E-BIKE **FRAME**

ME3 DMT

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PROJECT BRIEF & OBJECTIVES

Designing a frame for an **e-bike** which is robust, and which accommodates the other subassemblies from the group to create a fully functioning e-bike.

Providing sufficient strength under the **weight of a rider** to ensure safety during functionality.

MANUFACTURING TIMELINE

Custom tubes shipping
Metals 4u

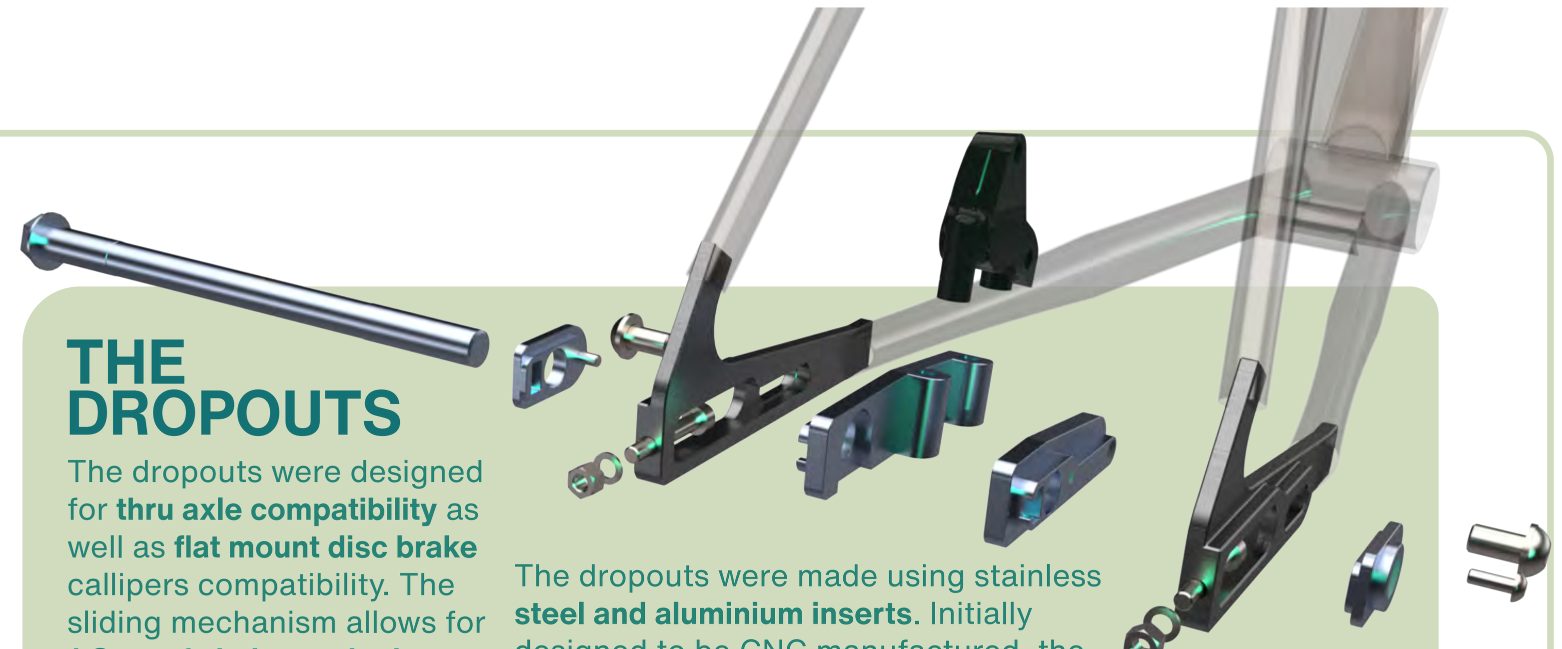
Motor plate shipping
Motor team

Dropout plate manufacturing
LaserMaster

Frame frabrication
The Bicycle Academy

Frame delivery
Testing begins

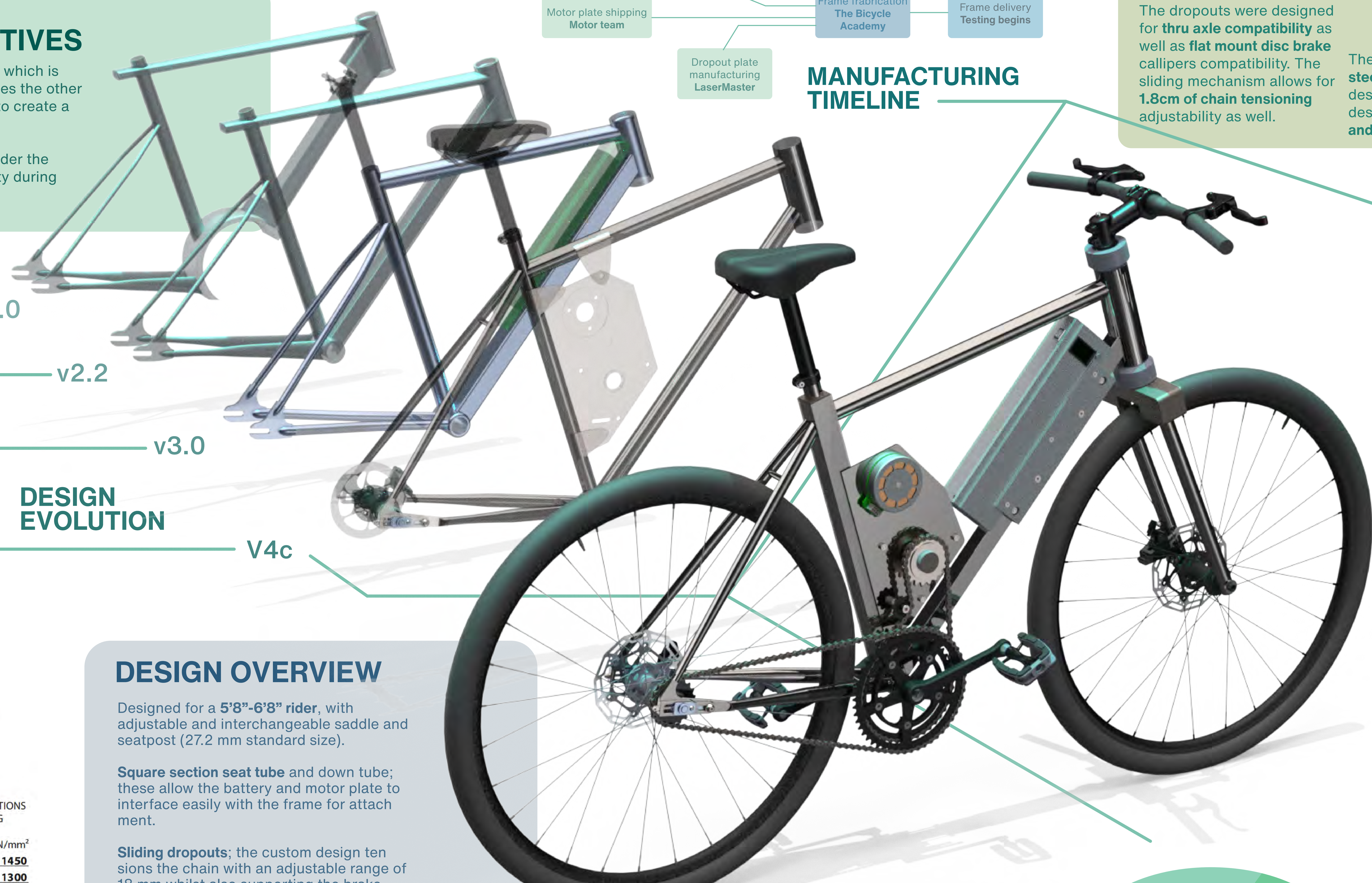
THE DROPOUTS



The dropouts were designed for **thru axle compatibility** as well as **flat mount disc brake** callipers compatibility. The sliding mechanism allows for **1.8cm of chain tensioning** adjustability as well.

