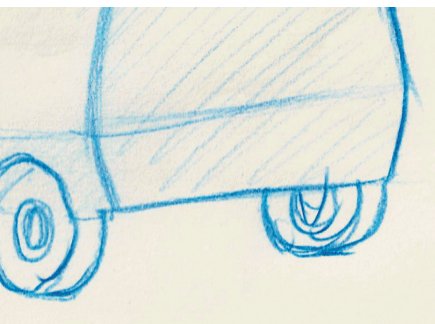


*A large footprint makes the ambulance grounded and increases the stability of the vehicle.*

*A big rounded nose is a welcoming contrast to the vehicle.*



gives better room  
when handling



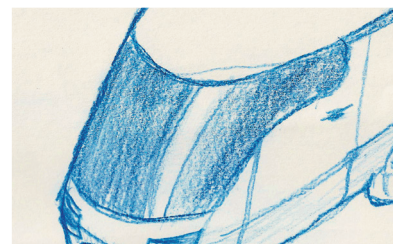
and tail is signaling a more  
posture, and is a sharp  
the more pointy nose of the

Lighting increases the visibility of the ambulance, but can  
also communicate the importance of the ambulance. Also  
messages like keep distance, move from the lane etc can be  
communicated through simple point screens.

The contrast between the bright green/yellow color and a dark  
grey skirt "pulls" the ambulance from the ground and almost  
makes it hover.



Letting the base surround  
the back vehicle protects  
the wheels and gives more  
room to the cabin.



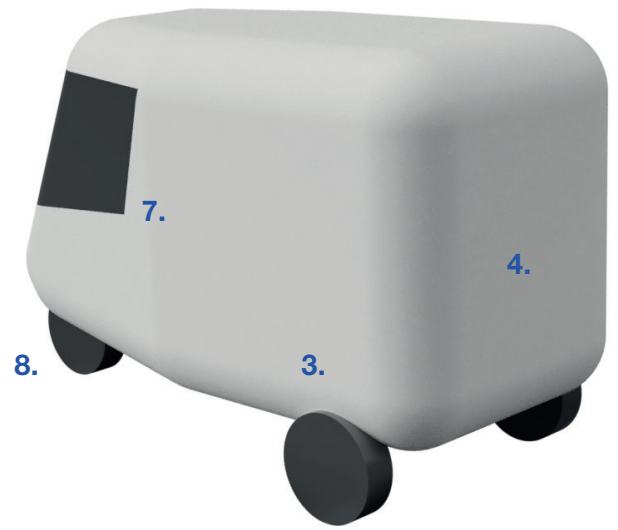
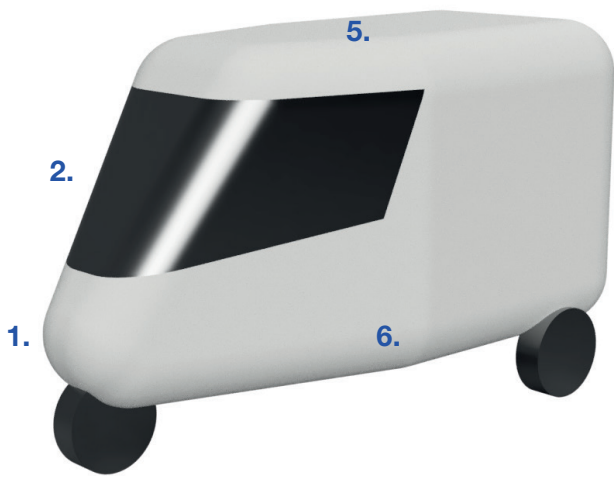
A larger front window  
increases the driver visibility  
and makes it easier to  
manoeuvre in tight traffic



## Requirements for construction & exterior design.

### Exterior

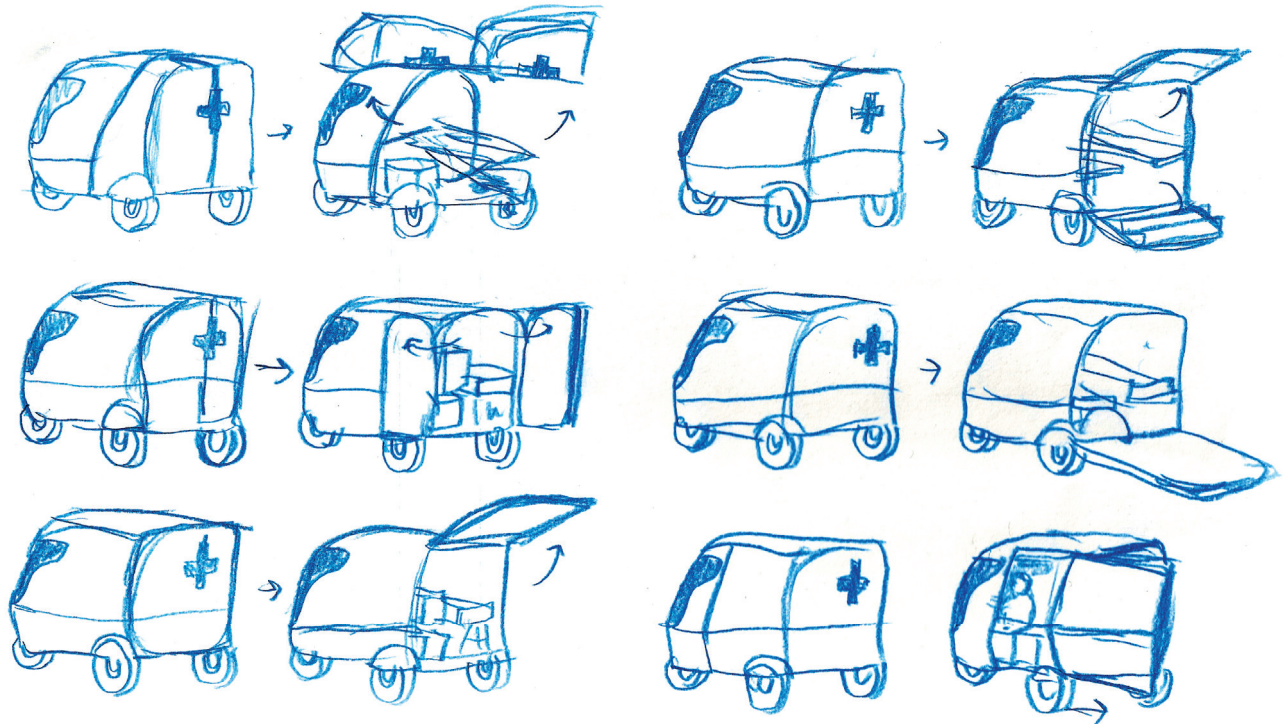
1. Apex front of ambulance. This is to give the ambulance a more aggressive look and signaling to other motorist to move. It also helps on the balance of the vehicle.
2. Large window to give driver a better overview of the traffic.
3. The hull of the vehicle should go to the outer edge of the back wheels, but no further. This is to give as much room for the patient, paramedic and the equipment.
4. A large rear part gives more room to load and unload the patient and equipment. A rounder rear also signals care to the patient and relatives.
5. The front, back and side of the ambulance needs a lot of lighting to signal to other motorists.
6. A skirt in a darker color divides the ambulance, and almost gives the impression of a hovering vehicle.
7. Large sliding door to give plenty of room to paramedics and driver.
8. A little larger wheels gives more credibility to the ambulance and gives more stability in rough terrain.
9. Adding bumpers to the front and side of the vehicles protects both the ambulance and fellow road users.



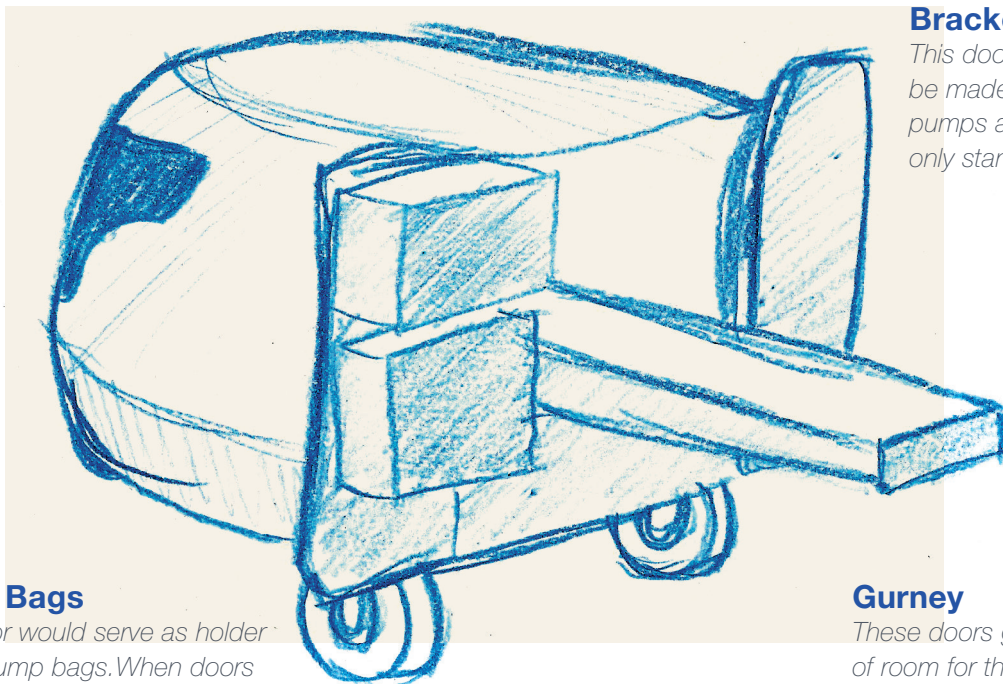
## **Tailgate**

Having a sketching session on the tailgate helped me to define how the patient can be placed in and out of the ambulance. Also, how the paramedics can access the jump bags and ECG.

## Sketching



## Double Swing Doors



### Jump Bags

The door would serve as holder for the jump bags. When doors are closed the paramedic has access to the content and when opened the paramedic can easily place and grab the bags.

### Brackets

This door system can be made cheaply as no pumps are needed, but only standard brackets.

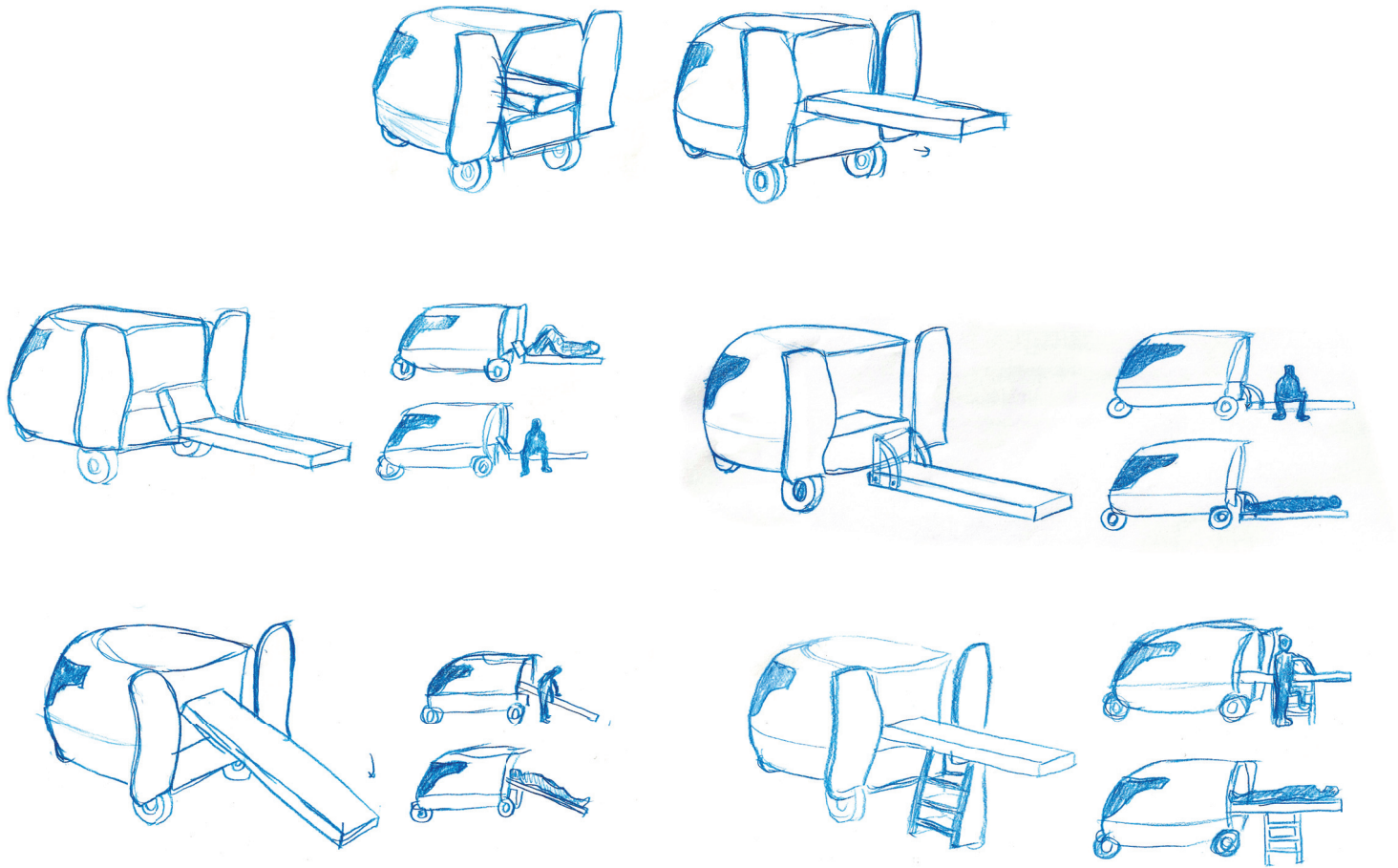
### Gurney

These doors give plenty of room for the gurney to be slid in and out from the back of the ambulance.

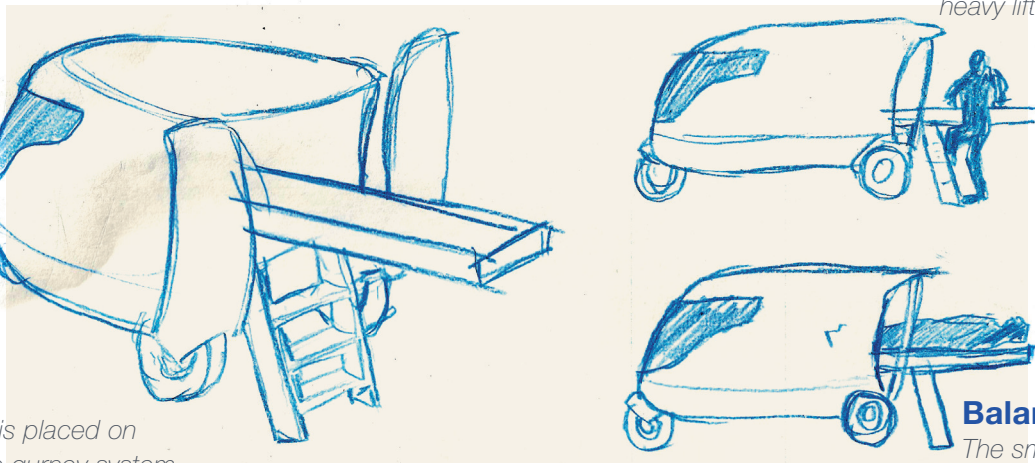
## **Gurney**

Having a sketching session on gurney helped me to define how the patient can be placed in and out of the ambulance without implementing complex, technological and expensive equipment.

