Imperial College London

The Mobula Ray – Dare to Dive

The Underwater Propulsion Device for Leisurely Divers

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Features

Performance

- 2 hours underwater on one charge
- Average speed of 2 kph
- Up to 15m depth
- Operation temperature range 5-50°C

Functionality

- Twin motor and propeller systems
- Rechargeable lithium Ion Batteries (18650)
- Fits two devices in standard hand luggage

Ergonomics & Recyclability

- Hard handle case is wrapped with a textured flexible TPE
- Propellers placed laterally
- Easy disassembly and replacement of parts

Price

- Initial price evaluation: ~£150
- Sold at ~£180
- Profit margin: ~ 20%

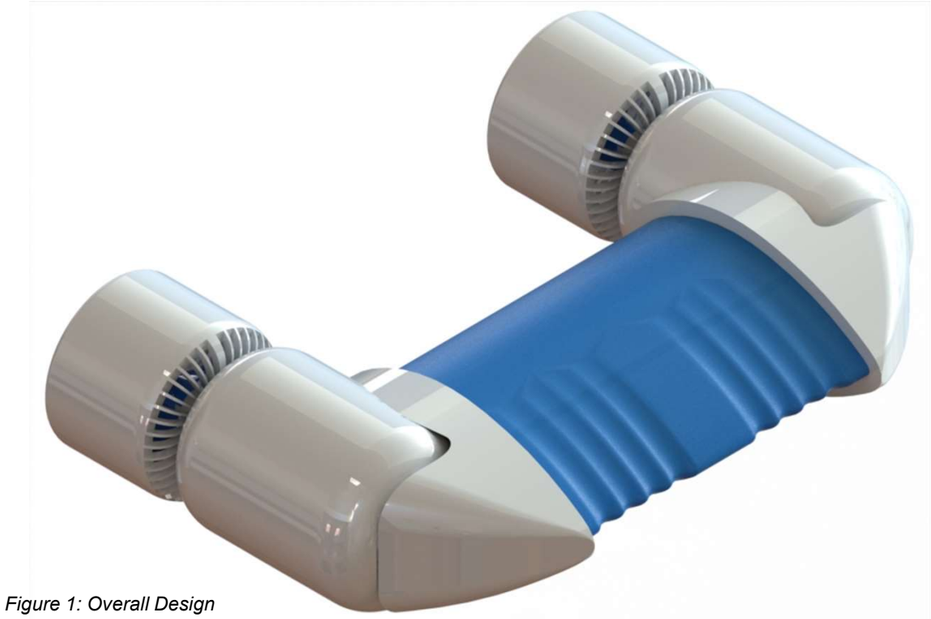

Figure 1: Overall Design

Power Transmission

- Batteries provide 180 W
- Motor operates at maximum efficiency (67%)
- Transmission with gear ratio of 1:11.9
- Propeller accelerates the water providing thrust.

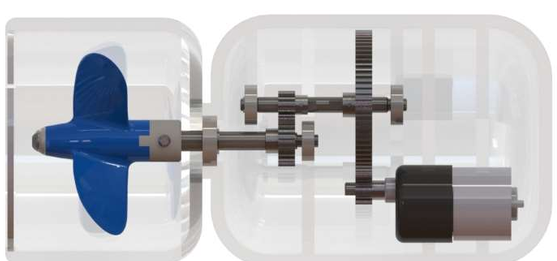

Figure 2: Power Transmission Design

Casing

- Fully recyclable LLDPE casing with modular design
- Battery module within the handle for convenient charging
- Waterproof- protecting electronics and transmission
- Streamlined design reducing drag (drag force = 17.3 N)

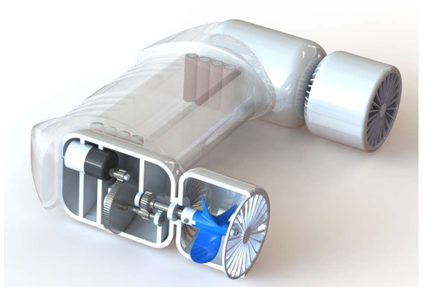

Figure 3: Sectioned View of Casing

Failure Mitigation

- Low stress on the casing from operating pressure (Safety Factor = 5.24)
- Low stress from the bending moments and torsion on transmission shafts (Safety Factor = 13.1)
- Low fatigue stress of transmission shafts (Safety Factor = 11.6)

Materials & Manufacturing

AISI 1015 cold-formed carbon steel for the shafts

Linear Low Density Polyethylene for the casing with these properties:

- Excellent for injection moulding
- Excellent durability in fresh/salt water
- Low density (918 kg/m3)
- Water absorption of 0.005% gain in weight after 24 hours
- Injection moulding for production of 25,000 units
- Constant thickness of 6 mm to allow plastic material to cool evenly

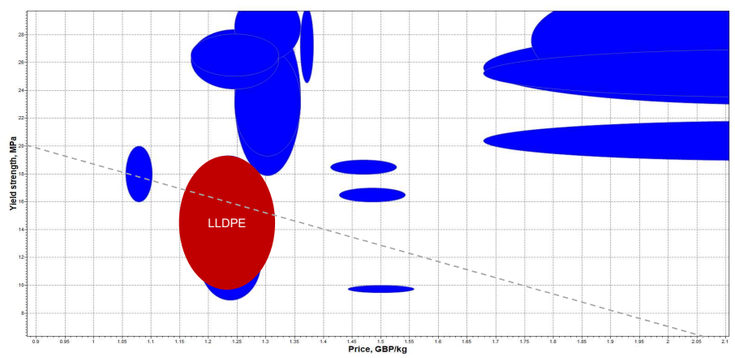

Figure 4: Yield Stength vs. Price for injection moulded plastics –Index filters materials based on densities

References
- CES EduPack. (2019). Granta Design.
- SOLIDWORKS 2019