The dropouts were made using stainless **steel and aluminium inserts**. Initially designed to be CNC manufactured, the design was later modified to be **laser cut and brazed** lowered cost by 3 times.

DESIGN EVOLUTION



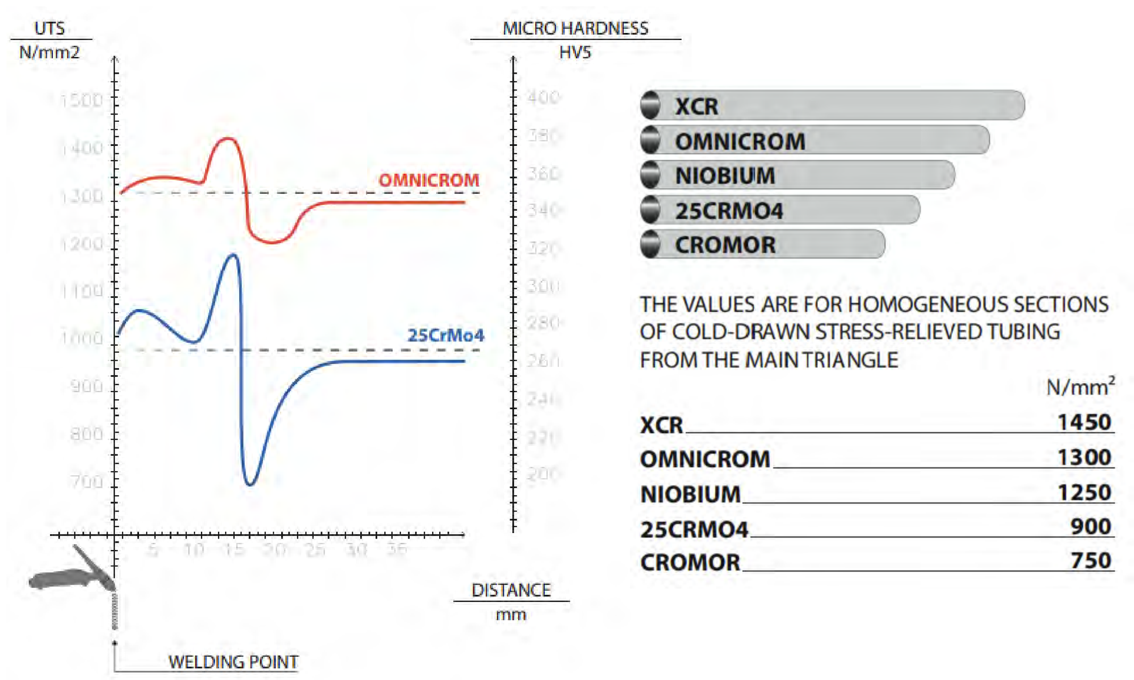
MATERIAL SELECTION

Materials selection was focused on finding a balance between greatest strength and stiffness, lowest mass and best economics.

