

Project MARCH: behind the technology of robotic exoskeletons

Final Exercise Week 6 – instructions

General Information

As we explained in the video, it's time to create your very own exoskeleton! This document provides you with the tools we use at Project MARCH to design our exoskeleton - and therefore it should work just fine for you, too. At Project MARCH, we tend to use post-its and markers to get creative, but be sure to use whatever works for you!

Keep in mind that this design exercise will not ask you to go through a *whole* design process, but up to a first sketch of your design. For this sketch, a template will be provided. Furthermore, the last part of this document gives an example of the process for the design of a car. Good luck with the exercise!

The Goal of Your Design

Before you can start brainstorming and designing your exoskeleton, your exoskeleton should first have a concrete goal. For example, the goal of Project MARCH's exoskeleton is to stimulate technological innovation within exoskeleton technology. We then always keep this goal in mind during the design process, enabling us to take more risks than other exoskeleton groups might take. Other examples of goals include designing the most lightweight exoskeleton, designing the exoskeleton with the same amount of joints as human legs, or designing an exoskeleton that provided the user with complete autonomy. There are, of course, many, many more goals, so be sure to get creative!

For this part of the process, it is difficult to provide you with a set template to come up with a goal. We can, however, recommend that you find a value or set of values, or experiences, from your own life that you deem important enough to serve as a goal for your exoskeleton, or use something that you learned in one of the previous weeks. Be sure to take enough time to come up with your goal!

The Requirements & Wishes of Your Design

Within the process, your design should fit certain requirements and wishes. Requirements are parts of the design that are absolutely necessary to create a working, functional device: they are *required*. Wishes are then the parts of the design that are necessary to reach the goal of your design: they are *wished for*.

For the **requirements**, be sure to think about:

- a. The user
- b. The context
- c. The wanted interaction
- d. Side effects to be avoided

Be sure to formulate the requirements by starting with "*the exoskeleton must...*".



For the **wishes**, be sure to keep your specific goal in mind and try to come up with a set of wishes that will help achieve your goal. Be sure to formulate the wishes by starting with “*the exoskeleton should...*”.

Make sure you take enough time to think about these requirements and wishes, since they will provide the basis for the upcoming ideation!

The “How To’s” of Your Design

After obtaining a set of requirements and wishes, it is time to start the ideation! For this, we will use the ‘**How to**’-method. This requires you to reformulate your requirements and wishes into how to’s. For example: the requirement “*the exoskeleton must be safe to operate*” translates into the how to “*how to make an exoskeleton safe to operate?*”. Be sure to do this for all of your requirements and wishes!

After you have created your how to’s, it’s time to brainstorm. For this, you need paper sheets (A3-size works fine), something to write with, and a timer. Be sure that you will not be distracted during this process, so that you can fully focus on getting creative. Label each of the paper sheets with one of your how to’s, until you have all of them written down on separate sheets. Then, take a sheet and lay it in front of you. Set the timer to 3 minutes, and press start. During this time, write down as many answers to your stated how to as you can think of - there are no wrong answers! If possible, make a sketch to visualize the idea. After the 3 minutes, stop brainstorming, grab the next how to and repeat the process. Do this until you have finished all of your how to’s! Some might be more difficult or abstract than others, but you will surely come up with at least one idea per how to.

Picking the Components of Your Design

By now, you should have a wide variety of ideas to fulfill your requirements and wishes. But, how should you then make a selection of all the ideas you have generated?

In week 2, you used a *C-box* to assess the ideas you generated. For this exercise, you are free to do so again if you want, but you can also choose a method of your own! In the end, it’s about being able to justify the design choices you make by arguing why they fulfill the set requirements and wishes.

