

Materials and Manufacturing:

Re-design Component

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1. Introduction

Design is mainly about coming up with new ideas, illustrating them and considering any further developments before coming up with the final product. Sometimes, there's already a market which needs investigation and development of current existing products. But, there are plenty factors to consider before starting a new designing project. Design starts from moral and ethical aspects which need to be respected through the whole process of design and development. For example, there is the need to think about sustainability in design, because what surrounds us has to be protected. An important part of sustainable design is also being able to redesign existing products.

As Jonathan Chapman said in his book, *Design for (Emotional) Durability*, 2009, “Sustainable design is maturing”. So, in this design report, there will be a re-design of an existing product, such as the Scooter X Sport Go-Kart, and it will be transformed into a new and completely different product: a Mars exploration buggy.



Figure 1

2. Part analysis

The simple design of the Scooter X Sport Go-Kart mainly consists of the external steel frame, which has a straightforward design but also sporty look. This thin frame can satisfy its main purpose: fun riding experience for pre-teenage children. But due to being too thin, it doesn't have much resistance and strength for off-road extreme karting, “the kind that involves lots of bumpy roads and rocky mountains” (My Pro Rides, 2017).

The material the frame is produced off is widely known in the transportation industry as it is one of the most used. Steel has a high strength to weight ratio, which leads to a lightweight material with high strength per unit mass. It is also hard and resistant, which makes it last long on outdoors and extreme conditions. Moreover, producing the frame is easy as steel is ductile, which makes it easily deformable without losing toughness. Firstly, raw steel is casted into a better and more workable starting form. After that, it is “made into a pipe by stretching the steel out into a seamless tube or forcing the edges together and sealing them with a weld.” as said in the forum: how products are made, 2019. Lastly, it takes the desired form by forge and by bending machines.

But, the go-kart is also composed of other important parts, such as the wheels. These are probably made of aluminium, which is characteristic for being cheap and giving a good performance. Wheels of this type are usually manufactured by casting which is the process of getting molten aluminium inside a mold to form the desired shape.

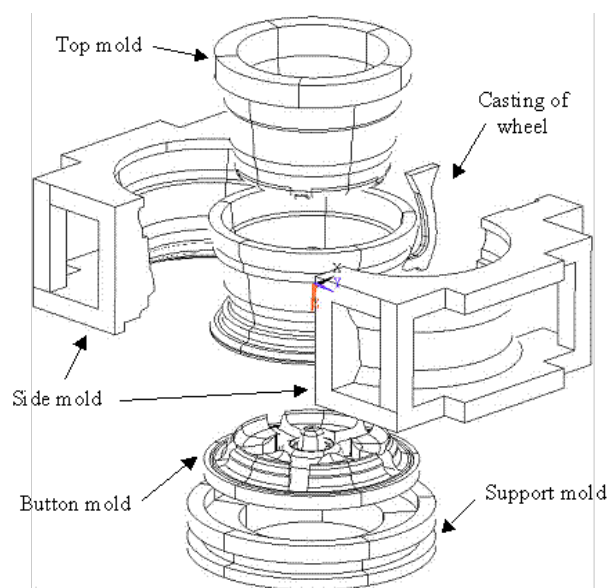


Figure 2

Lastly, the other main part of the go-kart is the seat, which is made of plastic, more specifically, of a high density polyethylene. This lightweight, durable and cheap material gives security to the rider as its' form is adapted to human shape. It is manufactured by injection moulding, which is a process where melted plastic is injected into a mould and then left to cool and to solidify.

3. Typical use and work environment

The Scooter X Sport Go-Kart is not an extreme off-road vehicle as similar ones might be. It is manufactured to fit between the age range of "children and pre-teens" (My pro rides, 2017), so it can only handle some uneven terrains, like mud and sand, for example. It is typically used for having fun outdoor experiences while being safe, as it doesn't exceed 45 MPH but it lasts a long time on flat surfaces.

