1. NARRATIVE

I/ Initial situation

In French cities of more than 100.000 inhabitants, people spend 45 min to 1h30 a day to travel from their home to their job[1]. In addition, 7 working people out of 10 use their car every day to go to work *e.g.* more than 20 million people.[2] This periodically recurring travel between the place of residence and the place of work, called commuting, has become a major phenomenon in today's society.

II/ The emergence of a disruptive element

Today, the world is facing multiple crises. We are currently experiencing global warming, an unprecedented level of pollution, we observe a decrease in the planet's biodiversity, and resources are getting scarcer.

Mobility as we know it today has a big impact on these different crises. It is responsible for 23% of the world's greenhouse gas emissions.[3]In France however, it is responsible for about 30% of the greenhouse gas emissions (GHGs) and cars for 15% of the GHG emissions.[4] This is thus a big contributor to climate change. Furthermore, today cars are on average 1240 kg in France, have 5 to 7 seats, but in 90% of the cases only one person is present in the car.[5] Cars are on average more than 15 times heavier than the passenger inside. This results in a massive energy loss. More than half of all urban journeys in developed cities are made by private motorized vehicles.[6] With the increase of the number of vehicles these past few years, the driving conditions in cities have deteriorated : toxic smoke levels and endless traffic jams.[7]
Additionally, people use their car for an average of 32 km per day.[8] Also here there is an overconsumption of the material used per car. Therefore, lightweight, smaller, and more modulable vehicles will have a significant impact on the future of mobility.

To this end, it is important to propose greener alternatives to car owners and commuters in order to reduce our impact on the planet. This is a call that our group *Moby!* will try to answer. We are young internationals (18-35 years) from various industries, committed to societal and environmental challenges as well as to the acceleration of the ecological transition. We hope that through the Extreme Defi, we will be able to share our vision about the vehicles of the near future.

Different solutions have been initiated during the last years through the increase in bicycle lanes, or through the creation of low emission zones (LEZs), where the most polluting *vehicles* are regulated. For example, London is building 12 bicycle superhighways dedicated solely to bicycles. In Denmark and Belgium, car-free zones have been introduced.[9] However, to change the impact of mobility on climate change, more radical changes need to be put in place.

Previous examples show how inside the city solutions are put in place. But few options are available for people who are commuting from outside the city to the city center. People have to own a car in order to be able to go to work or run their errands. This is why we will focus on this part of mobility, in this project, we will design a vehicle dedicated to commuters.

III/ The personas and customers journeys

Student who uses public transport

Name: **Edmond**
Surname: **Dupont**
Age: **23**
Where he lives: **Craponne**
Profession: **student**

Typical day
7.00 he wakes up
8.00 he walks to go to the bus station
8.10 he takes the bus
9.05 he arrives at uni
13.30 he has lunch
16.30 he finish class and takes the bus home
17.45 he arrives home
20.00 he has dinner
00.00 he goes to bed

Biography

Edmond is 24 years old and studies Aerospace Engineering at the École centrale de Lyon. Edmond was born and raised in a small town outside the gates of Lyon, Craponne. To this day he still lives here with his family, which consists of his mom Mélanie, dad André, his sister Sophie, and two cats.
Edmond has always been a big fan of science subjects and space, since he was a child his parents often gave him books on science, and for his 10th birthday they gave him a telescope that Edmond still owns and is very jealous of. This passion prompted him to choose the master's degree in Aerospace Engineering in college, where he met, during his freshman year, his girlfriend Josette.
Josette lives in Lyon and is an out-of-town student often Edmond stays over when they are too late at night and there are no more trains home.
Edmond since childhood has always played soccer in the role of a defender, is a big soccer fan, and is a fan of the Lyon team that he often goes to the stadium to watch with his father.