Sketching Your Design

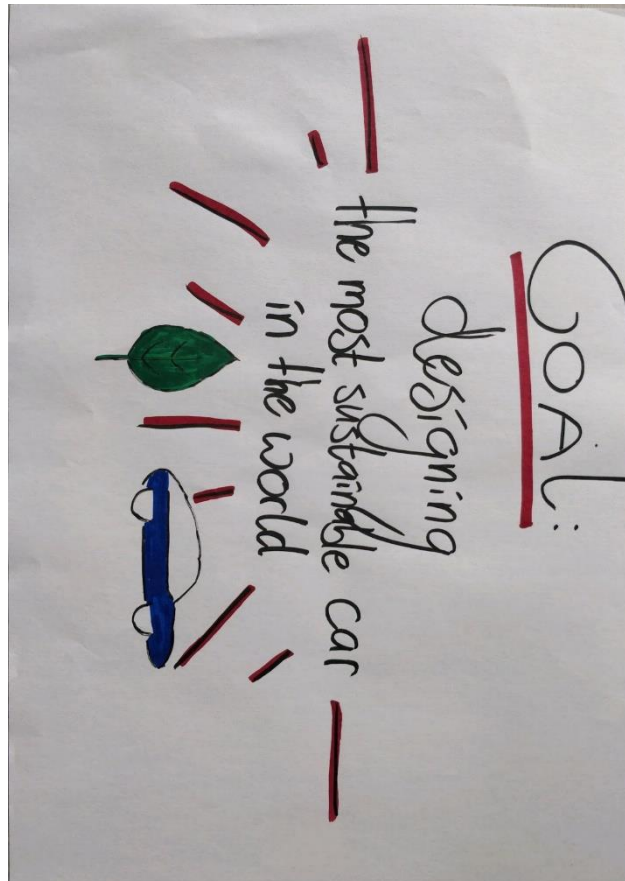
Now that you have a selection of your preferred ideas, it’s time to create a sketch! The template is provided as a separate document on EdX.

Example

For this exercise, we have provided an example of a similar design process for you to use as inspiration and guidance. In this example, our goal was to design *the most sustainable car in the world*.

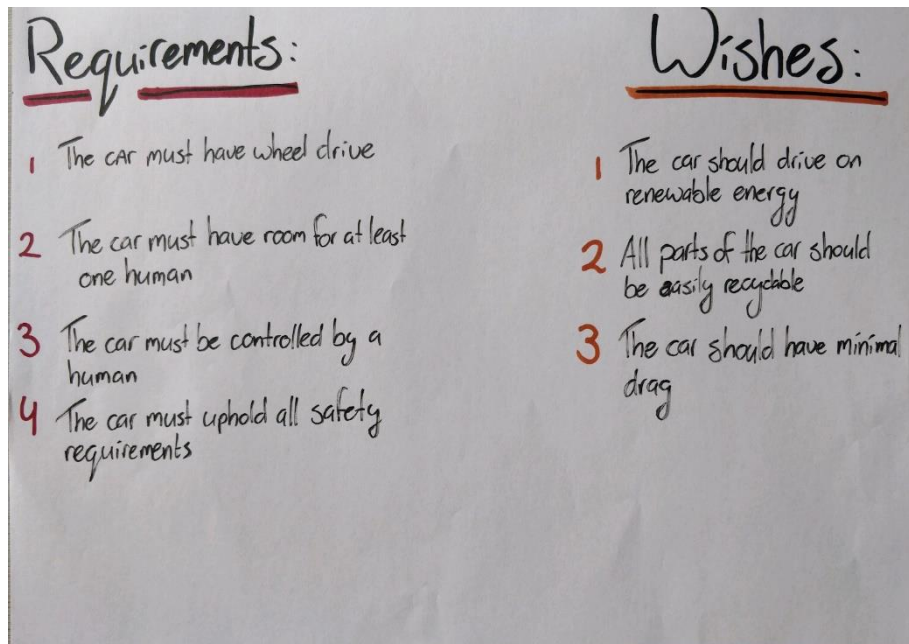
The goal of this design

We greatly value sustainability, and recognize its increasing importance in our world. Therefore, the goal of our design is to create the most sustainable car in the world.