4. New work conditions

For an updated and totally new use for the product and its' frame, we will consider making a light Mars exploration buggy. The main issues to be considered are the weight, as it is very important for transporting objects to space, and its' needs to have off-road ability. For this, it is necessary to make the buggy more resistant, as Mars' surface conditions will be similar to the ones we get in mountains or rocky deserts. This new

work conditions are not liable for the current go-kart, as it is not strong enough and it's wheels can not handle those obstacles and uneven surfaces.

5. Design considerations

To enable the new frame to complete new tasks, the main focus has to be on the modified overall structural elements and therefor on the new materials and manufacturing processes. These modifications are mainly focused on the weight of the whole Mars buggy, as it's one of the most important factors taken into consideration when transporting things to space.

The whole buggy is thought to be only for the astronaut and its' commodity, as well for it to have more control over movility and directions of the vehicle. For this, the seat will be bigger and safer. But, it will have to carry, when necessary, a trailer with useful things such as storage space, a special aid kit and repair tools. This gives the possibility of gaining movility and speed when the exploration doesn't requiere extra storage, such as a quick trip from base to base.

6. New part design

The new Mars buggy will have minor exterior changes to maintain the essence of the go-kart. But, these changes will have a massive impact on further performance. As said before, it's important to improve the strenght and weight of the vehicle. For this, it will

be necessary to use the strongest and lightest materials possible, such as metallic microlattice. This innovative material has “Strength and record-breaking lightness” which “make it a potential metal for future airplanes and vehicles.” (Yang, 2015). This material will be used as a structural reinforcement for the frame in places such as the bottom, front and sides of the buggy. But, the rest of the frame will be made of carbon nanotubes, which is “nearly 20 times stronger per pound than carbon fiber” (Sherman, 2015). Also, the whole frame will be thicker, but as the materials used are already stronger than the go-kart frame, it will only need to be a small percentage thicker.

Another important part to consider are the wheels. These will be replaced by bigger and more resistant ones, which can handle the obstacles and uneven surfaces on Mars. These wheels will be similar to the new and innovative non-pneumatic tires (NPT) Hankook iFlex. This cutting edge technology is entirely built with eco-friendly materials, and most importantly, they are airless which means that they will never suffer a flat tire, which gives security to the whole Mars exploration. The South Korean Company has developed a geometrical structure which is strong enough to resemble a traditional wheel.



Figure 3

Also, the movility of the buggy will be generated by high technology batteries connected to solar cells, which all will be located in the back. This will not only make it sustainable, but also self-sufficient. The astronaut will also have two supplementary small bags in each side of the seat, with utilities such as basic tools, small first aid kit and free space for storage.



Figure 4

7. New manufacturing method

The manufacturing process will be complex for some of the high-end technology materials. Metallic microlattice is a new material which can be manufactured by processes such as “deformation forming process” which “involves shearing and

expanding metal sheets” (Rashed, M.G. et al, 2016). This will create a perfect and strong sheet for the bottom of the buggy.

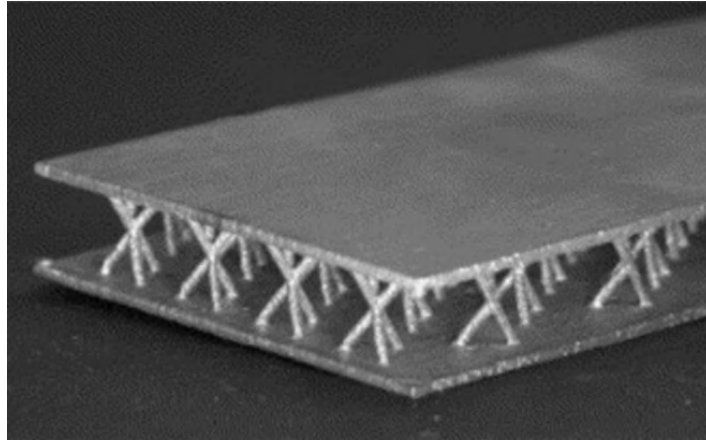


Figure 5

Carbon nanotubes are produced by zapping together carbon particles with a laser in furnaces. This material has already been introduced in the automotive industry, for example, with great results due to its' lightweight and strength. So, the manufacturing process for the new frame, will be done by an external specialized company, such as Zyvex Technologies in Ohio, US. Also, the seat will be made of carbon fiber, manufactured by this company with a molding process.