## Sketching



## Ladder on ambulance



### Durability

If the ladder is placed on the door, the gurney system needs fewer moving parts and increases the durability

### Accessibility

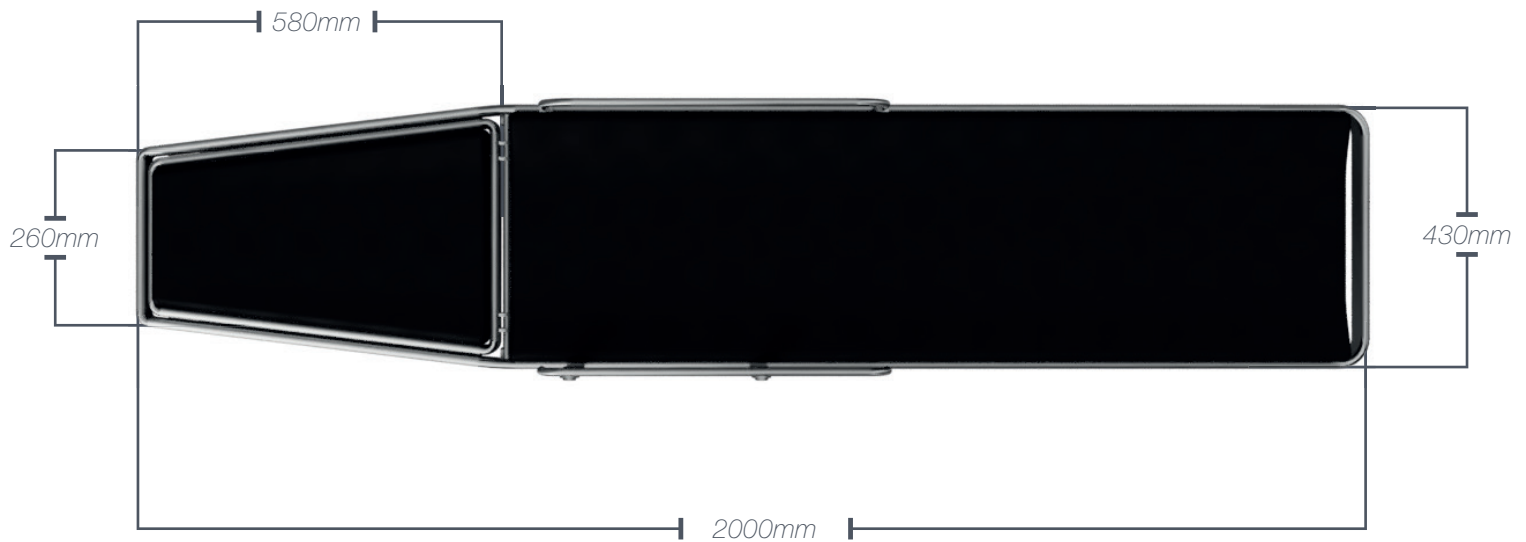
The patient, if capable, needs to climb the ladder. But the ambulance personnel avoids heavy lifting.

### Balance

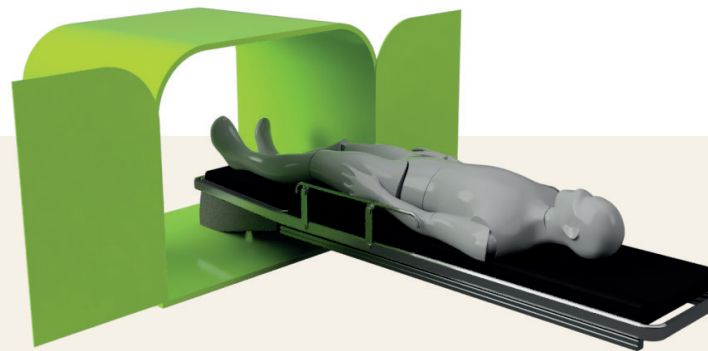
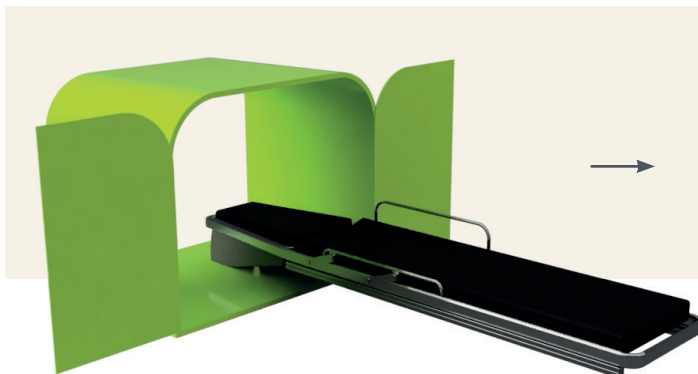
The small size and weight of the ambulance, means that the gurney can only be partly pulled out to avoid tipping.

## Gurney

The gurney is the same length as danish ambulance gurneys, but 70mm narrower. The gurney is narrower at the feet end and folds down when pushed in place. This gives more room for the driver and protects him from kicks from the patient.



*Gurney pulled out of the  
ambulance tailgate*

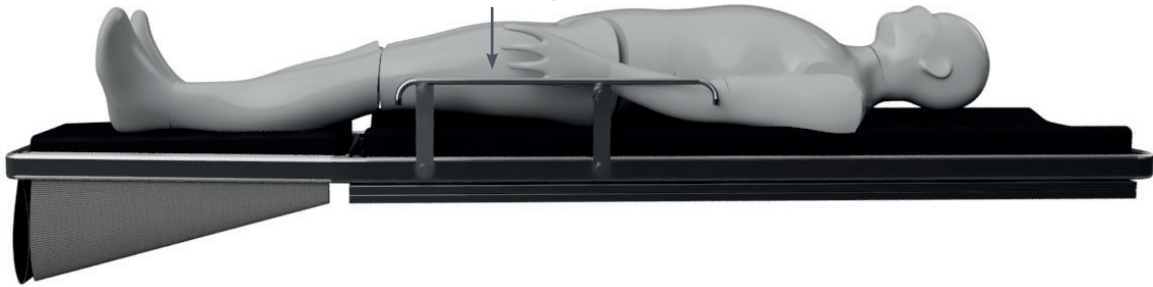


*Patient are crawling or placed  
on the gurney*



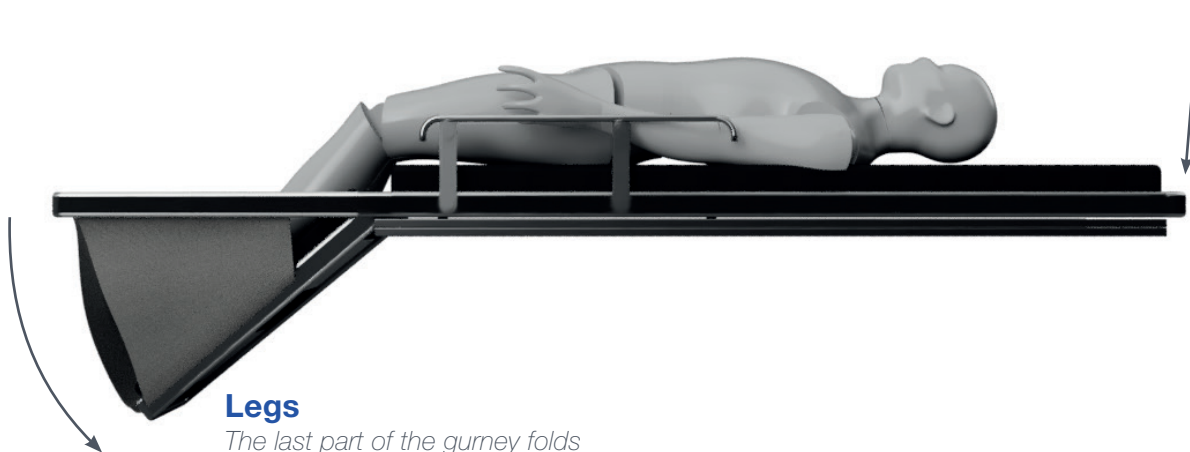
### Railing

Adjustable rail on the paramedics side ensure that the patient can climb and leave the gurney and are secured during transport.



### Handle

Simple handle part of the gurney frame to pull and push the gurney in place.

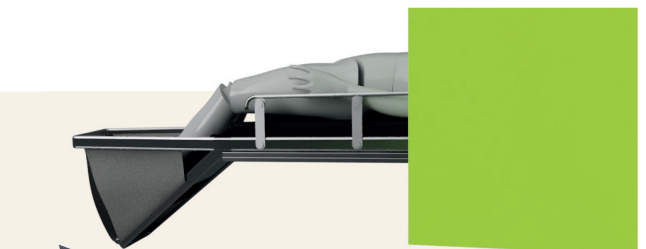
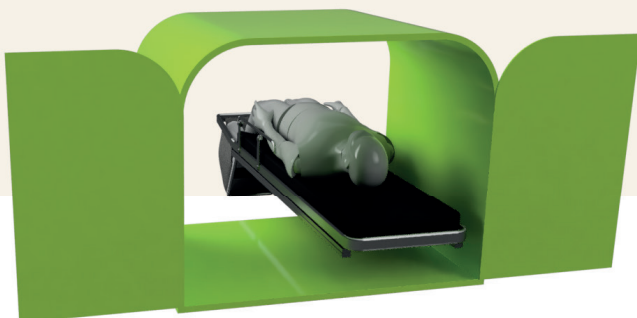


### Legs

The last part of the gurney folds down and covers the patients legs. This is need to give more room for the driver, but also protects him from kicks.



The gurney are pushed back in the ambulance

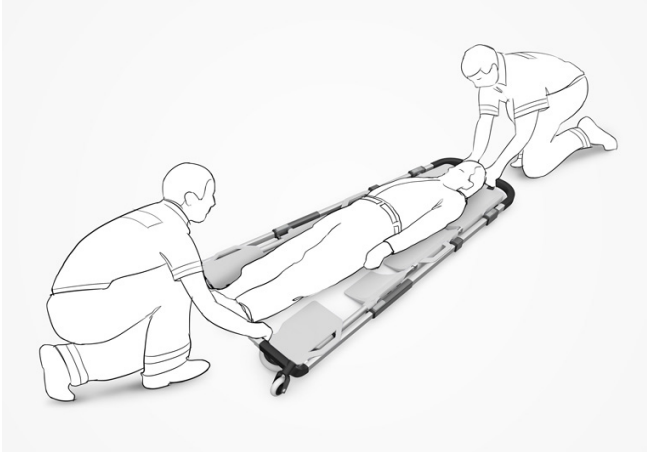


The gurney is slightly tilted and the legs are folded down to give more room for the driver

## **Scoop Gurney**

As the gurney is fixed to the ambulance a scoop gurney is needed. Optimally the patient can climb the gurney himself - but if not, the paramedics needs to transport the patient. I have chosen to use this scoop gurney made by a Dutch engineer company. It serves as a gurney, scoop gurney, wheelchair and can be packed to take up very little space.

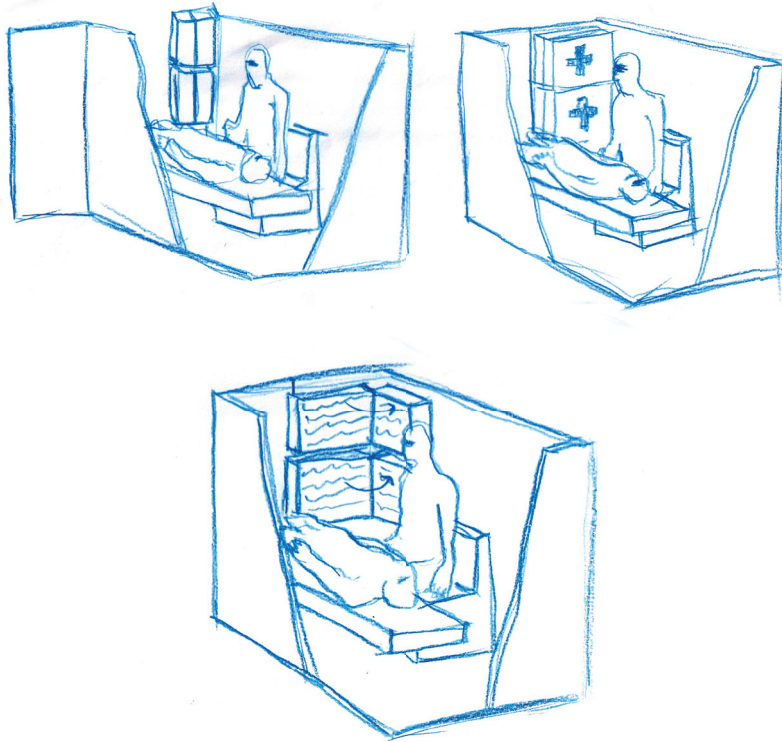
**Multi Scoop Pro by Studio Rotor**



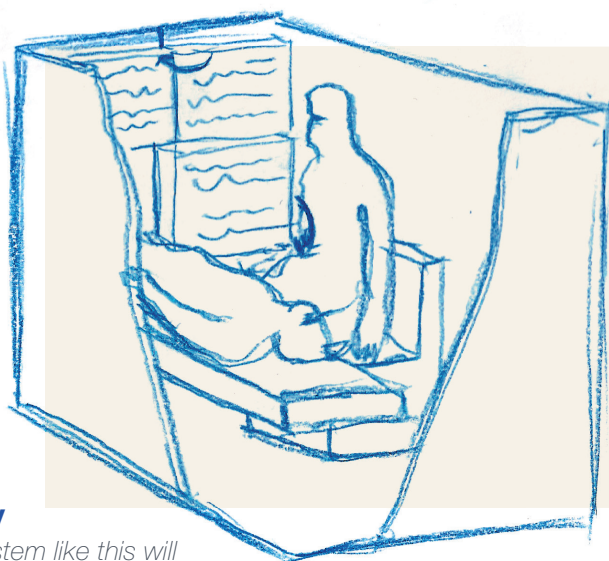
## **Jump Bags**

Having a sketching session on the jump bags helped me to define how the jump bags can be placed so the paramedic both have access to the equipment inside the ambulance as well as easily being able to take them from the ambulance to the place of injury.