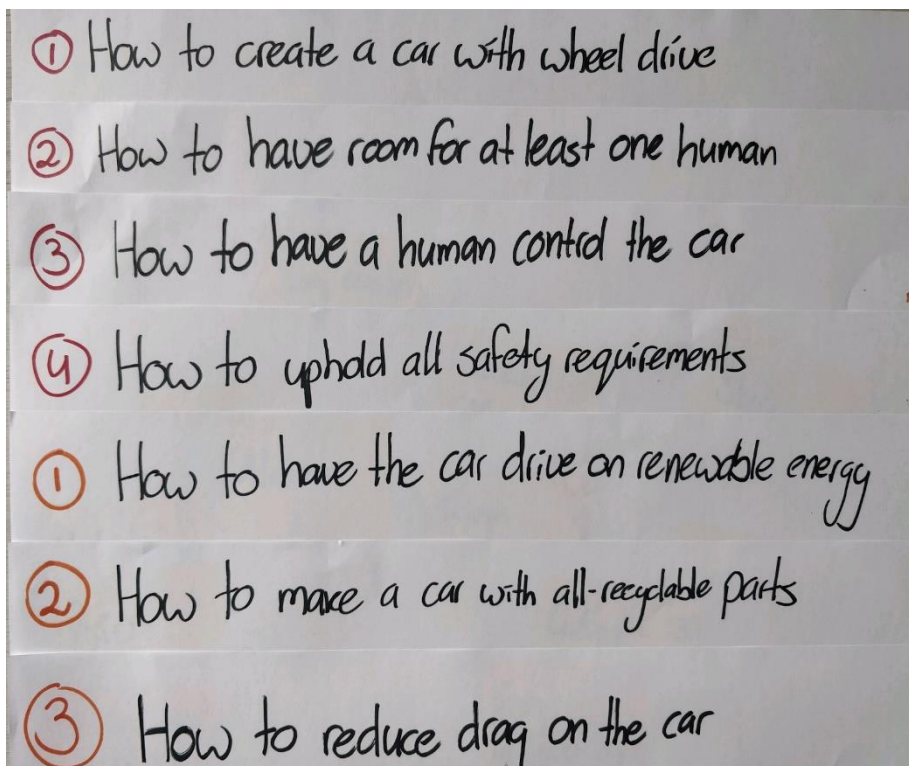
Requirements & Wishes

There are certain requirements that should be fulfilled in order for a car to fulfill its purpose of being an actual car. Then, for it to actually be the most sustainable car in the world, it should meet certain wishes, too.



How To's

In order to start brainstorming, the requirements & wishes have been rewritten to their respective how to's.



After brainstorming, the following ideas were created:

① How to create a car with wheel drive

Connect engine to wheels 1

② How to have room for at least one human

Lay down 1

Standing 3

A door 2

Seat 4

③ How to have a human control the car

Brain-computer interface 1
 Pedals 2
 Voice Control 3
 Human-car interaction 4
 Steering wheel 5
 Buttons 6

④ How to uphold all safety requirements

Meters 1
 Alarms 2
 Tough material 6
 Crumple zone 7
 Automatic shut-down mechanism 4
 Safe batteries 3
 Airbag Mirrors Lights 5
 International standards 8

