Master's Thesis Engineering Technology

2023-2024

Validation and prototyping of the Outrunner design on a Formula Student race car

A Formula Electric Belgium thesis

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Master of Electromechanical Engineering Technology

FEBs current set-up

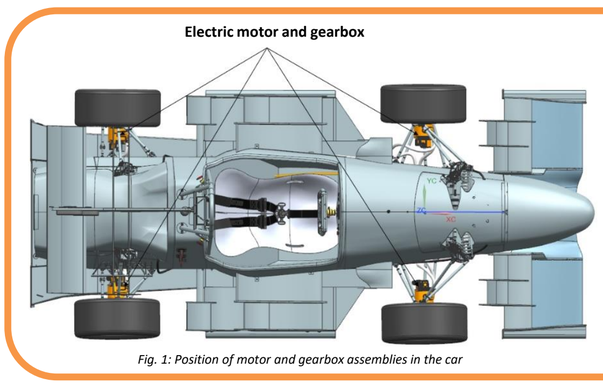


Fig. 1: Position of motor and gearbox assemblies in the car

- Motor and gearbox are inwheel placed at every wheel
- Drives on 13-inch rims
- High top speed – low acceleration
- A planetary gearbox with a stationary ring gear
- High inertia of the wheels

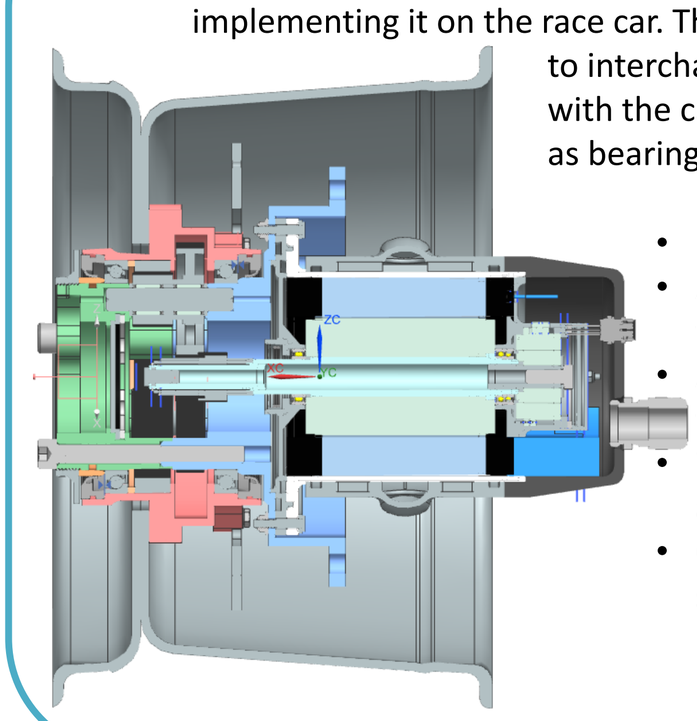
FEBs needs

- Gearbox and motor fully embedded in the rim
- A compact design capable for 10-inch rims
- A working and tested prototype ready for season '23-'24
- A planetary gearbox with a rotating ring gear
- High acceleration, a gear ratio of 11,35/1
- It needs to last 10 hours in real life

From Digital To Physical

Digital Design without errors

Following design is made specifically for the test bench. It is designed to validate the performance before implementing it on the race car. Therefore, its designed to interchange as many parts with the current gearbox such as bearings, gears and hardware.