## Sketching



## Jump bags on door folding in

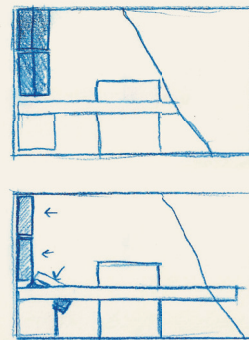


### Simplicity

A simple system like this will improve of the final cost and durability of the ambulance.

### Accessibility

The paramedics needs to have acces to all equipment, when placed in ambulance. While easy bringing the bags when leaving the ambulance.

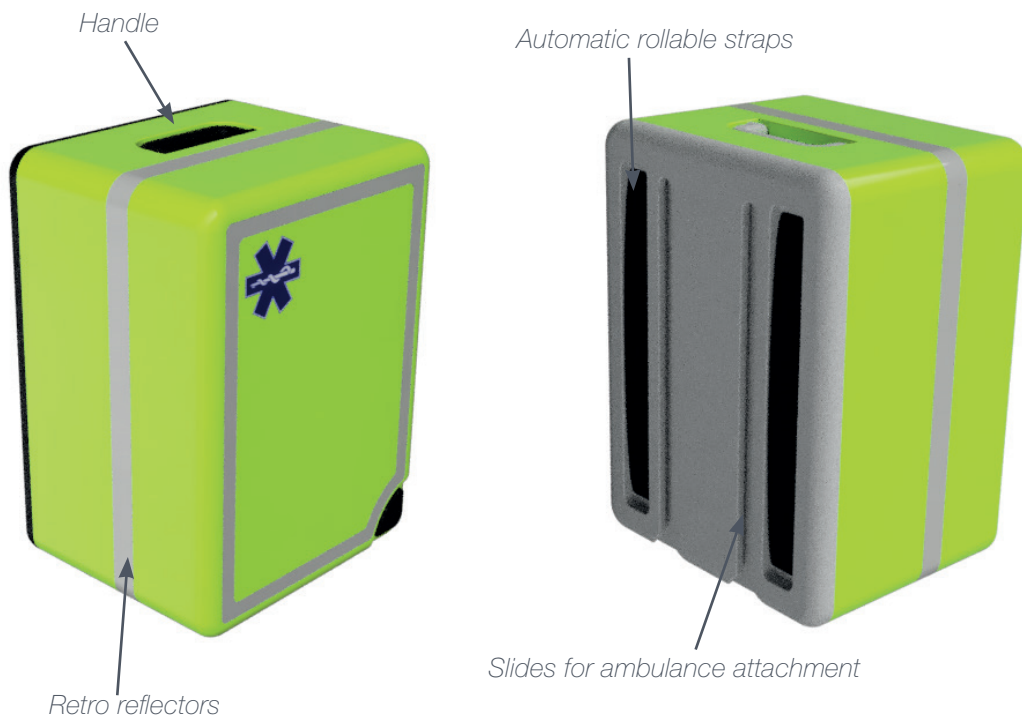


### Focus

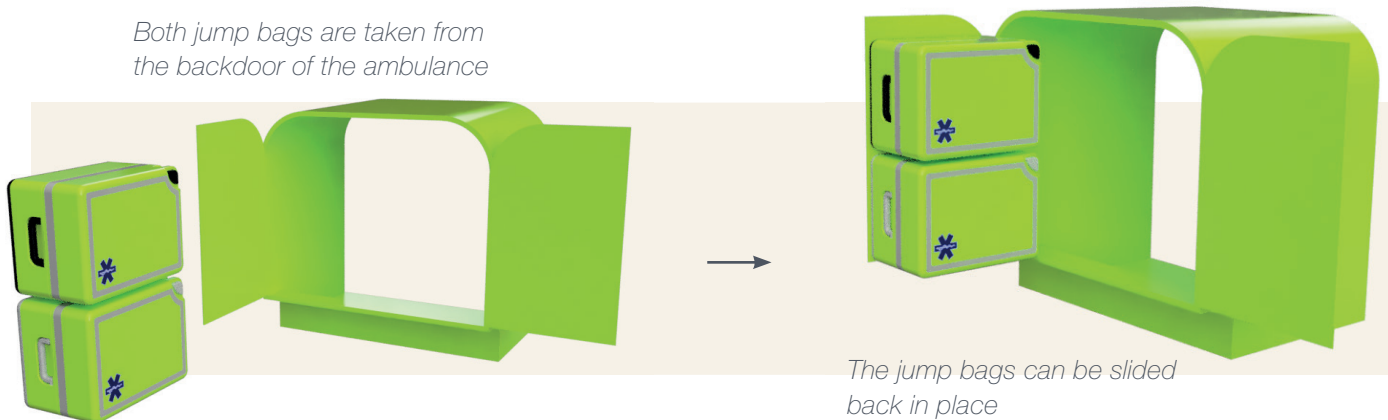
I need to find a solution to quickly attach and detach the jump bags.

## Jump Bags

The ambulance needs two jump bags, carrying all equipment. The jump bags can then be carried to the place of injury.

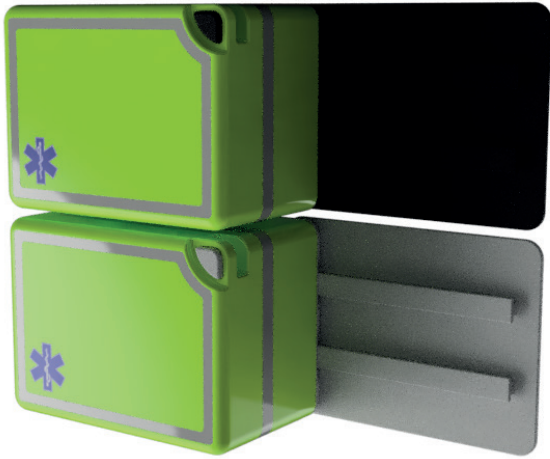


Both jump bags are taken from  
the backdoor of the ambulance



### Slide

The bags can be slid in place on the back door and locked tightly in place when driving in two colors for correct attachment.



### Content

All medical equipment are available from the big compartments.



### Transport

The jump bags can be brought to place of incident either as a ruck sack or a brief case

The paramedic now have acces from inside the ambulance

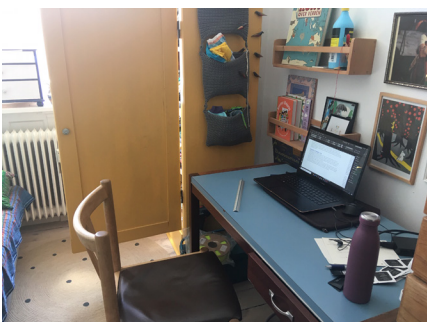


The jump bags can be opened and all equipment is now available

## Testing Proportions

I have continuously tried out different proportions, trying to validate the concepts. I have used my own body as measurement, and used a scale factor of 1:0,9, because of my height relevant to average height in India. I have tried out seat heights and positions, patient in lying position and climbing to the gurney, paramedics access to patient and equipment. Trying to lift the scoop gurney to the load height. I have used remedies accessible in my apartment to set up proportional accurate models. If I had access to a workshop I would have used more time building a 1:1 model to test the proportions.





## Interior Layout

### ECG

The ECG (green box) are placed over the patient. This way the paramedic has view over the patients vitals. The ECG can also be brought to the patient.

### Driver

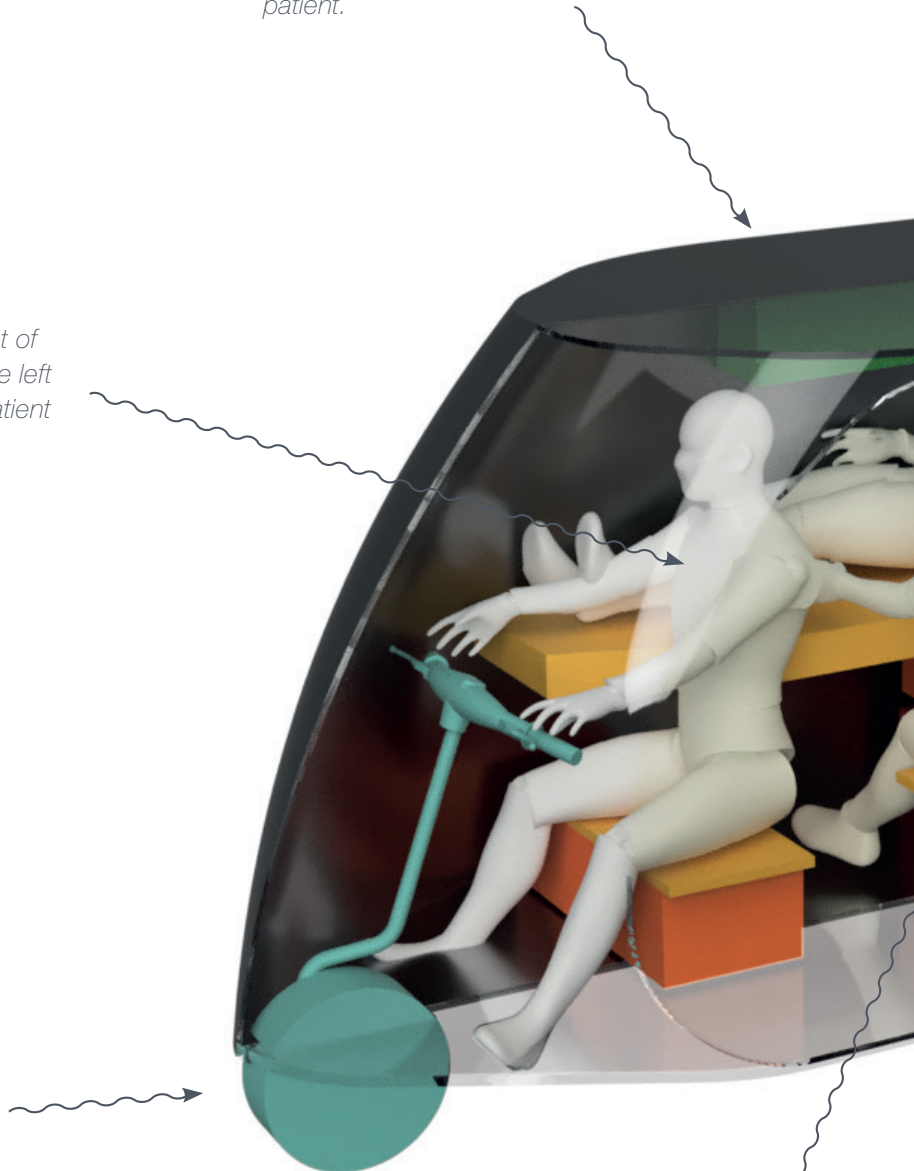
Driver are placed in the front of the ambulance. A little to the left to give more room to the patient and gurney.

### Steering

Handlebar and wheels are placed in same position as the base vehic

### Paramedic

The paramedic needs acces to the patient, ECG, jump bags and should also be able to sit comfortable when driving



## Patient

The patient is 195cm, well above the Indian average. It is a tight fit - but it is nearly the same size as the danish ambulance gurneys.

## Jump Bags

The two jump bags are placed on the back door. When the doors are opened the paramedics can take the jump bags with them to the patient. In the ambulance the jumpbags can be opened and give easy access to all the medicine and medical equipment.

## Extras

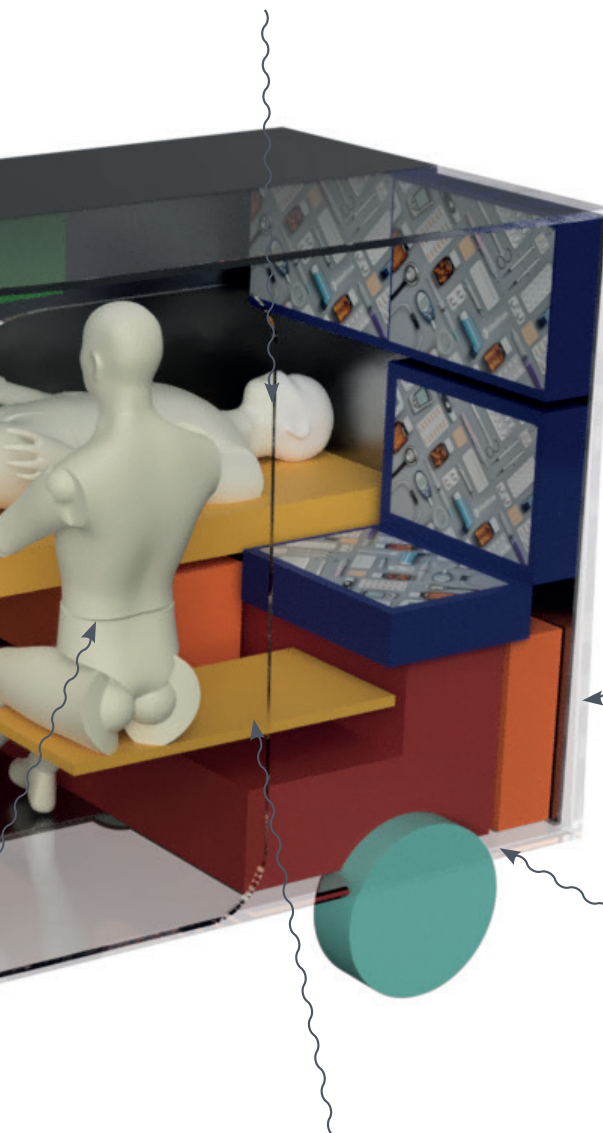
The orange spaces are reserved for extra equipment like scoop stretcher, oxygenflask and extra medicine.

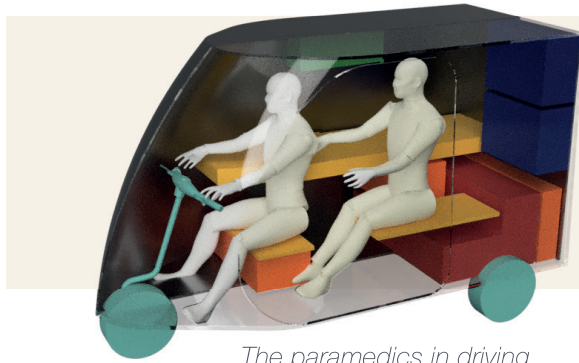
## Engine

The red box are the engine. It is in the same position as the base vehicle and are shielded to avoid noise and odor nuisance.

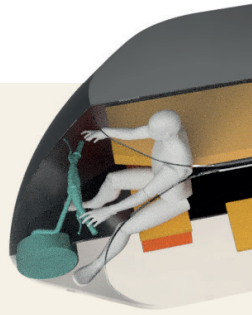
## Gurney & seating

The yellow boxes are gurney and seatings for paramedics and driver. The gurney should be pulled out the back for easy access.