① How to have the car drive on renewable energy

Bio-fuels 1
 Solar power 2
 Wind power 3
 Nuclear energy 4
 Hydrogen 5

② How to make a car with all-recyclable parts

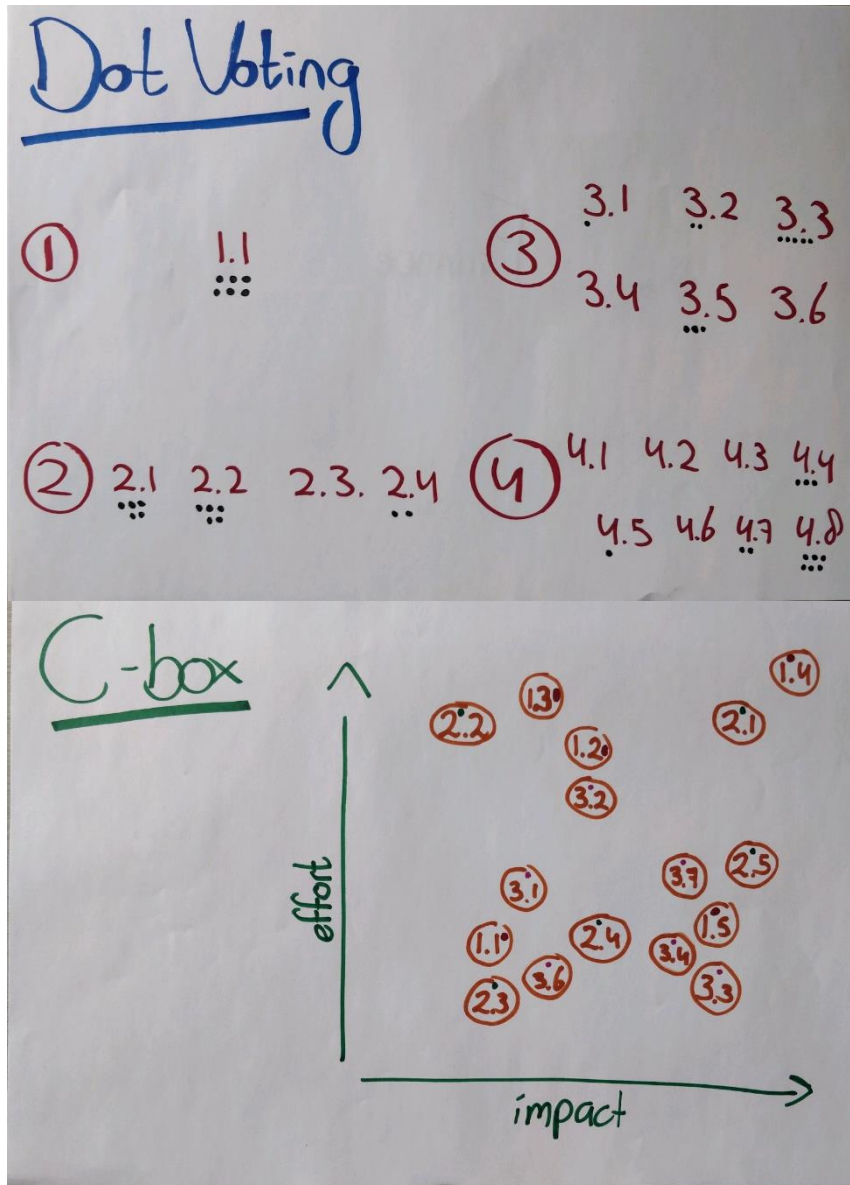
Biodegradable parts 1
 Modular car 2
 Easy disassembly 3
 Recycled material for production 4
 Recyclable material → no plastic 5

③ How to reduce drag on the car

Base minimum: no luxuries 1
 Very small 2
 Lightweight material (carbon?) 3
 Smooth surface → golfball dimples 4
 Close to the ground 5
 Droplet Shaped 6
 Small amount of tires 6

Picking the design components

With so many design ideas, it can be difficult at first to pick the most feasible ones. For this, two methods were used. First, the requirements were ranked using the 'dot voting' method: for each requirement, a top-3 was created by assigning your favorite idea 3 dots, your second-favorite idea 2 dots, and your third-favorite idea 1 dot. The other ideas get no dots. You can do this individually, or together with other people. Second, the wishes were ranked using a C-box similar to the one from week 2, with the axes on this C-box labeled 'effort' and 'impact'. The effort-axis tells you how much effort is needed to implement the idea, while the impact-axis shows how much impact the idea has on the goal (of designing the most sustainable car).



The numbers correspond to their respective How To and generated ideas.

Design Sketch

After making a selection of the best components, the following sketch was created! While this is clearly a very rough sketch of what the eventual design would look like, it does provide the basis to further design upon, ultimately creating the most sustainable car in the world!