Dream and expectations

Edmond wants to graduate at the end of next year and start looking for a job in aerospace. His big dream would moved to Paris to work at the Centre national d'études spatiales (CNES)

Context

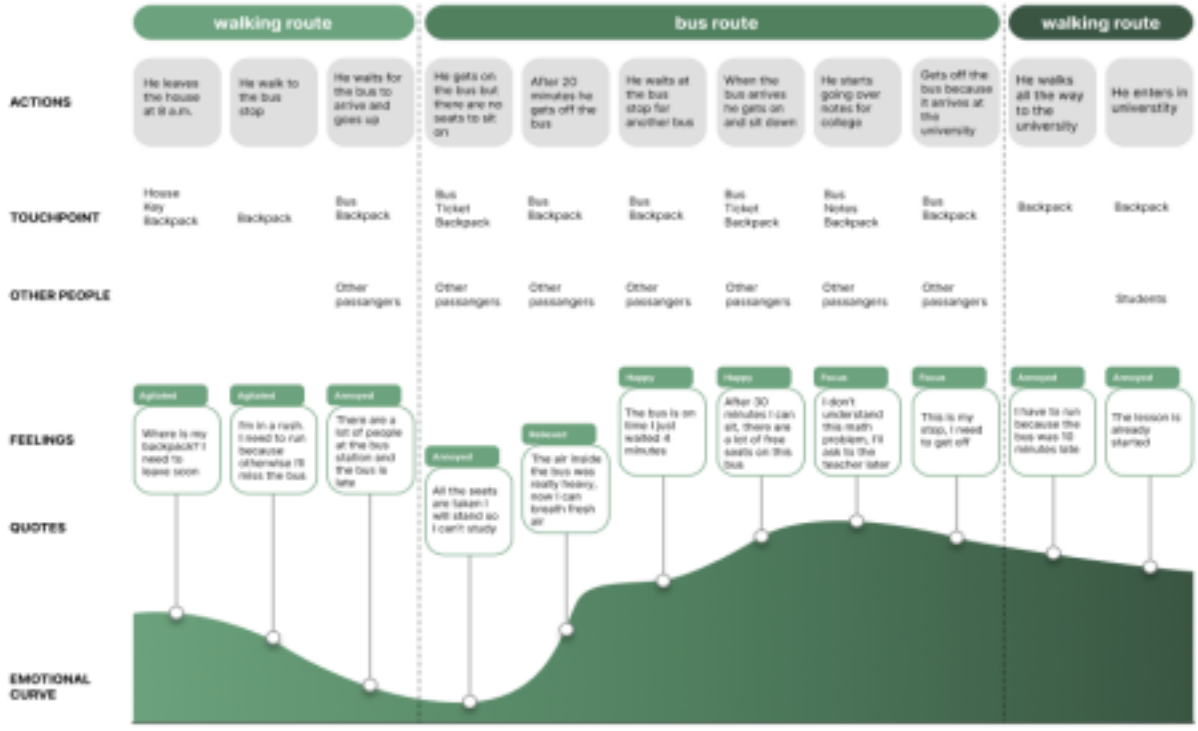
Living in Craponne since childhood Edmond has many friends in this small town, until he started college he never needed a car to go out with friends and the few times he needed it he used his parents' car. Now, however, he very often uses the car to visit his girlfriend in Lyon and when he cannot use it he is forced to take transportation but since there are few trains back during the evening he is forced to sleep at Josette's place

Pain point

- Time issue: Edmond takes more than one hour and half a day to get to university
- Logistic issue: Uses two different buses and the walking route to get to uni, sometimes he arrives late for the lesson because he misses the bus.
- Privacy issue: bus has a lot of people so no calls
- There aren't a lot of option to come back at home at night from Lyon center

Gain point

- During the bus trip he can review before classes
- He can go to Lyon and to university without using his parents' car as he often cannot use it



Retiree who uses private transport

Name: **Emilie**
Surname: Durand
Age: 68
Where he lives: **Paris**
Profession: retiree

Typical day
6.00 she wakes up
6.30 she takes the car to go to Lisa's house
7.00 she arrives at Lisa's house
08.00 she takes the children to school
9.00 she returnes at home
12.00 lunch
16.00 she takes the children from school and return to Lisa's house
20.00 dinner
23.00 she goes to bed

Biography

Emilie Durand is 68 years old and worked for 42 years as a buyer in a candy company. Now she is a happy retiree. She got married at 28 to Gerard, the love of her life, and they have always lived in their house in the city. Emilie and Gerard had three children, Rosa (50y), Alain (47y) and Lisa (34y). Emilie loves cooking and taking care of her 4 grandchildren: Sophie (10y) - Jenna (8y) - Gerard (11y) - Cris (6y).