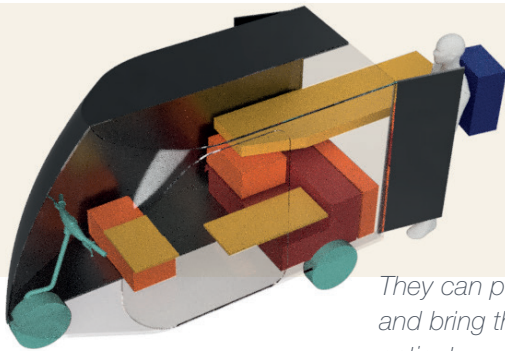




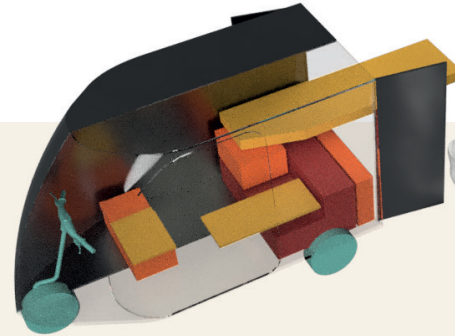
The paramedics in driving position going to the place of emergency.



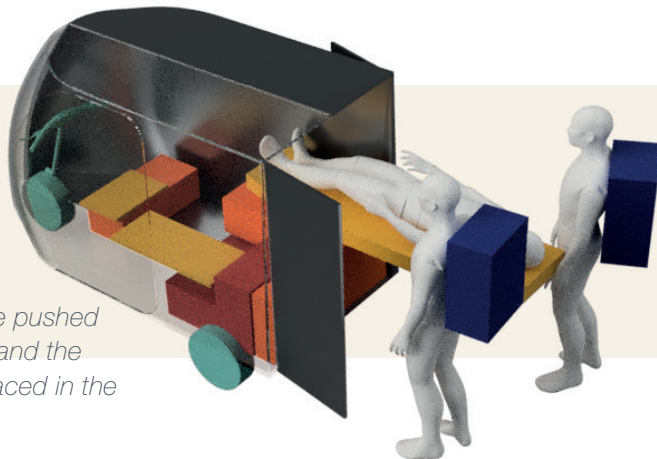
On arrival  
leave the



They can pull out the gurney  
and bring the equipment to the  
patient.

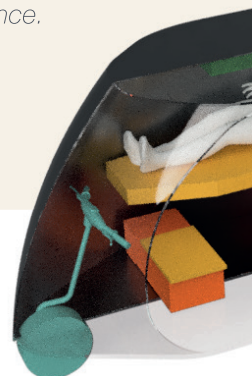


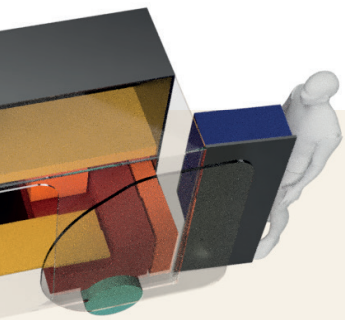
On arrival  
jump bags  
to all me  
equipme



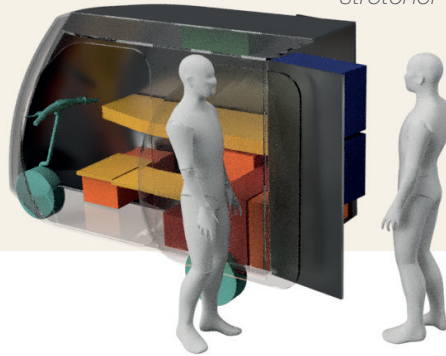
The patient can be pushed  
in the ambulance and the  
equipment can be placed in the  
ambulance.

The jump bags are placed back  
on the door and driver and  
paramedic can return to the  
ambulance.

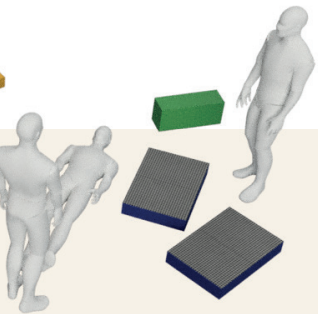




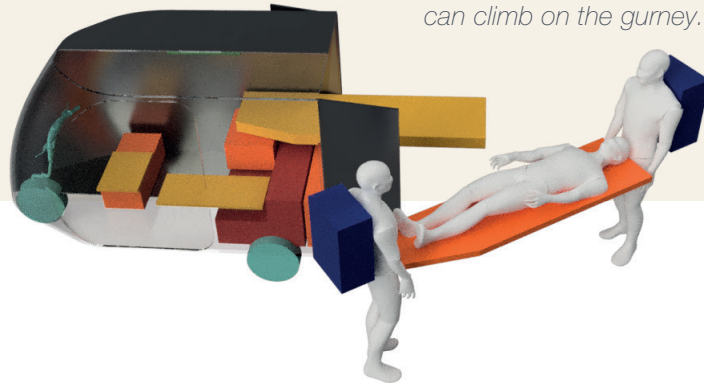
From the back of the car the personnel can have access to the jump bags, ECG, scoop stretcher etc.



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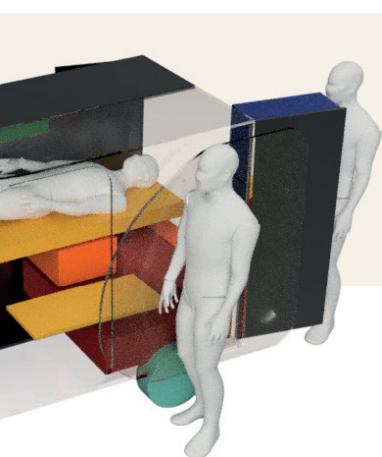


Depending on the patient's condition the paramedics can either carry the patient on a scoop stretcher, or the patient can climb on the gurney.



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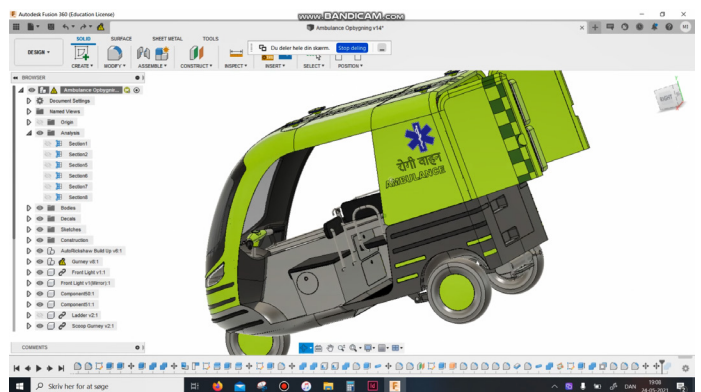
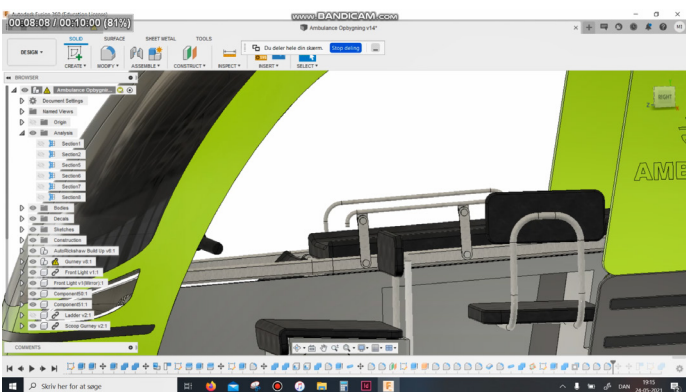
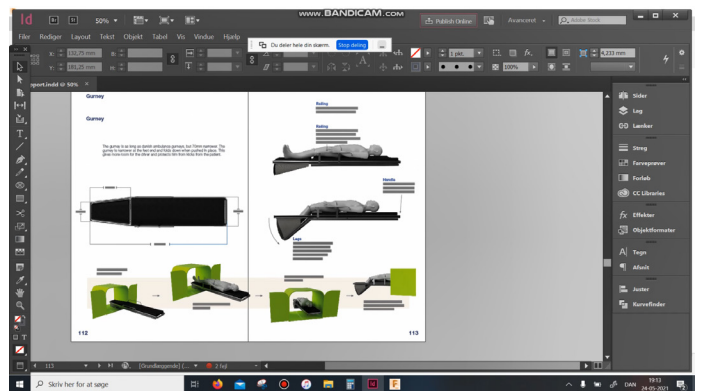
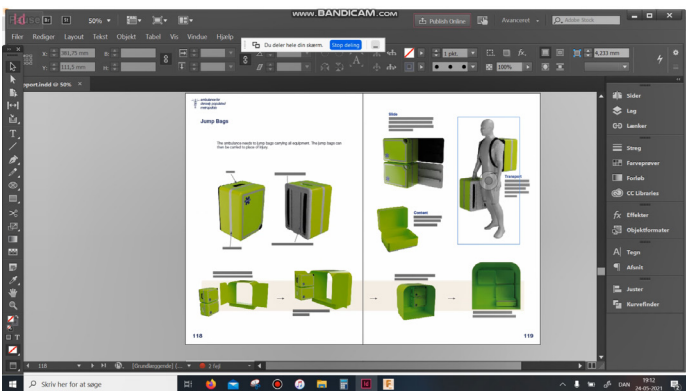
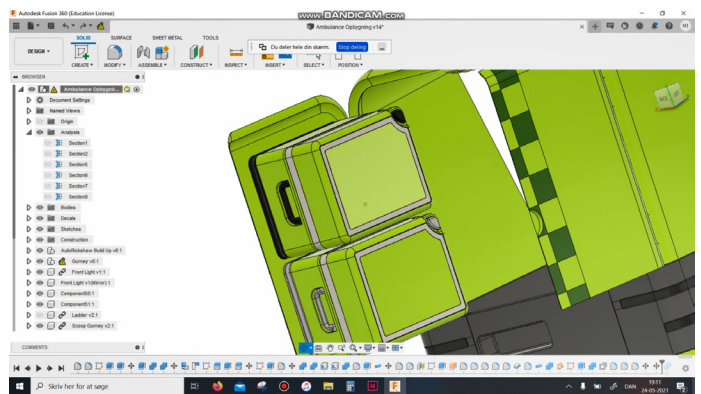
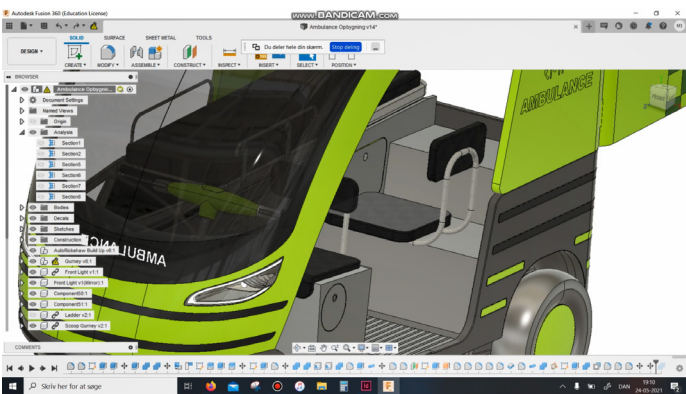
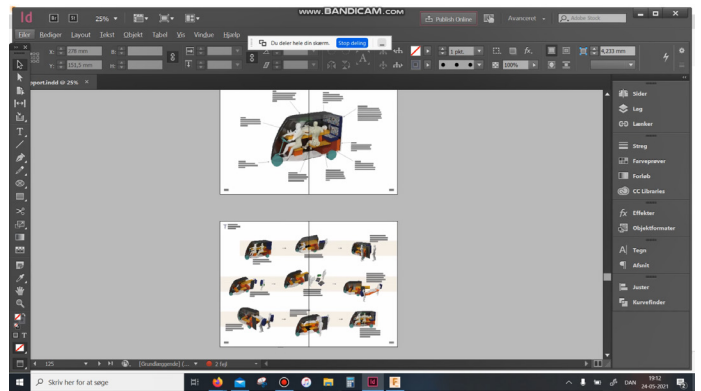
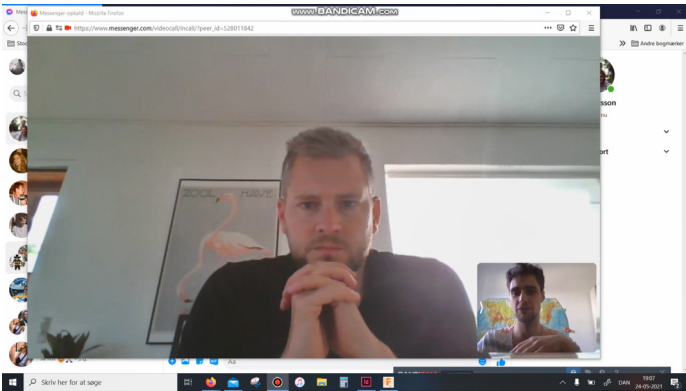
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Driving to the hospital the paramedic has access to the content of the jump bags, has an overview of patient vitals on ECG and can treat the patient.