Even though the wheels will be manufactured by Hankook, we can assume that the producing method will be similar to the conventional way of manufacturing tires, with processes such as: blend, mill, build and cure.

8. Advantages and manufacturing process

Mainly, there are advantages about the new materials used for the buggy. These improve the overall performance of the vehicle, as well as satisfying the main necessities of being lightweight, strong and resistant.

Also, using high quality materials and manufacturing methods derive in more security for the overall project.

9. Cost justification

As many parts will be manufactured by external companies due to their specialization, the cost will increase. But, even though the overall costs will be high, they are justified, because a fail on a space exploration is a massive loss of money. It is preferable to secure high quality products, than losing millions invested on the exploration.

10. Conclusion

All in all, constructing a Mars exploration buggy from an existing go-kart is not an easy job, even more if we want to maintain the essence of it and make minor changes to its exterior appearance. Sustainable design helps us achieve the goal of this project and more importantly, makes us think about making a change for the environment with our work. "The real passion of design is in its philosophical, ethical and practical debate" (Faud-Luke, 2009). So, let's start a change by designing sustainably.

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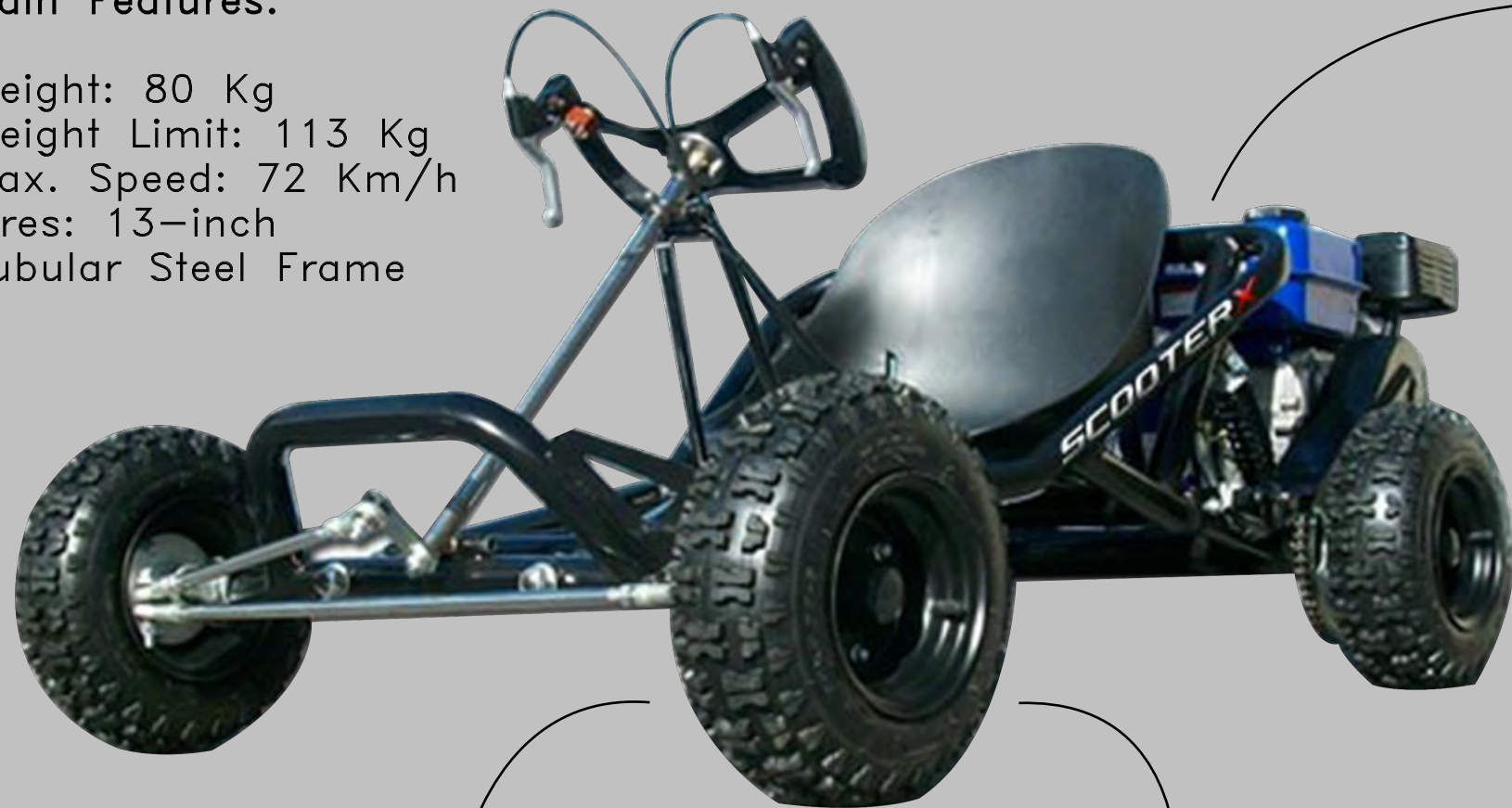
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SCOOTER X SPORT GO-KART: PRODUCT ANALYSIS

