

Faculty of Engineering
MCG 2101
Introduction to Design of Mechanical Systems

Design project B: NC-Handcycling new product

Context

The paralympic games are becoming every day more competitive over the different categories of each discipline. In particular, para cycling road H5 had champions from Netherlands and USA in 2024 Paris Paralympic games (see **Figure 1**).



Figure 1: Gold medalists in the Paris Paralympics games 2024 in the category of Para Cycling Road H5 in men (left; Mitch Valize, NED) and women (right; Oksana Masters, USA) competitions.

In this project, you will play the role of a consultant company specialized in the design of mechanical systems. Your client is the company NC-Handcycling, specialized in manufacturing bikes for people with different types of disabilities. This company has recently obtained funding from Team Canada to develop a bike for competition in the category “Para Cycling Road H5”. In the context of Paris para cycling, we have the H1 to H5 (H is for “handcycling”) categories involving athletes with spinal cord injuries or competing with prosthesis in one or both lower limbs. Take the following section as a direct communication from NC- Handcycling CEO.

NC-Handcycling request

We are interested in the development of a new product consisting of a bike for the mentioned competition “Para Cycling Road H5”. Even though there are many options in the market available for adults, there are no such bikes for children and thus we are interested in the development of a product for them. Team Canada is interested in training children to become future sport stars and needs our help to manufacture the bike they need to get trained. We would like to take the

following into account for its design,

1. We need the product to be **safe and comfortable** for children as they may use them for many hours during a single day.
2. An ergonomic design is important to **prevent any injuries** from cyclists.
3. We need the bike to be as **energy efficient** as possible so children can get used to speed race which is needed to be competitive in paralympic competitions.
4. We need it to be made with **materials available in Canada** so we can use this property for marketing purposes in the future.
5. Of course, the design must be **feasible** to be manufactured by machine shops available in Canada.

The consideration of these factors in your design is essential for us as they will be key elements to strongly position our product in the market and develop a sustainable business. We will also appreciate any further considerations you may have from your end to develop a product of high quality to satisfy the exigent market Canadian cyclists with disabilities.

Here we describe the product that we have in mind and the specific parts where we seek for your help considering your experience with mechanical system design. **Fig. 2** shows a raw ide of the system we have in mind where 4 main components are identified namely: the frame including a seat (1), front wheel (2), rear wheels (3), and the transmission system (4). We note that we have purposely kept the design as simple as possible to give you the freedom to use your imagination and propose any modifications you estimate convenient. Your help is needed to design the transmission system and frame (including seat) as highlighted by the red box in **Fig. 2**. The wheels will be purchased from a specialized company. We are particularly interested in adapting these components for children between 9 to 17 years old interested in training for competitive handcyle racing.

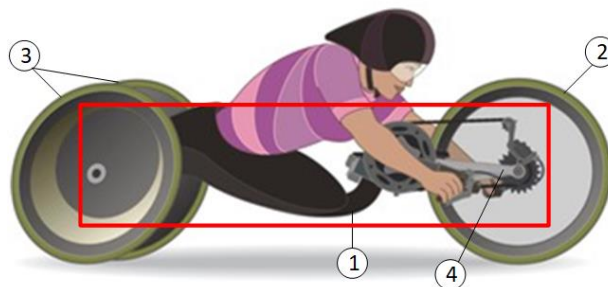


Figure 2: Main components of a handcycle consisting of a frame (1), front wheel (2), rear wheels (3), and transmission system (4).

Important considerations

This project will be carried out step by step all along the winter term. By the end, you will submit a complete and detailed design including the requested transmission system and frame. Please note that you **do not need to design additional components of the handcyle** including the

wheels. However, your design must certainly take them into account to be ensembled together.

By the end of this project, you will **submit a report** and make an **oral presentation** where you will explain how your design addresses all the concerns of the NC-Handcycle company.

The system that you will design must be purely mechanical – you can use pneumatic/hydraulic switches if needed, but everything else must be enacted by mechanical components only. Similarly, you cannot simply propose a commercially available design as it will not meet the requirements of the NC-Handcycle company.

Although there are some design considerations not mentioned by NC-Handcycle, they are expected from professional engineers which is the role you play in this project. This includes health and safety as well as environmental considerations. Of course, making a realistic design that could be manufactured by machine shops in Canada and that NC-Handcycle can use to obtain profit from selling the new product is essential.

Development of your concept must be based on the methodology steps discussed in class. The concept must reflect the work that you will do then, and the conclusions that you will reach, working in teams, going through these steps.

You must present an assembly drawing featuring enough orthogonal projections ('2D views'). The assembly drawing hardcopy must be produced on a large sheet (minimally A1 for example) or in pdf format if you worked with a CAD software. On the assembly drawing, your main parts must be identified with numbers that also appear in a list of parts on the drawing. Your assembly drawing must be presented on a single sheet. Use of color is not advised; 2D views must be drawn in black only. Use different line types for axes, hatching (when needed), etc. following rules discussed in class. You may use isometric projections ('3D views') showing all or part of the assembly in the report – along with renderings – to discuss your design and its operation. However, limit the number of isometric projections and avoid renderings in your assembly drawing.

YOUR ASSEMBLY DRAWING MUST ENABLE COMPLETE & QUICK UNDERSTANDING OF THE CONFIGURATION AND OPERATION OF YOUR CONCEPT, USING ONLY REASONABLE EFFORT AND NO GUESSING. THE DRAWING MUST MAKE PERFECTLY CLEAR HOW THE CONCEPT IS BUILT, AND HOW IT WORKS.

As discussed in class, the number of views required is left to your good judgment but must enable good understanding of the concept, its operation and its construction. You can, if you wish, add A LIMITED NUMBER OF FEW 3D views. However, the drawing must be complete. It is expected that you will do most of the design working in teams, out of class hours.

A SolidWorks file is optional and appreciated – however, submitting the drawing is mandatory as it is the drawing only that will be marked. **SUBMITTING ONLY SOLIDWORKS CAD FILES WITHOUT A PDF ASSEMBLY DRAWING AS DESCRIBED HERE = A MARK OF ZERO FOR THE PROJECT, WITH NO EXCEPTIONS.**

Online resources

Below is a list of online resources that may have important information to consider for your design. By all means, you are expected to do your own research.

Canada Para Cycling: <https://paralympic.ca/sport/para-cycling/>

Bike on: <https://bike-on.com/handcycles/>

International Paralympic committee: <https://www.paralympic.org/cycling>

Nathan Clement story: <https://www.youtube.com/watch?v=Bqj28CtHTvs>

Sanguinetta, M., Incerti, G., Amici, C., & Legnani, G. (2024, January). Handbike for Daily Use, Sport, and Rehabilitation Purposes: A Literature Review of Actuation and Technical Characteristics. In *Actuators* (Vol. 13, No. 2, p. 50). MDPI. <https://www.mdpi.com/2076-0825/13/2/50>