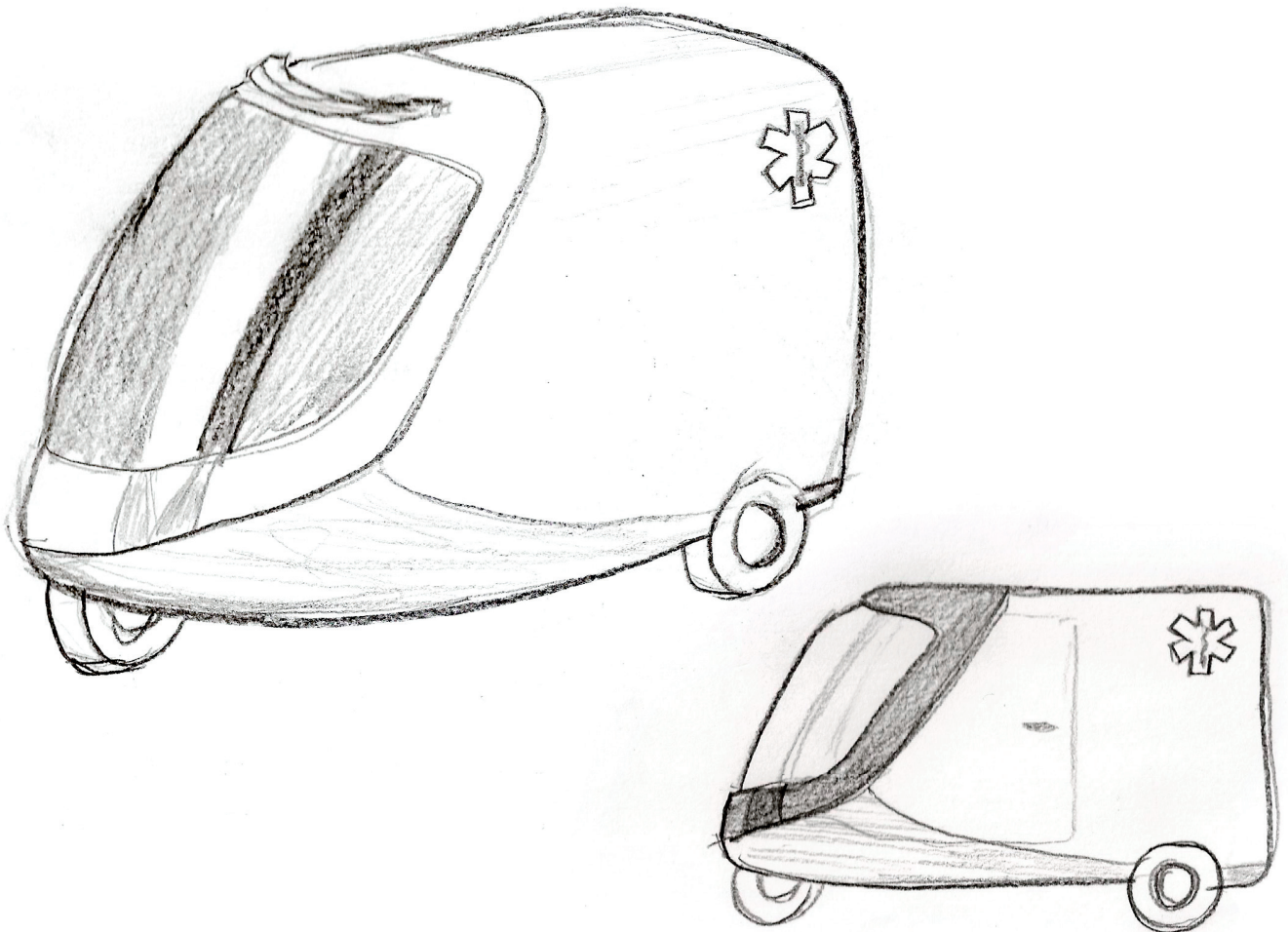
## Validation of Concept

During the creation process I had follow-up conversations with Jan Nilsson from Falck, presenting my concepts and design. We talked about solutions and changes to problems concerning equipment, patient positioning, sterility and work positioning. We talked about how the open environment of the ambulance could affect the treatment of the patient. This would mostly be a concern on gravel roads and not on asphalt as smog is not an issue. Another thing is the privacy aspect. The open design is maybe not the most optimal environment for treating patients, but with the compromise of faster dispatch time it is not a deal breaker. We also had a conversation about the gurney and potential issues about folding the legs down. This could be a concern in some instances with patients with blood loss or heart conditions. In these instances, the problem can be solved by restraining the patient's leg so the driver is not in risk of getting kicked by the patients. Small but important modifications were implemented based on my conversations with Jan.



## Designing the Ambulance #1

I started preparing concepts for design freeze implementing all the insights and knowledge obtained through my long process. I created a basic box fitted with all equipment, interior and persons, and modelled a shell that obtained my aesthetic design wishes.



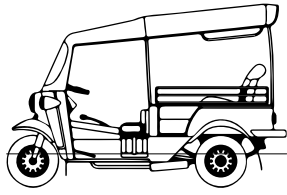




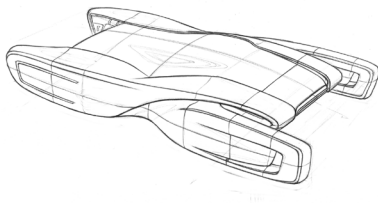
## **Directional Decision #2 - Realism vs Rewarding**

After drawing several models, I realized how far away I got from my initial problem statement. My assignment was to design an ambulance using the Bajaj auto rickshaw and making it as small and cheap as possible. The problem was the integration of the auto rickshaw. I moved so far away from the initial form, so an entirely new base was needed. The closed shell meant that air conditioner was needed, power steering etc. In the end I might as well could have built a new ambulance from scratch. But this would be way to expensive and sacrifice the relevance of the project.

I stepped back and looked at my auto rickshaw removing unwanted elements and building up the ambulance once more.

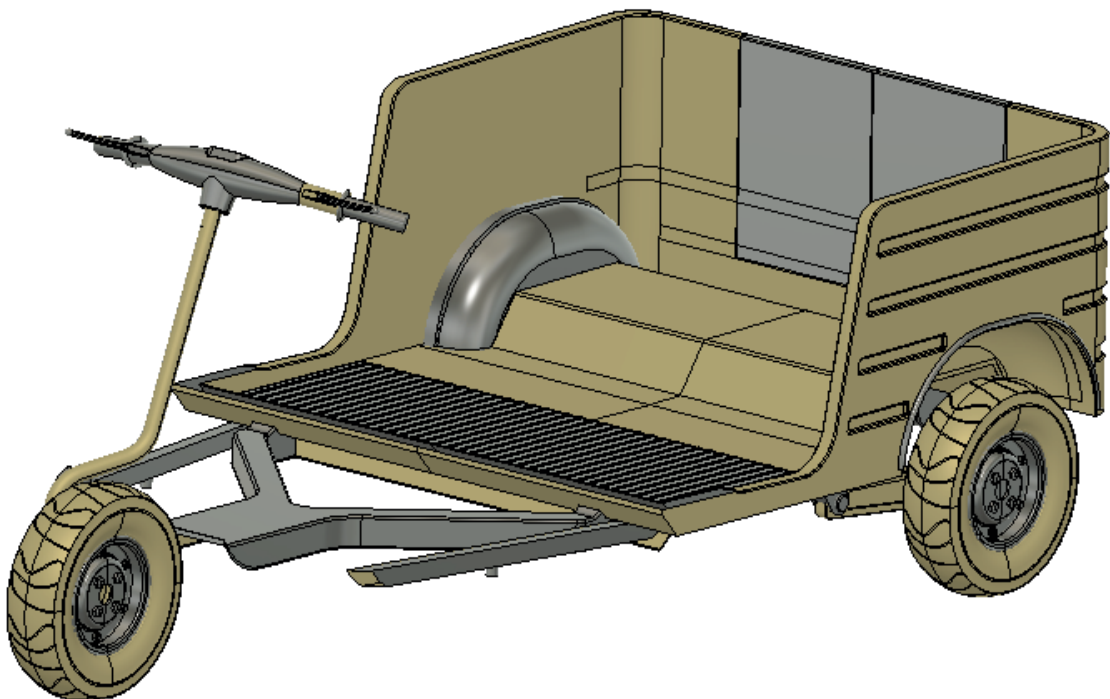


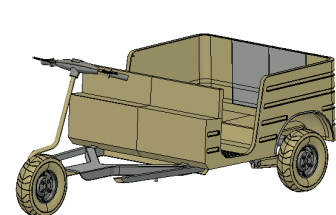
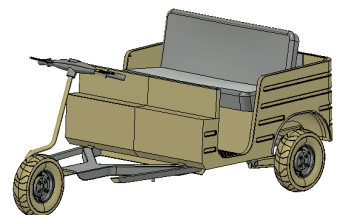
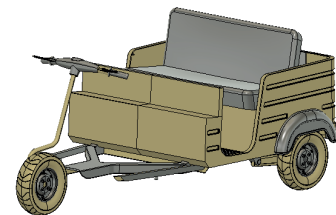
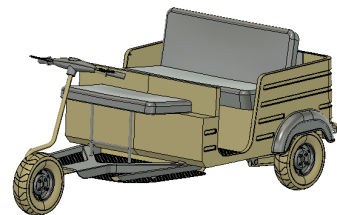
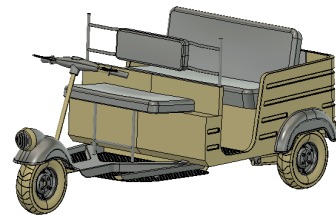
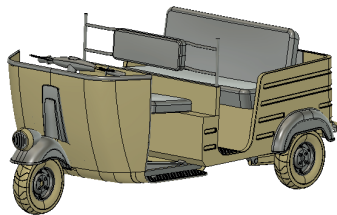
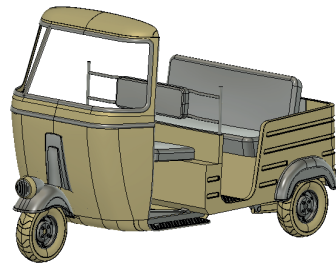
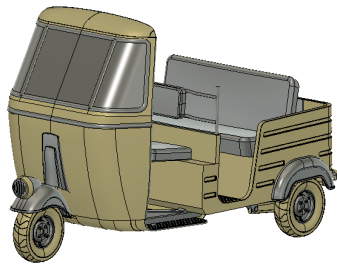
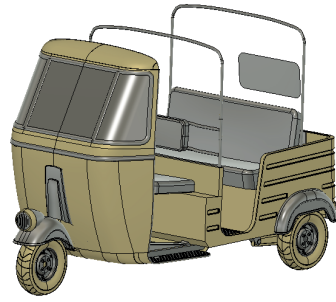
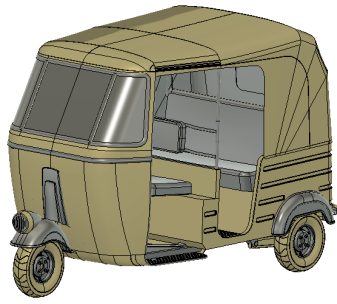
MY  
COMPROMISE



## Auto Rickshaw Tear Down

Using the Bajaj RE auto rickshaw I started peel off parts and layers from the auto rickshaw to make a new starting point to work from. I ended up with the wheelbase, engine, steering mechanism, chassis and the back “coach”. This would serve as a good base to work from.





## Ambulance Apex - Sketching

Using parametric design, I could set up parameter to create and evaluate multiple designs of the front and window very effectively. This quantitative method gave me a wide range of possible solutions to assess and work from.





## Front Window - Sketching







## Ambulance - Aesthetic overview





### Completed alignment

Completing the alignment from the checkers graphics in the front window I have integrated the graphics layer with the muscle layer of the front.



### Color

Using the color RAL 1016 I have increased the visibility of the ambulance, and made it stand out more clearly in the cityscape

### Emergency lights

Four 360 degree emergency lights on the ambulance roof signals to other motorists.



### Bridging the new & existing

Reusing the lines from the very cubistic cart, in the new more organic front I have attempted to merge the existing design with new

s on  
er



### **Alignment**

*Insted of only using arcs and straight lines I have incorporated splines in the front window. This is inspired by the very organic alignment used in Indian architecture and henna*



### **Continuing the monolithic**

*On the back of the ambulance I have continued the very monolithic design of the existing cart, making the ambulance very compound and grounded to increase its reliability.*



### **Ligth signaling & bumbers**

*The two top lines contains RGB in help signaling the intentions of the ambulance driver with turn lights and emergency lights. The two bottom lines are rubber bumper protecting the ambulance in tight traffic*

### **Filling the cracks**

*The four lines added to increase strength in the back cart is no particularly pleasing for the eye. I have filled the out making them less apparent. The two top lines is filled with RGB panels like in the front.*

### **Front light**

*By applying inspiration from the indian design tradition and architechure in the front light I have obtained an Indian inspired aesthetics without overpowering the ambulance design.*



## Functional overview

### Driver seating

The drivers seat is stationary and is above a compartment with car battery and oxygen flask.

### ECG

Slided in place above patient. In this position it can be read by the paramedic, connected to the patient and slided in and out from the back of the ambulance.

### Jump B

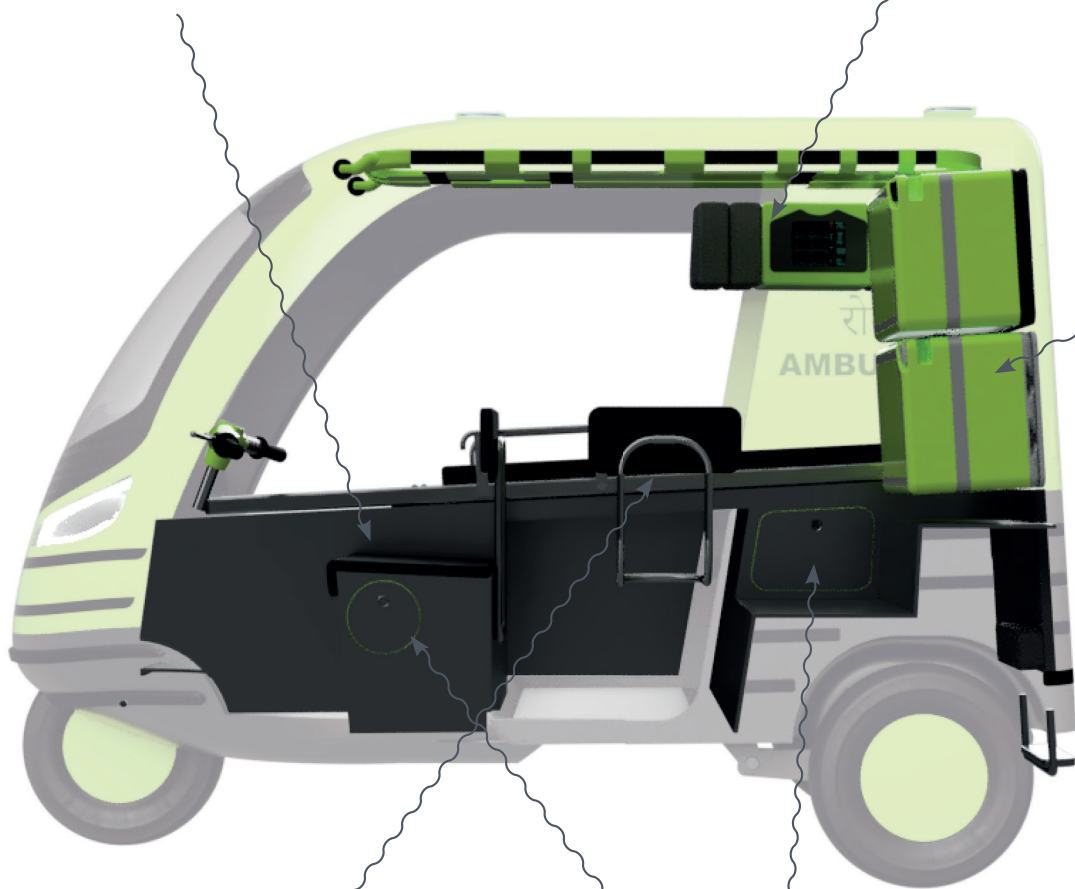
Attached to the ambulance, accessible from the ambulance, can be accessed by paramedics.

### Paramedic seating

The paramedics seat can be rotated and slided back and forth. This improves his access to the patient and stabilizes him during fast driving and maneuvering.

### Extra space

There are various compartments for extra medical supply, birth kits and oxygen bottles.



### Scoop Gurney

The scoop gurney is slid in the roof of the ambulance. Here it can be slid in and out of the ambulance without taking up room in or outside the ambulance

### Stretcher

Attached to the bag door of the ambulance making them easy to slide in and out of the ambulance while content is accessible by the paramedic from the inside

### Ladder

If the patient is well there is a ladder built in the ambulance to crawl to the gurney

### Gurney

The gurney is slid in on the right side of the ambulance beside the paramedic and driver. If the patient is suffering from heart diseases or blood loss the lower legs will be kept up and tied down.