Main Features:

Weight: 80 Kg
Weight Limit: 113 Kg
Max. Speed: 72 Km/h
Tires: 13-inch
Tubular Steel Frame



FRAME: STEEL

Properties:

- High strength to weight ratio
- Ductile
- Durable
- Cheap
- Easily produced

Manufacturing method:

- Raw steel is casted
- Rteel streched into a tube
- Sealing with a weld
- Desired form by bending and forge

SEAT: HIGH DENSITY POLYETHYLENE

Properties:

- Lightweight
- Durable
- Cheap
- Resistant
- Tough

Manufacturing method:

- Injection moulding:
- Inject melted plastic into a mould
- Let cool and solidify

WHEELS: ALUMINIUM

Properties:

- Lightweight
- Good performance
- Cheap
- Easily produced

Manufacturing method:

- Casting:
- Melt aluminium
- Put inside a mold to obtain the desired shape

TIRE: RUBBER

Properties:

- Abrasion resistance
- Extensible
- Tensile
- Easily produced

Manufacturing method:

- Mix raw materials, mill and remix with additional chemicals
- Squeezed in mills into sheets and extruded
- Tire-building machine
- Cured



SCOOTER X SPORT GO-KART: OLD vs NEW

FRAME:

Steel:

Strong.
Lightweight.
Easily produced.
Cheap.
High maintenance cost.

VS

Carbon nanotubes:

Stronger.
Lightweight.
Tough.
Stiff.
Expensive.

Metallic microlattice:

Strongest.
Lightweight.
Energy absorption.
Stiff.
Expensive.



SEAT:

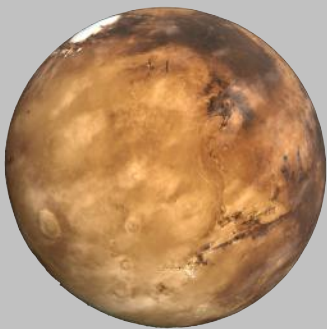
Plastic (HDPE):

Lightweight
Durable
Cheap
Resistant
Tough

VS

Carbon fiber:

Strong.
Lightweight.
Rigid.
Resistant.
Expensive.



WHEELS:

Aluminium:

Lightweight
Good performance
Cheap
Easily produced

Rubber:

Abrasion resistance
Extensible
Tensile
Easily produced

VS

Eco-friendly materials:

Non-pneumatic tires
Strong
Abrasion resistance
Secure

Main Features:

Weight: 40 Kg
Weight Limit: 223 Kg
Max. Speed: 90 Km/h
Tires: 20-inch

