Para-cycling prostheses development:
Reflections & benefits of a holistic approach.

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Background
Introduction

‘There is currently limited information and guidance to help inform NGB’s as to how to develop the high performance technology of elite athletes who possess limb absence’. (Dyer, 2018).

Introduction

‘The potential grounds exist for assistive technology to provide a measurable mechanical ergogenic effect’. (Dyer & Disley, 2019)

London 2012 Project
Cycling Prosthesis Project

2012 Brief: To create a lower limb cycling prosthesis:

1) For an elite level athlete

2) For the demands of two very different events

3) With extremely tight development time (6 weeks)
Mixed Race Objectives –

- **Track 1km TT:**
  - An event requiring an aggressive start and high power output for ~60 seconds @ ~600w

- **Individual Time Trial:**
  - An endurance event of ~20km. Aerodynamic efficiency is critical. Effort = ~300-400w
Project Constraints

• Lack of expertise ….. so had to be found.

• Lack of knowledge …….. so had to be discovered.

• Lack of development time….. so had to be shortcut.

• Lack of resources ….. so had to be theoretical.
‘When it comes to prosthetic-level components, aerodynamics matter’ (Dyer 2015)

The Concept: The Kamm Tail

- A profile that utilises aerodynamic efficiency
- Is stiff laterally
Iteration as a tool of development in both fit and function prior to final finishing.
Design Realisation
Design Justification

• Reduced Weight – increased acceleration of athlete.

• Increased stiffness – efficient power transfer.

• Improved aerodynamic efficiency – reduced drag.

• Does not infringe current bicycle technology legislation.
Rio 2016 & Invictus Games Projects
Cycling Prosthesis Project

2016 Brief: To refine and quantify performance enhancement for an evolved design of lower limb cycling prosthesis:

1) For an elite level athlete going to Rio 2016 (and another at the Invictus Games).

2) For the demands of 3 very different events:
   - 1km track TT.
   - Road race.
   - Individual time trial.
A New Model
Statistical analysis of event results revealed that the athlete classification were dominated by those using a prosthetic limb. Best scope for investment and medal success!

Legislative rules analysis revealed loose/vague criteria and therefore allowed plenty of scope.

Aerodynamic testing of a technology (never before evaluated) defined the best concept and a quantifiable performance enhancement.

Personalised customisation of prosthetics builds a potential athlete-product positive relationship.
2016 Design Realisation (2)
What about the future of Paracycling technology?

(it may not be in engineering & technology at all !)
Where else can we look for performance enhancement?

Is emotional design a solution?*

**Method:** 5 elite paracyclists were surveyed using a modified 31 question product attachment survey.

**Results:**

- The basis of an emotional product relationship was highly polarized.
- That an ‘appearance follows performance’ approach may be of value.
- The prostheses decorative personalisation is desirable in some cases.