Dream and expectations

Since her children grew up, Emilie and Gerard were left alone and started travelling until Gerard fell ill and they had to stop. Now she loves taking care of her grandchildren, which keeps her busy. She loves taking her older grandchildren to exhibitions and museums and going to breakfast with them on Saturday mornings.Her biggest dream is to go on a trip to America, she was supposed to go with Gerard but then life got in the way

Context

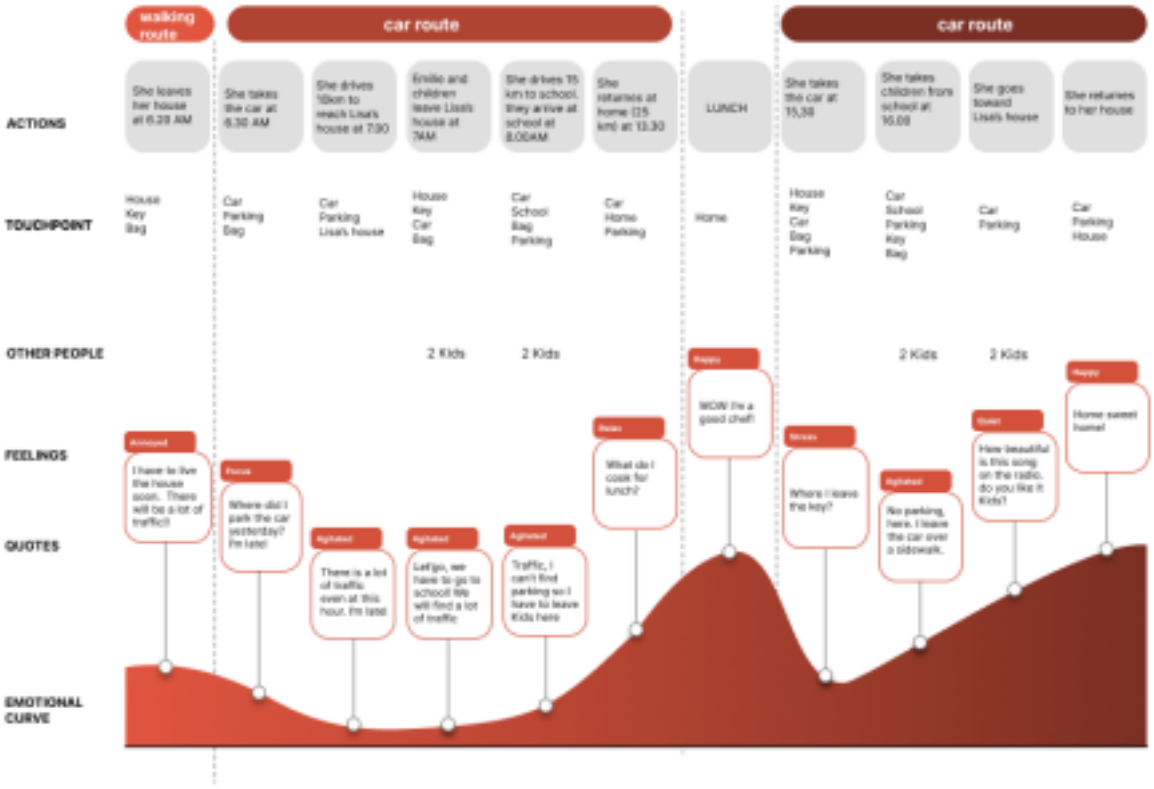
Lisa, Emilie's daughter, goes to work early in the morning, so Emilie at 6:30 a.m. takes the car to her daughter's house to take care of the children. Emilie has always driven but she is tired of having to leave so early because of traffic, her daughter's house is only 10 km from her home but Emilie cannot make it on foot. While vehicles would leave Emilie too far from her daughter's home. In addition, Emilie has to take the children to school and therefore cannot use a bicycle.