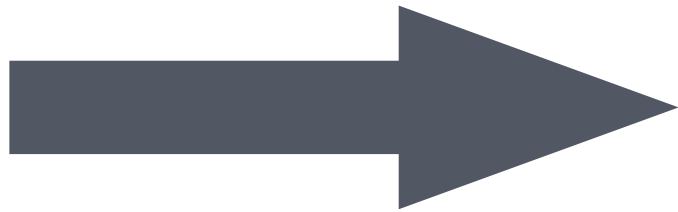


## Conclusion - an Assignment of Balance

This assignment has, to a large degree, been an assignment of contrasts - and the balance of such. When making school projects, and design in general, there is always a need to balance form and function. They define each other to a degree, but not fully and we as designers, always need to understand and cultivate these two pillars fully. But in my process of creating a new ambulance, I have worked more with balance, compromises and synergy than ever. The starting point of the creative process was to find the balance between size and equipment of the ambulance and the dispatch time to the emergency, defining the entire project. But later I have also worked with balancing the old auto rickshaw with the new, merging the aesthetics of the already existing vehicle and my vision of a new small ambulance. I had to balance the interior layout and construction to give an optimal workspace for the paramedics, with the need of a sharp exterior, demanding respect from the motorists and other road users. I tried to balance details from the Indian design tradition with more modern details to make it adapt to the Indian metropolises both today and tomorrow.

The result is an ambulance with a very small footprint only 1200mm in width. This can help the ambulance to easier navigate in the congested traffic and cut of valuable seconds in the response time - which is a bigger and bigger problem in the ever-growing cities of India. This is without sacrificing the treatment of the patient as all medical equipment is still fitted in the ambulance as well as giving the patient room to lie down and workspace for the paramedic. Even though the ambulance is smaller, it is more apparent in the traffic, as more lights and brighter color makes the ambulance more visible and lets it stand out. The price of the ambulance is kept down by using the cheap Bajaj RE auto rickshaw as a base for the ambulance. This vehicle is widely used in India and repair shops and spare parts are to be found everywhere.

I noted in my problem specification that I would look at new and upcoming technologies that could enhance the medical treatment in the ambulance. But even though most of the ideas and technologies I stumbled upon could improve the ambulance service, it wasn't so much an addition or change to the ambulance itself, but more to strategic solutions to the structure of the ambulance service. I have noted the solutions in the "Strategic Design" section.



## Reflections - School v. Realism

During my design process I have put a lot of thought of the relevance of the project. As this is my final master's assignment in industrial design, I have certain learning objectives, and I need to show I have a understanding of and convey scientific as well as artistic methods, tools, materials and technologies. To fulfill this I have deviated from the solutions and decisions I would have made, was it a "real" project. As one of my key goals was to make the ambulance as cheap as possible, I would have used way more of the original auto rickshaw, and wherever possible choosing existing products instead of making a new gurney, jump bags etc. Instead, I have given myself an opportunity to create and cultivate an aesthetic. As this is a key objective for me as a designer, it has been the obvious route for me. When that is said, these choices are not for nothing. All design details chosen has a foundation in knowledge and empirical data obtained from my extensive design process.

### **Sterility, privacy & professionalism**

As a designer I usually try to put myself in the end user's place. And how would I react to be picked up in an ambulance like this? Would I feel secure in an open ambulance? And would I be ok with people looking inside my crisis-stricken situation? Here in Denmark, I would probably be baffled by the situation. But knowing that this ambulance could reach me way faster than a traditional ambulance it is a compromise i would be willing to make. And as described in "Conclusion - an Assignment of Balance", this has truly been a task of compromises. Because no! An open ambulance so tightly packed that all content barely fits isn't perfect, but in its compromise, it is certainly an improvement.

### **Challenges in size**

Making an ambulance have been a very big challenge and a very comprehensive task, with a hundred parts that could have taken my attention the last five months. The jump bags or gurney could have been a masters project by itself. My solution has been to focus on the interior layout and the exterior design. But also giving proposals to the interior design, and the individual items like jump bags and gurney. Giving more time these parts would have gained my attention.

### **Design around the world**

This is a design project by a danish designer for Indian metropolises. Why me? I do not have the same access as a local designer. While that is certainly true there is also an immense value in observing issues from the outside. Sometimes it takes the eyes from a stranger to observe problems that might have become an everyday reality for a native. And while it has been difficult to gain local contacts and knowledge in general from relevant persons it has been a very given exercise.

## **Strategic Design**

The problem with ineffective infrastructure in Indian metropolises is a huge problem and cannot be solved with the ambulance alone. Quite the contrary I personally believe the easiest and cheapest way to solve the problem is by have a central dispatch call center. Instead of calling one of several ambulance services. This could easily be done by algorithms as seen in Nairobi, with the app Rescue (Moh, 2017) You could also use complex algorithms to place the different ambulances the most effective places during the day. I have listed my proposals to show other solutions to the same problem.

### **Dispatch Planning**

App or automatic call center to dispatch different ambulance services

### **Dispatch Centers**

Dynamic ambulance whereabouts. The ambulances stopping place should be moved during the day after algorithms to avoid traffic congestions.

### **Automatic Initial Diagnosis**

Index to make initial diagnosis. This can help personnel prepare before arrival. Furthermore should the following assesment by ambulance personnel be available to hospital personnel.

### **Awarenes About Ambulances**

Public campaigns to raise awarenes about ambulance dispatch times

### **National Color Theme**

National decided color theme to improve recognition of the ambulance in traffic.

## Towards Exam

### **Finishing CAD Model**

Making the last details on the CAD model - mostly aesthetic changes.

### **3D Model**

3D printed model in 1:5 containing as many details as possible. I hope to make the model modular to explain the function of the ambulance and its detail.

### **Video**

Video sequences to explain details of ambulance and process in presentation. Also, a standalone video clip (2min) that by itself explains the concept of the ambulance using animations, filmed and stock clips.

### **Posters**

1:1 technical drawing of the ambulance as well as poster describing concept and design by itself.

### **Presentation**

Finishing presentation material.

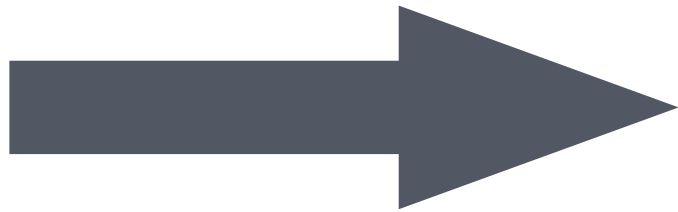
### **Production, Pricing & Materials**

Defining the last details of the ambulance as means of production, pricing and materials used for the ambulance.