- Uses valid motor mounting
- Axial power distribution happens through aluminum components
- A pretension nut is added to set the preload
- 77% of the motor and gearbox are embedded
- Custom designed and made PDR-sealings are used

Fig. 3: Digital render of the new Outrunner design

Digital Design with errors

This thesis starts from previous research where made a digital design has been made with following error's:

- Invalid motor mounting by the Formula Student Rules
- Axial power distribution appends through weak components
- Only 50% of the motor and gearbox are embedded in the rim
- No way to adjust the preload on the bearings
- Used under-qualified sealings
- Axial power distribution happens through weak components
- No interchangeability with the current design
- This design is not fully assemble-able

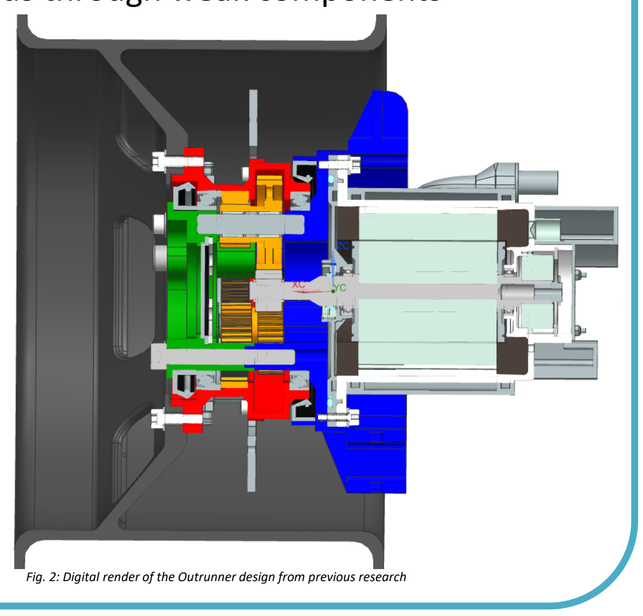


Fig. 2: Digital render of the Outrunner design from previous research

"Outrunner"

Prototype validation

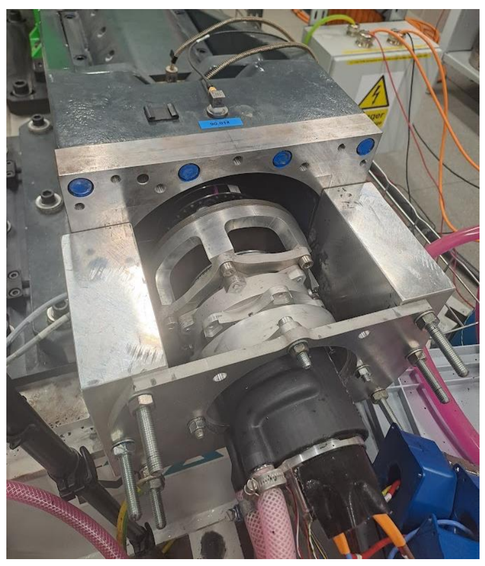


Fig. 4: Physical Outrunner assembly on the test bench

As validation the gearbox will continuously run a real driving cycle of a race. Based on temperature, vibrations and oil leaks through time, the gearbox will be evaluated.

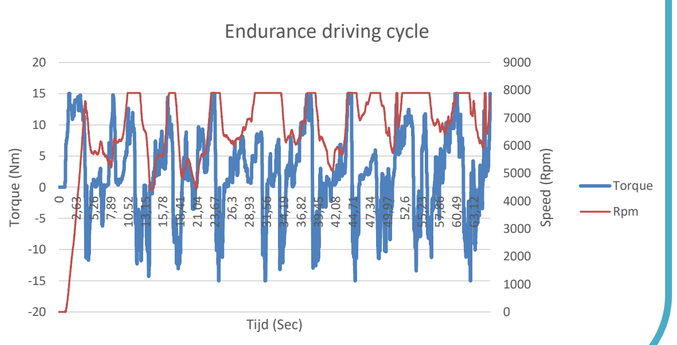


Fig. 5: Endurance driving cycle

Results

- The gearbox is fully manufacturable and assemble-able.
- An oil leak has occurred due to a surface that is too soft.
- The gearbox can run for 28 hours under realistic load.
- All needs are fulfilled.

Fig. 6: Outrunner assembly

Fig. 7: Outrunner components lay-out

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De opleiding industrieel ingenieur is een gezamenlijke opleiding van UHasselt en KU Leuven