Pain point

- Traffic in the morning (time, stress)
- Parking (no parking in Paris or Payment parking)
- She loves nature, but she can't take the bike. She needs a vehicle for more than 2 persons

Gain point

- More relaxed
- Not having to worry about parking
- Not having to get up very early to walk 10 km



Worker who uses private transport

Name: **Catherine**
Surname: **Bernard**
Age: **39**
Where he lives: **Tourcoing**
Profession: **Account Manager**

Typical day
7 am : she wakes up and have a breakfast
7:30 am : she awakes her kids
8:15 am : She leaves the house with the children to take them of at school
9 am : she arrives at the Office
12:30 pm : She has lunch with her colleagues
6 pm : she leaves the office and go to the grocery store to buy ingredients for diner
8 pm : diner with the family
11 pm : Go to bed

Biography

Catherine is 39 years old. She is from Nantes but she moved after her studies in Lille. She is working in a big company in the city center as a Senior account manager for 4 years. She is part of the middle class and lives in a house with her 2 children Martin 11 (y), Julie(8y) and her husband Marc in the suburb of Lille (less than 20 km from her office).
They have a dog called Poppy since the birthday of their youngest daughter.

Context

Every morning, from monday to friday, at 8.15 am, she uses her thermal car to drop the children off at school not far from the hometown. To go to her office in the city center and she is doing the ride alone. Since the covid Pandemic, she is allowed to have 1 or 2 remote days per week so she avoids the traffic jam and the time spent inside her car. She can use some extra time to go to the groceries during the lunch break. Her car is a citadine one and her husband has a bigger one used for long distance/holidays. On average, she is driving 60km per day.

Dream and expectations

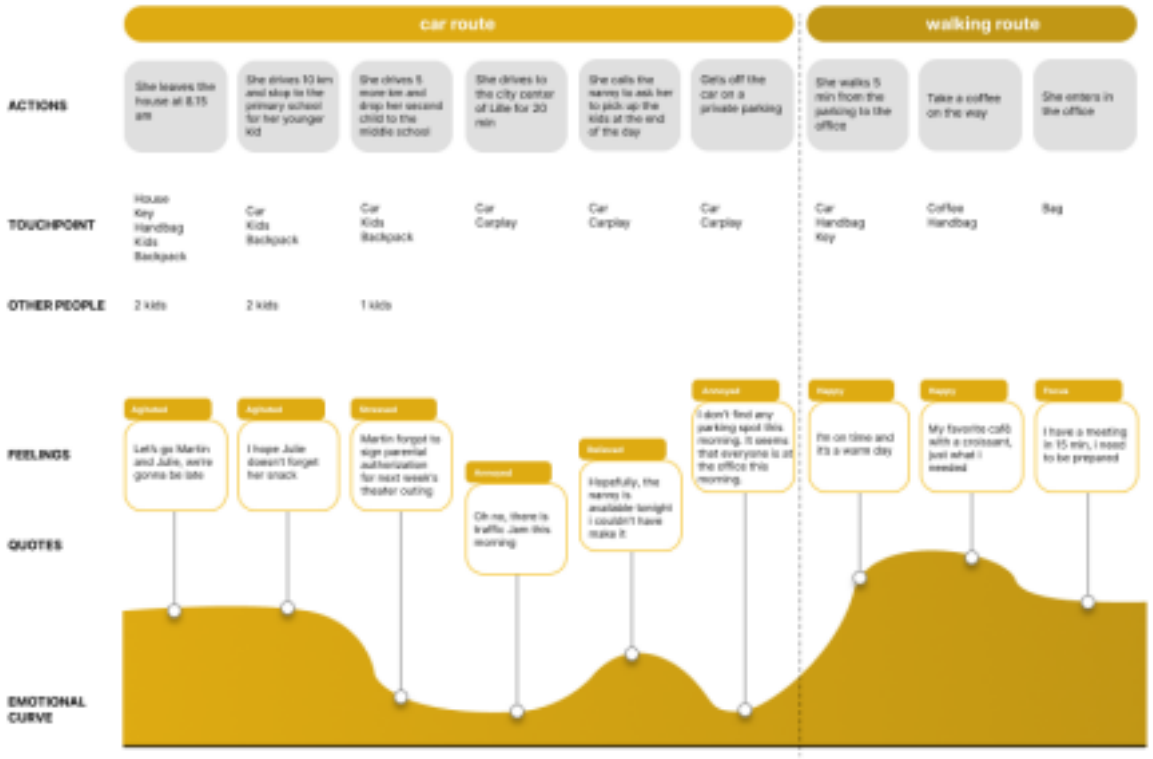
When her kids reach adulthood , her dream is to move to the countryside of La Provence (South of France) and live in a Mas (typical house in the region). She would like to make a professional retraining to open a guest house with her husband.