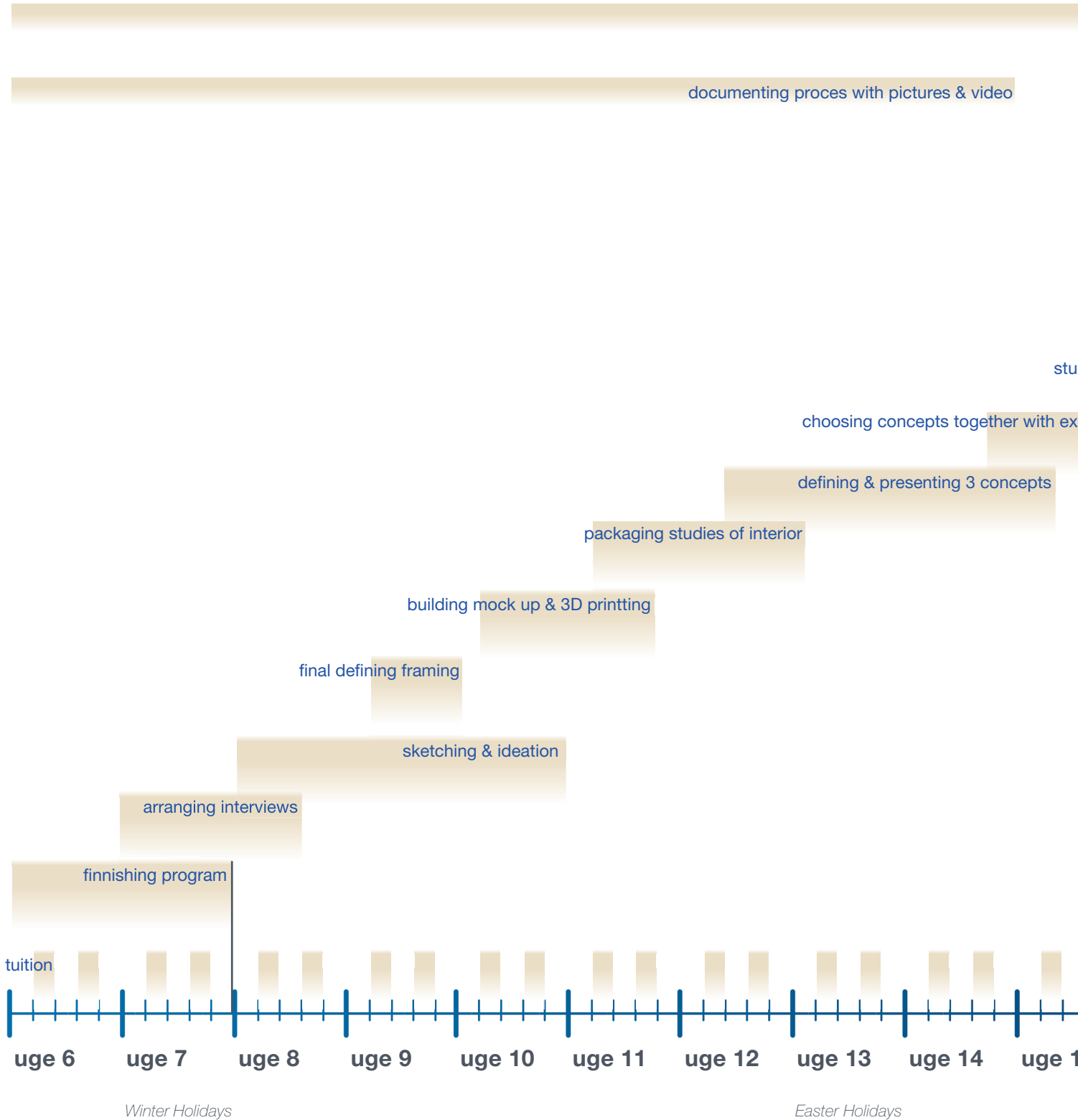
### **Heroshot**

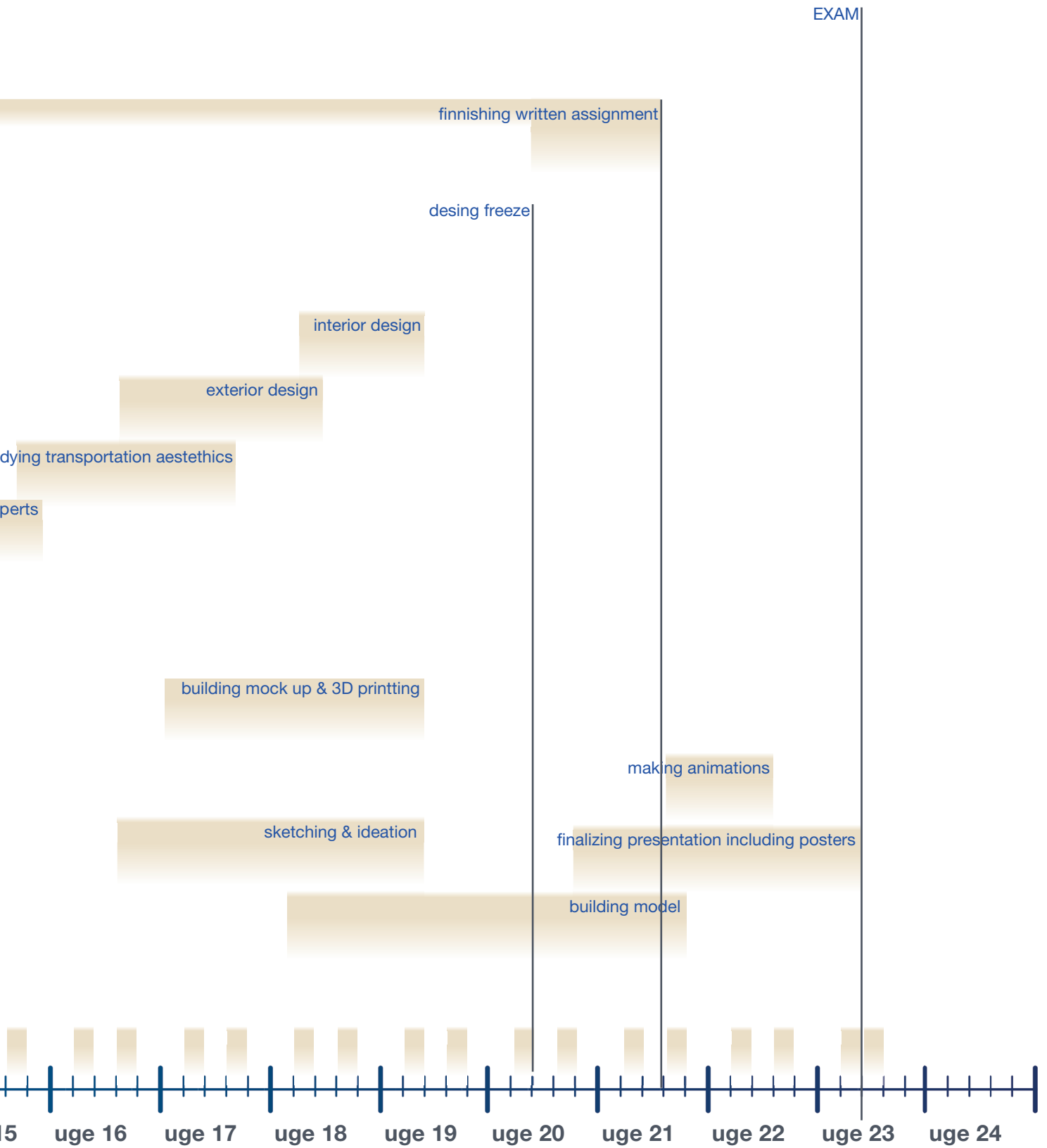
Final render of the ambulance



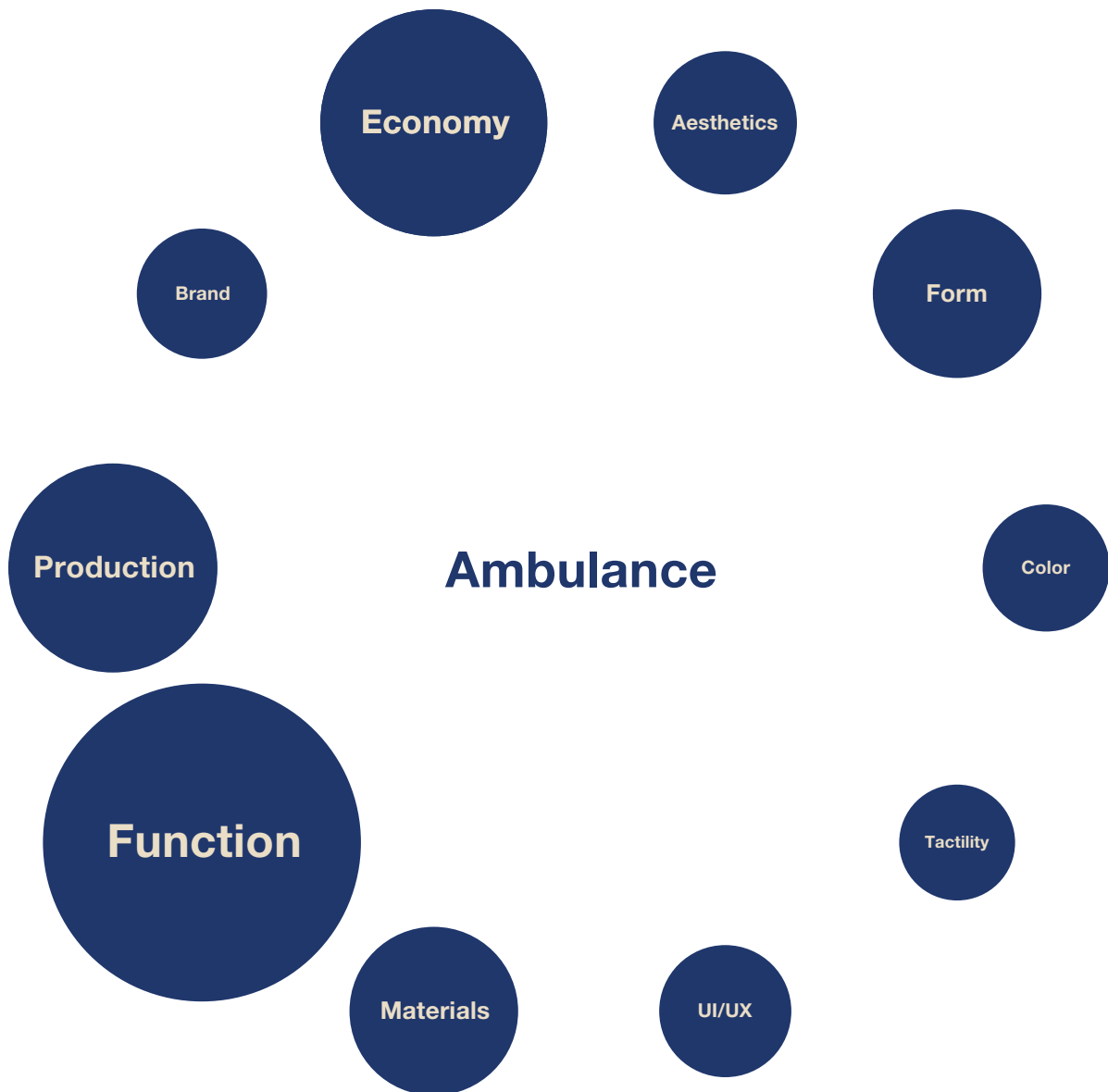


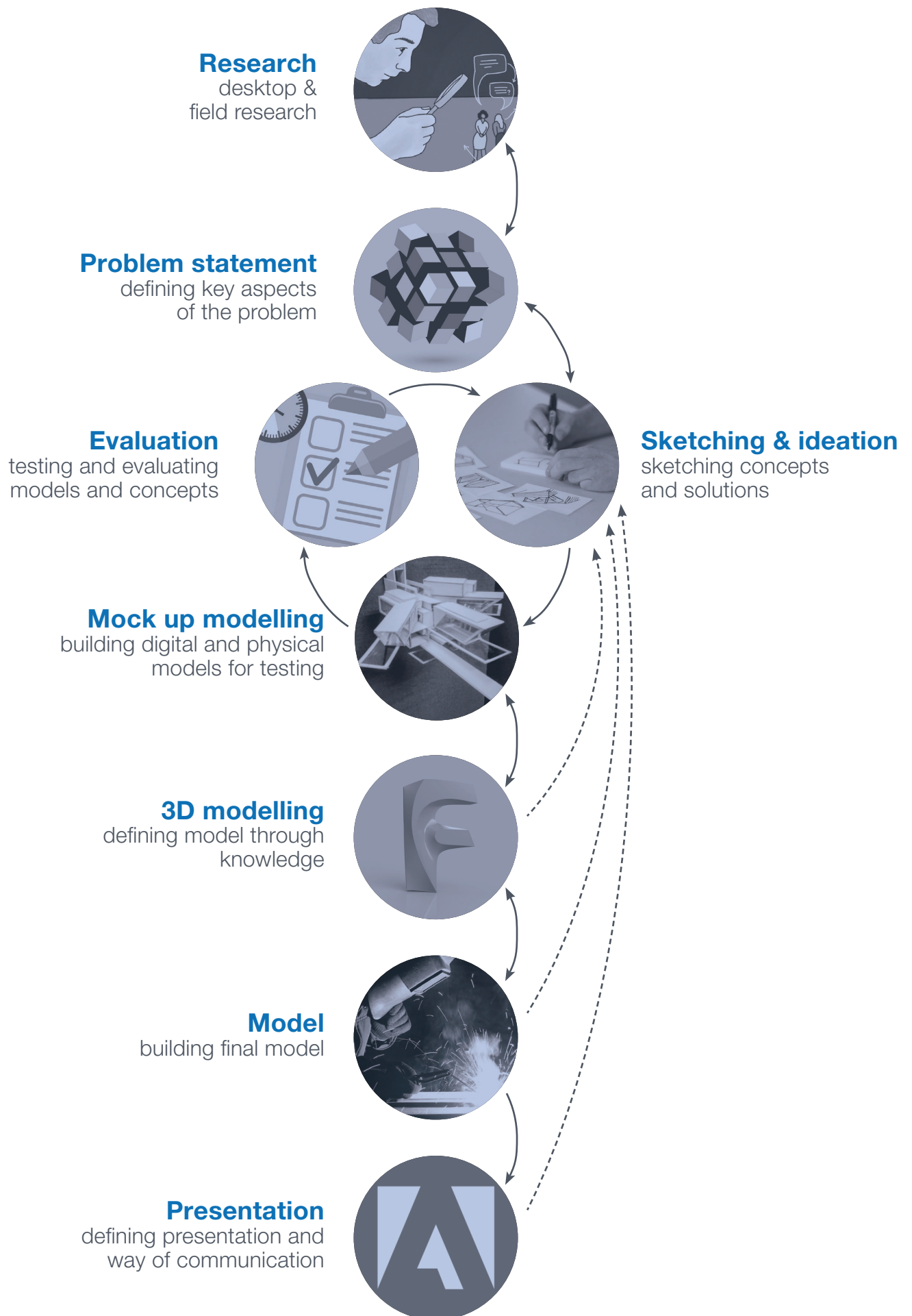
## Timeline





## Focus





## Deliveries

### **Program**

10 pages - process oriented, research framing, time plan etc.

### **Written Assignment**

15 pages - theoretical, methodical and process oriented.

### **Presentation**

30 min. Describing problem, empirical evidence, process decisions and end design including materials, production, price, form, details etc.

### **Process documentation**

Mock-up models and sketches

### **Posters**

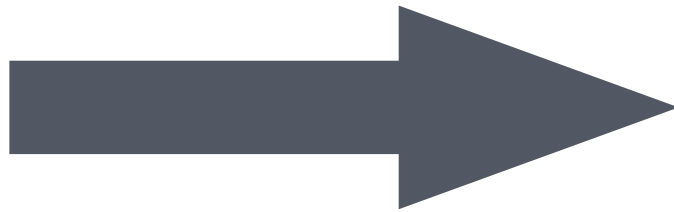
Briefly describing project solutions and 1:1 technical drawings

### **Video**

Standalone project video (roughly 2min) and interwoven in presentation, specifying details and more. Animations, stock and filmed video clips

### **Model**

Scale model 1:5, 3D printed parts.



## Theory

In this project I have studied and used different theories on transportation design, design thinking/pragmatic design and inclusive design. In this chapter I will shortly describe my curriculum.

### **Transportation**

In "Car Design Essentials Part 1: Bones", Nick Hull (2018) presents a way to perceive automotive form. Hull breaks down a car design into three steps: bones, muscles, and graphics. Together they form a set of principles for understanding automotive form.

In "Emotional Design" Donald Norman (2004) explains how humans feelings and emotions are defining how perceive the world around, including designed objects. And furthermore, how this perception influences the way we act and make decisions. This theory was relevant for designing both the exterior and interior design of the ambulance

### **Pragmatic Design - Design Thinking**

In "Pragmatic design: how does design thinking fit into the real world?", Davey van der Woert briefly explains the values of design thinking in creative processes, and how a simple line of methods can yield a more effective and pragmatic result. Circling between Empathize, Defining, Ideate, Prototype and Testing is one of the most well-known design thinking approaches, and is method I usually find useful.



### **Health Care Design For Non Western Countries**

In "Designing incentives for rural health care providers in developing countries" Jeffrey Hammer is describing the difficulties in implementing new medical equipment and processes. This insight has helped help me defining a scalable solution that can easier be implemented in other countries, especially in fast growing third world countries in Africa and Asia.

### **Inclusive Design - Health Care Design**

In "Designing inclusive environments and the significance of universal design" Rob Imrie (2014) describes how the designed environment affects the process of rehabilitation. This theory was relevant to the design, mainly of the interior, but also exterior of the ambulance. As the patient's relation to the objects affects the patients relation to the treatment.

In "Socially Inclusive Design: a People-centered Perspective" Rama Cheerawo (2015) makes the case for Inclusive Design as well as Imrie. More precisely he describes the process ethnographic analysis (Ethnographic Design) and presents tools to a achieve it in a design process.

## Curriculum

Folkmann, Mads (2016). "Designkultur, Teoretiske Perspektiver På Design".

Gheerawo, R. (2015). Socially Inclusive Design: a People-centred Perspective. Pp. 304-316

Hull, Nick (2018) "Car Design Essentials Part 1: Bones".

Car Design News. Visited 25.10.20.

<https://www.carsdesignnews.com/insights/car-design-essentials-part-1-bones/25915.article>

Imrie, R. (2014) Designing inclusive environments and the significance of universal design. Disabling barriers—enabling environments Pp. 287-296.

Madsbjerg, Christian (2017) 'Introduction. The Human Factor', ppxi-xxi og Chapter One. 'Making Sense of the World', pp1-24 in Sensemaking. What Makes Human Intelligence Essential in the Age of the Algorithm. Little Brown: London. (33p)

Norman, Donald (2004) "Emotional Design - Why We Love (or Hate) Everyday Things". New York, Basic Books

Oxvig, Henrik (2018) 'Design, samfund . . . . og omtanke: Resonans'. Introduktion til forelæsning (1p)

Stiffman, Arlene Rubin, and Ebrary, Inc. (2009) The Field Research Survival Guide. New York: Oxford UP, Web.

## References

AGCAS (2020), Paramedic - Job Profile, Prospects, <https://www.prospects.ac.uk/job-profiles/paramedic>

Akutberedskab Region Hovedstaden (2018), Årsrapportdata, <https://www.regionh.dk/om-region-hovedstaden/akutberedskabet/akutberedskabets-aktivitetsdata/Documents/Aktivitet%20for%202017%20og%202018.pdf>

Chee, Chan Heng (2018), Big challenges facing big cities of the future, Worlds economic forum, <https://www.weforum.org/agenda/2018/10/the-5-biggest-challenges-cities-will-face-in-the-future/>

Dickson, Peter (2018) "Chauffeur and Nurse, Too, is the Ambulance Driver", Popular Science, vol. 93 no. 2, August 2018, ISSN 0161-7370

Euronews (2020), Smart ambulances: the hi-tech future of accident and emergency healthcare, euronews Knowledge, <https://www.youtube.com/watch?v=f8nTAZEYarY>

Folkmann, Mads (2016). "Designkultur, Teoretiske Perspektiver På Design".

Frazer (2019), Is Your Ambulance Fleet Costing You Too Much Money?, <https://www.frazerbilt.com/blog-ambulance-cost/>

Gheerawo, R. (2015). Socially Inclusive Design: a People-centred Perspective. Pp. 304-316

Gough, A & Saunders, G (2003) Emergency ambulances on the public highway linked with inconvenience and potential danger to road users  
Emergency Medicine Journal, 20 209-209 Published Online First: 01 May 2003.

Hammond, Dr Phil (2004), Keeping patience with patients, BBC news, [http://news.bbc.co.uk/2/hi/programmes/your\\_nhs/3550855.stm](http://news.bbc.co.uk/2/hi/programmes/your_nhs/3550855.stm)

Healthdata (2018), India Datasheet, <http://www.healthdata.org/india>

Hull, Nick (2018) "Car Design Essentials Part 1: Bones".  
Car Design News. Visited 25.10.20.  
<https://www.carsdesignnews.com/insights/car-design-essentials-part-1-bones/25915.article>

Imrie, R. (2014) Designing inclusive environments and the significance of universal design.  
Disabling barriers—enabling environments Pp. 287-296.

Katherine T. Barkley (1990). The Ambulance. Exposition Press.

Madsbjerg, Christian (2017) 'Introduction. The Human Factor', ppxi-xxi og Chapter One. 'Making Sense of the World', pp1-24 in Sensemaking. What Makes Human Intelligence Essential in the Age of the Algorithm. Little Brown: London. (33p)

Norman, Donald (2004) "Emotional Design - Why We Love (or Hate) Everyday Things". New York, Basic Books

O'Hara, Rachel & Johnson, Maxine (2015) Decision making and safety in ambulance service transitions, May 2015, Emergency Medicine Journal

Oxvig, Henrik (2018) 'Design, samfund ..... og omtanke: Resonans'. Introduktion til forelæsning (1p)

Payscale (2021), Average Ambulance Driver Salary in India  
[https://www.payscale.com/research/IN/Job=Ambulance\\_Driver/Salary](https://www.payscale.com/research/IN/Job=Ambulance_Driver/Salary)

Petersen, Jan (1997), 880 ambulancer kommer først efter 20 minutter, Sygeplejersken 1997 ; (38): 10-12, <https://dsr.dk/sygeplejersken/arkiv/sy-nr-1997-38/3880-ambulancer-kommer-foerst-efter-20-minutter>

PrepMedic (2018) Paramedic Jump Bag <https://www.youtube.com/watch?v=KggKw5HG7BQ>

Ruud, Nieljs (2014), Ambulance Drone is a flying first aid kit that could save lives  
<https://www.springwise.com/ambulance-drone-flying-aid-kit-save-lives/>  
Chung, Prof. Soon-Jo (2021), Overview, Graduate Aerospace Laboratories of the California Institute of Technology, <http://aerospacerobotics.caltech.edu/urban-air-mobility-and-autonomous-flying-cars>

Schaft, Peter van der (2018), Firefighting Drones Aim to Fly Higher, Help Save Lives, <https://www.roboticsbusinessreview.com/unmanned/firefighting-drones-aim-to-fly-higher-save-lives/>

Stiffman, Arlene Rubin, and Ebrary, Inc. (2009) The Field Research Survival Guide. New York: Oxford UP. Web.