Pain point

- She is alone in the car but in need of more space for extra people or stuff
- Heavy car (1000 - 2000 kg) for transportation of Mr or Ms Michel of 65 kg.
- Traffic jam → loss of budget and time, stress (when will I arrive at work?)
- Time loss due to traffic
- Budget, dependence to gas fluctuation, car insurance, technical check up, reparations.
- Parking spot rage
- Too polluting car to enter the city (extra taxes)
- Space at home for parking the car

Gain point

- Travel is a time to make some calls for the work
- Avoid public transports during the weekend / to go to the city center
- Use the car to bring her kids to their extracurricular activities



IV/ The first solution idea - Segmobyl V1

To respond to our different persona's, we have designed a new type of vehicle (see Figure 1). The vehicle has following characteristics:

- The vehicle has 4 wheels for safety reasons.
- The size of the vehicle will aim to be half the length of a regular vehicle in order to park two vehicles in one parking spot.
- The passenger inside the vehicle will be weather protected. Light textile materials will

be used to do this *i.e.* dyneema fabrics or flax composites.

- The vehicle has two swappable batteries of each around 20 kg. Smaller batteries will be possible to purchase in case smaller ranges are needed.
- The vehicle can reach a maximum speed of 45 km/h without a driving license. ● There are two seats in the vehicle.
    - There will be no radio or GPS as the driver will have a spot above the steering wheel where one can put his own smartphone. The smartphone will thus do office work such as the GPS and the radio. A resonating box will do the office as a speaker.
    - This feature is important for the reduction in the use of materials and energy used to manufacture the different items.
- The vehicle is modular, in more detail, the frame of the vehicle comprises a segway, which can be removed in order to do the last kms needed to go to the destination once the vehicle is parked. One will need to put the vehicle on stands prior to removing the segway and using it. Parts of the car battery will be able to be dismounted in order to use the battery on the segway separately.
    - This feature is important for the reduction in the use of materials and energy available. The vehicle frame and battery serve for different purposes. Furthermore, this will reduce the amount of cars inside the city.
- A small solar panel will be included in the casing, in order to power the accessories of the vehicle.

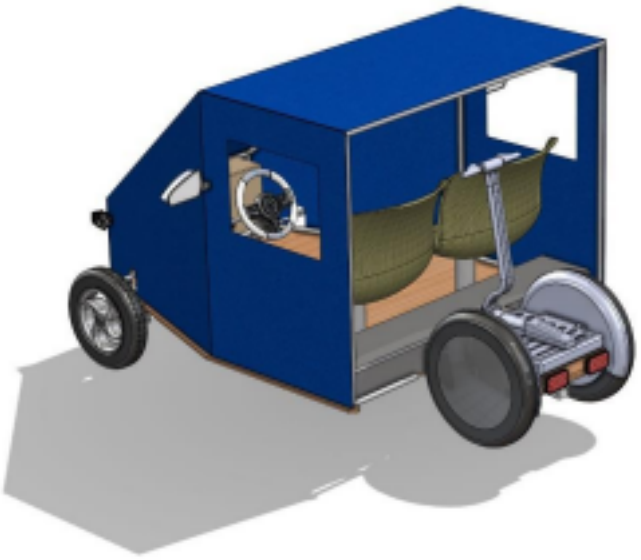


Figure 1: First design of the prototype

V/ Critical look to our first prototype

This first prototype comprised a Segway in order to drive the last kilometers. However, the Segway is not widely available or spreaded in our society. It is a result of its driving complexity as the driver needs a good equilibrium. In addition, the brand “Segway” stops its Segway production. Therefore, we made the decision to change the Segway to another mono-person vehicle, to drive the last kilometers.

VI/ The final solution - Segmobyl V2

To respond to our different persona’s, we have designed a new type of vehicle (see Figure 2). The vehicle has following characteristics:

- The vehicle has 4 wheels for safety reasons.

- The size of the vehicle will aim to be half the length of a regular vehicle in order to park two vehicles in one parking spot.
- The passenger inside the vehicle will be weather protected. And the pilot is more protected than on a bike. Light textile materials will be used to do this *i.e.* dyneema fabrics or flax composites.
- The vehicle has one swappable battery around 20 kg. Smaller batteries will be possible to purchase in case smaller ranges are needed.
- The vehicle can reach a maximum speed of 45 km/h without a driving license. ● There is one seat for the driver and one bench seat for passengers.
    - There will be no radio or GPS as the driver will have a spot above the steering wheel where one can put his own smartphone. The smartphone will thus do office work such as the GPS and the radio. A resonating box will do the office as a speaker.
    - This feature is important for the reduction in the use of materials and energy used to manufacture the different items.
- The vehicle is modular, in more detail, the frame of the vehicle comprises an electric scooter, which can be removed in order to do the last kms needed to go to the destination once the vehicle is parked. One will need to put the vehicle on stands prior to removing the electric scooter and using it. Parts of the car battery will be able to be dismounted in order to use the battery on the electric scooter separately.
    - This feature is important for the reduction in the use of materials and energy available. The vehicle frame and battery serve for different purposes. Furthermore, this will reduce the amount of cars inside the city.
- A small solar panel will be included in the casing, in order to power the accessories of the vehicle.

Figure 2: Second design of the prototype

VII/ The final situation (the uses and benefits of our solution)

The characteristics of this vehicle make it eco-responsible while meeting the needs of users.

It meets people needs:

The vehicle is made for short and middle-sized journeys (0 to 60 km) and fits with daily needs to go to work, to run errands, to visit friends, to have activities, etc within a 60 km radius. It uses the classic road network and is driven in the same way as an electric scooter with a seat. This vehicle is much lighter than a classic car, and much less energy consuming, it is the perfect vehicle for two persons and their luggage. It can be used in most types of weather thanks to its coverage.

It is eco-responsible:
The ratio of transported weight to the vehicle weight will be much bigger. We are targeting a weight of 200 kg (when empty). Thanks to its lower weight, it will also be much less energy consuming. In addition, the energy in this vehicle is electrical, which is less polluting than a gasoline-powered car if one takes its electrical energy from renewable sources.[10]

If a significant share of the vehicles going from the suburbs to the city will be comprised of this proposed intermediate vehicle, many benefits will arise from this trend:

- Cleaner and less energy intensive journeys.
- Less polluting vehicles coming into the city.
- More parking space available in the city + ease to park on the side of the roads + less traffic jams in the inner city.
- Less noise near residential buildings.
- Dedicated lane: needed for the transition; however, will not need it if/ when this type of vehicle will be widely used.
- More money saved when buying such a vehicle compared to standard cars.
- More money saved when “refueling” the vehicle.
- Ease of maneuverability due to small size and lightweight.
- Ease of navigating through narrow roads in the city.

The limits:
The major drawbacks of this vehicle:

- It was not designed for long journeys, thus a different long-distance option is needed (a car with a greater range, or train, car-sharing…).
- The maximum capacity is for 3 people.
- It is not as safe as a standard car due to the smaller size and lighter weight.

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