Tan, Dr Steve (2018), What's Inside an Ambulance?, health plus, <https://www.parkwayeast.com.sg/healthplus/article/inside-ambulance>

Tan, Dr Steve (2021), During an emergency, what exactly goes on inside an ambulance? What do paramedics use to attend to injured or sick patients?, <https://www.parkwayeast.com.sg/healthplus/article/inside-ambulance>

Tandon, Suneera (2018), Traffic jams in just four Indian cities cost \$22 billion a year, Quartz India, <https://qz.com/india/1255427/traffic-jams-in-delhi-mumbai-bengaluru-and-kolkata-alone-cost-india->

Tesser, Martina (2020) Motorcycle ambulances? An Italian solution exists and it is designed for most jammed areas, Jul 10, 2020, Emergency Life, <https://www.emergency-live.com/ambulance/medical-motorcycles-ambulances-italian-way-and-study-for-jammed-areas/>

Tesser, Martina (2020), The future of the ambulance: A smart emergency care system, <https://www.emergency-live.com/ambulance/the-future-of-the-ambulance-a-smart-emergency-care-system/>

TOI (2016), Choking life: 12 on way to hospitals die in traffic jams, <https://timesofindia.indiatimes.com/city/raipur/choking-life-12-on-way-to-hospitals-die-in-traffic-jams/articleshow/54910538.cms>

United Nations, Department of Economic and Social Affairs, Population Division (2018), The World's Cities in 2018, World Urbanization Prospects: The 2018 Revision, [https://www.un.org/en/events/citiesday/assets/pdf/the\\_worlds\\_cities\\_in\\_2018\\_data\\_booklet.pdf](https://www.un.org/en/events/citiesday/assets/pdf/the_worlds_cities_in_2018_data_booklet.pdf)

Dar, Vaishali (2020), Aesthetics or emerging technology? Which way is the future of Indian art headed, Financial Express, <https://www.financialexpress.com/lifestyle/aesthetics-or-emerging-technology-which-way-is-the-future-of-indian-art-headed/1835149/>

Vogt, Frederic (1976). "Equipment: Federal Specification, Ambulance KKK-A-1822". *Emerg Med Serv.* 5 (3): 58, 60–4. PMID 1028572.

Yaneva, Alben (2009). Making the Social Hold: Towards an Actor-Network Theory of Design" (PDF). *Design and Culture.* 1 (3): 273–288.

## Picture References

- p1** <https://www.amazon.com/Mumbai-Art-Print-Artwork-Bombay/dp/B01FPR9ZVC>
- p9** <https://www.bbc.com/news/world-asia-india-56517495>
- p11** <https://www.pinterest.com.au/mccurley0690/vintage-queensland-ambulances/>  
<https://www.pinterest.dk/pin/617415430138858289/>  
<https://www.pinterest.dk/pin/29062360076291195/>  
[https://twitter.com/dn\\_ambulance/status/956247490042396672](https://twitter.com/dn_ambulance/status/956247490042396672)  
<https://www.regionsyddanmark.dk/wm517764>  
<https://www.ladbible.com/news/interesting-futuristic-250k-ambulances-that-can-reach-99mph-seen-on-uk-streets-20190928>
- p18** <https://3frus.dk/referencegruppe-ambulance-corona-skaber-oeget-praehospitalt-pres/>  
<https://www.pinterest.dk/pin/766245324085695119/>
- p19** <https://www.amazon.com/Lightning-Large-Responder-Trauma-Dividers/dp/B00DAO9XTC>  
<https://www.worldpoint.com/practi-mask-ad-trng-bvm-4pk>  
<https://www.aedsuperstore.com/laerdal-medical-compact-suction-unit-with-disposable-bemis-canister-patient-tubing.html>  
<https://medikit.co.uk/spinal-board/>  
[https://www.spservices.ie/item/StifneckSELECTCervicalCollar\\_5\\_0\\_3924\\_1.html](https://www.spservices.ie/item/StifneckSELECTCervicalCollar_5_0_3924_1.html)  
<https://www.indiamart.com/proddetail/defibrillator-with-ecg-monitor-4673842291.html>  
<https://www.indiamart.com/proddetail/ge-healthcare-versamed-ivent-201-icu-ventilator-22241067055.html>  
<https://www.safetybasics.ca/Ambulance-Cot-Stretcher-p/003-c-3d.htm>  
<https://www.made-in-china.com/showroom/judyzhu168/product-detailLqfJOdXGZji/China-Rugged-Android-Mdt.html>  
[https://www.motorolasolutions.com/en\\_us/solutions/healthcare.html](https://www.motorolasolutions.com/en_us/solutions/healthcare.html)  
<https://baytechrentals.com/product/oxygen-tanks/>  
<https://www.sja.org.uk/first-aid-supplies/first-aid-kits/First-aid-kit-wall-brackets-empty-bags-and-boxes/St-John-Ambulance-Large-Empty-Zenith-Pouch-Bag/>
- p21** <https://punchng.com/patients-die-as-ambulances-get-stuck-in-traffic-jam/>  
<https://www.youtube.com/watch?v=l3hOBeQvc3M>  
<https://www.shethepeople.tv/news/traffic-snarls-women-give-birth-ambulances/>  
<https://www.newindianexpress.com/cities/bengaluru/2017/nov/03/three-ambulances-get-stuck-in-bengaluru-traffic-1690754.html>  
<http://www.thanhniennews.com/society/in-hanoi-ambulances-struggle-to-get-through-paralyzing-traffic-jams-51161.html>  
<https://www.newindianexpress.com/states/andhra-pradesh/2017/mar/21/iot-device-to-make-roads-free-for-ambulance-in-busy-visakhapatnam-traffic-1583847.html>  
<https://www.cag.org.in/blogs/ambulance-etiquette>  
<https://www.bangkokpost.com/thailand/general/1454453/fine-hike-call-for-ambulance-blockers>
- p25** reused
- p31** <https://unemg.org/>
- p32-33** <https://www.youtube.com/watch?v=2wBxaKnyFyY>  
<https://www.architecturaldigest.com/story/insiders-tour-india>  
<https://sk.pinterest.com/pin/215046950932554297/>  
<https://www.archdaily.com/791383/traditional-indian-architecture-meets-contemporary-office-space-in-this-naturally-lit-design-by-studio-symbiosis>  
<https://www.re-thinkingthefuture.com/fresh-perspectives/a1336-how-can-cultural-and-traditional-indian-architecture-be-more-sustainable/>  
<https://www.jaisalkot.com/best-time-to-visit-jaisalmer-rajasthan/>  
<http://www.home-designing.com/2015/02/a-sleek-modern-home-with-indian-sensibilities-and-an-interior-courtyard>  
<https://www.behance.net/gallery/91575945/INDUSTRIAL-DESIGN-PORTFOLIO-2020>  
<https://www.livemint.com/auto-news/mahindra-s-xuv300-is-first-indian-car-to-get-global-ncap-s-safer-choice-award-11581936922487.html>  
[https://commons.wikimedia.org/wiki/File:Jakarta\\_bajaj.jpg](https://commons.wikimedia.org/wiki/File:Jakarta_bajaj.jpg)  
<https://www.eater.com/2020/6/30/21307238/taking-back-indian-food-from-the-white-gaze-cookbook-recipes>  
<https://www.phaidon.com/store/design/sar-the-essence-of-indian-design-9780714870502/>  
<https://www.jewelrystoppingguide.com/types-of-indian-jewelry/>  
<https://sharkgaming.dk/shark-gaming-esport-edition>
- p35** <https://www.bajajauto.com/>

- p36-37** <https://www.youtube.com/watch?v=4nqkhC8zn8Y&t=14s>  
<https://www.youtube.com/watch?v=HghQ--fb1qI>  
<https://www.youtube.com/watch?v=nEHKpFApJk>  
<https://www.youtube.com/watch?v=YdtKLhwj0XY&t=86s>  
<https://www.youtube.com/watch?v=I31js0BIWD8>
- p39** <https://www.quora.com/What-is-the-most-visible-color-when-using-the-human-eye-to-see>
- p40-41** <https://www.youtube.com/watch?v=Uckb-avaGT0&t=134s>
- p43-49** own pictures
- p51** reused
- p54-55** <https://inhabitat.com/the-bringley-bike-is-car-alternative-for-busy-urban-environments/>  
<https://twowheelcompany.com/elcykler/butchers-bicycles/mk1-e-touring/>  
<https://electricmotorcycles.news/rapide-3-a-new-advanced-and-electric-way-to-deliver-goods-and-services-to-customers/>  
<https://www.pinterest.dk/pin/514747432394782365/>  
<https://hum3d.com/3d-models/tata-airpod-2017/>  
<https://escargomotorcycle.com/behind-the-build/escargo-progress-folio11/>  
<https://www.carbuyer.co.uk/renault/twizy>  
<https://www.pinterest.dk/pin/233694668136370982/>  
<https://www.nissan-global.com/EN/ZEROEMISSION/HISTORY/LANDGLIDER/>  
[https://www.tripadvisor.ie/LocationPhotoDirectLink-g147271-d207819-i191473355-Central\\_Park-Havana\\_Ciudad\\_de\\_la\\_Habana\\_Province\\_Cuba.html](https://www.tripadvisor.ie/LocationPhotoDirectLink-g147271-d207819-i191473355-Central_Park-Havana_Ciudad_de_la_Habana_Province_Cuba.html)  
<https://newatlas.com/arcimoto-deliverator/58926/>  
<https://autoportal.com/newcars/bajaj/re60/>  
<https://autoportal.com/newtrucks/bajaj/bajaj-maxima-c/>  
<https://autos.maxabout.com/cars/tata/magic-iris>  
[https://www.alibaba.com/product-detail/LK1500AC-electric-tuk-tuk-on-sale\\_60581281304.html](https://www.alibaba.com/product-detail/LK1500AC-electric-tuk-tuk-on-sale_60581281304.html)  
<https://www.electrive.com/2018/04/18/citkar-launches-electric-loadster-cargo-bike-that-is-a-car-almost/>
- p56-57** <https://carver.earth/en/product/carver-cargo/>  
<http://www.walkthroughindia.com/industry/top-10-best-three-wheeler-manufacturer-in-india/>  
[https://www.alibaba.com/product-detail/electric-cargo-tricycle-electric-truck-electric\\_60273715716.html?bypass=true](https://www.alibaba.com/product-detail/electric-cargo-tricycle-electric-truck-electric_60273715716.html?bypass=true)  
[https://www.alibaba.com/product-detail/Cargo-bike-cargo-Gasoline-bike-tricycle\\_1600170959107](https://www.alibaba.com/product-detail/Cargo-bike-cargo-Gasoline-bike-tricycle_1600170959107)  
[https://www.el-ladcykler.dk/vare/cargobike-cafe-electric/?gclid=Cj0KCQiAj9iBBhCJARIsAE9qRTBGATC-QXrkv84T4-T1BzDUJfW8WueZm8P72TL\\_cUKKUY8Ptc1BE3QaAIPuEALw\\_wcB](https://www.el-ladcykler.dk/vare/cargobike-cafe-electric/?gclid=Cj0KCQiAj9iBBhCJARIsAE9qRTBGATC-QXrkv84T4-T1BzDUJfW8WueZm8P72TL_cUKKUY8Ptc1BE3QaAIPuEALw_wcB)  
<https://ace.tatamotors.com/mini-truck/tata-ace-gold/tata-ace-gold-diesel.aspx>  
<https://www.bikewale.com/royalenfield-bikes/classic/>  
<https://indianautosblog.com/exclusive-bajaj-re-ev-electric-rickshaw-specs-leaked-launch-soon-p319474>
- p81** reused
- p91** <https://design.tutsplus.com/articles/create-a-futuristic-concept-car-in-photoshop--psd-19216>
- p92-93** <https://www.pinterest.dk/pin/518406607109974216/>  
<https://www.pinterest.dk/pin/701928291921968436/>  
<https://www.pinterest.dk/pin/146648531603751947/>  
<https://www.pinterest.dk/pin/478507529156852700/>  
<https://www.pinterest.dk/pin/776167317025042628/>  
<https://www.pinterest.dk/pin/852798879440152698/>  
<https://www.pinterest.dk/pin/73113193938341144/>  
<https://www.pinterest.dk/pin/557039047637064539/>  
<https://www.pinterest.dk/pin/388435536615090421/>  
<https://www.pinterest.dk/pin/256423772508249937/>  
<https://manyone.com/case/nembot>
- p94-95** <https://www.pinterest.dk/pin/518406607109974216/>  
<https://www.pinterest.dk/pin/701928291921968436/>  
<https://www.pinterest.dk/pin/146648531603751947/>  
<https://www.pinterest.dk/pin/478507529156852700/>  
<https://www.pinterest.dk/pin/776167317025042628/>  
<https://www.pinterest.dk/pin/852798879440152698/>  
<https://www.pinterest.dk/pin/73113193938341144/>  
<https://www.pinterest.dk/pin/557039047637064539/>  
<https://www.pinterest.dk/pin/388435536615090421/>  
<https://www.pinterest.dk/pin/256423772508249937/>
- p115** <https://www.studiorotor.nl/en/portfolio-item/ambulance-stretcher-design/>

## Field Research Contacts



**Otto Anker Nielsen**

Professor DTU - Transport, Network & Route Choice

*Contacted 24/02 - Declined my inquiry*



**Subash Dhar**

Senior Researcher DTU - Transport & Mitigation Analysis

*Contacted 25/02 & 01/01 - Declined my inquiry*



**Lisa Perrine Brown**

Professor Karnavati University - Design & Transportation

*Contacted 27/02 & 03/03 - Never answered*



**Jens Martin Skibsted**

Skibsted ID, Biomega, Manyone - Designer, Mobility

*Contacted 03/03 & 05/03 - Never answered*



**Harish CB**

HOD of Transportation and Automobile Design At Unitedworld Institute of Design

*Contacted 07/03 - Never answered*





**Falck, Hovedstadens Beredskab & Akutberedskabet**  
Responsible for all ambulance service in Copenhagen municipality

*Interests:*

- *Drive along in ambulance*
- *Inspect ambulance together with a paramedic*
- *Interview with paramedic and ambulance assistant*
- *Interview with emergency physician*
- *Interview with service employee/mechanic*

*Contacted Hovedstadens B. 26/01 - 02/02 - Declined my inquiry*

*Contacted Falck 26/01, 02/02 - 17/02 - Declined my inquiry*

*Contacted Region H 19/02 - 02/03 - Declined my inquiry*



**HOVEDSTADENS  
BEREDSKAB**

*Contacted Paramedic #1 01/03*

*Contacted Paramedic #2 01/03*

*Contacted Paramedic #3 01/03*

*Eventually I was contacted by Jan Nilson from Taastrup Falck Station leading to a very rewarding field trip.*