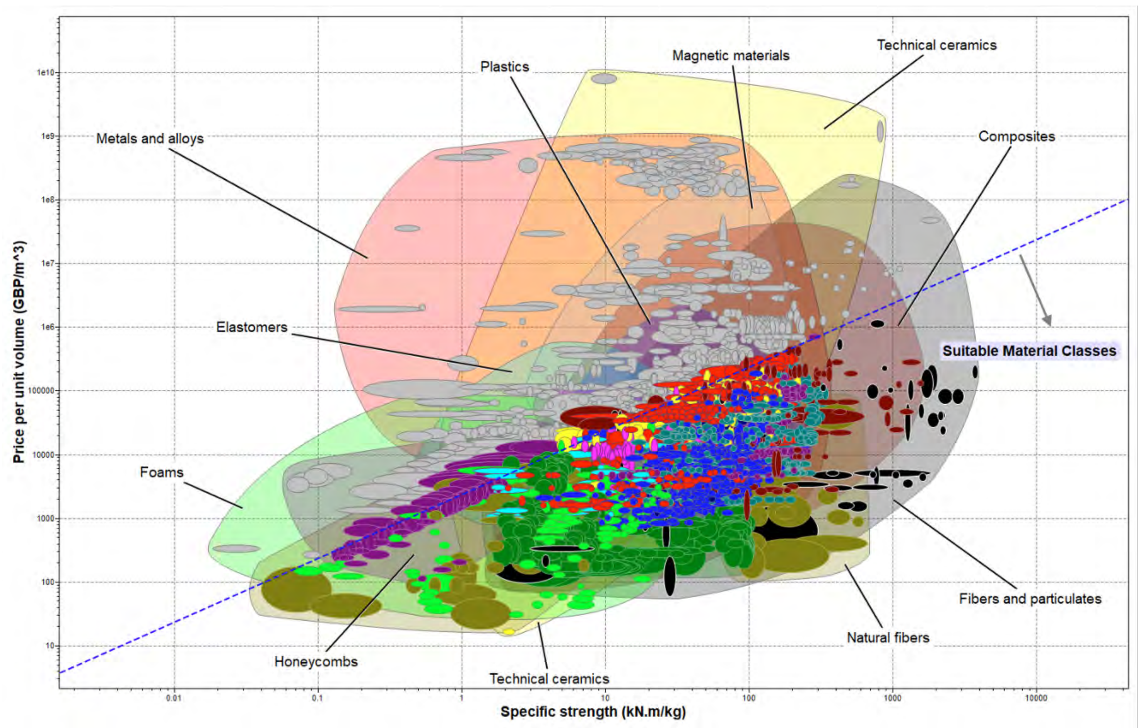
Pursuit of performance and affordability led to selection of **Aluminium and Steel**.

Performance Index analysis helped narrow appropriate material classes, and final selection boiled down to commercial availability and supplier reliability.

Ultimate Tensile Strength and comparison of **Columbus steel** tubing is shown below. [1] **Omnicrom** was chosen for providing the perfect combination between cost and strength:



Several **ashby maps** were used to identify suitable materials based on specific performance indexes:



DESIGN OVERVIEW

Designed for a **5'8"-6'8" rider**, with adjustable and interchangeable saddle and seatpost (27.2 mm standard size).

Square section seat tube and down tube; these allow the battery and motor plate to interface easily with the frame for attach ment.

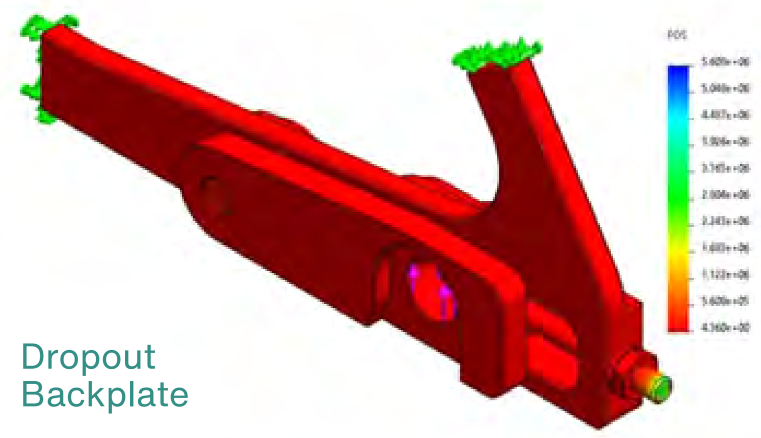
Sliding dropouts; the custom design ten sions the chain with an adjustable range of 18 mm whilst also supporting the brake calliper and keeping it aligned with the wheels.

Predicted safety factor of 3 in static loading, exceeded the design load in testing.

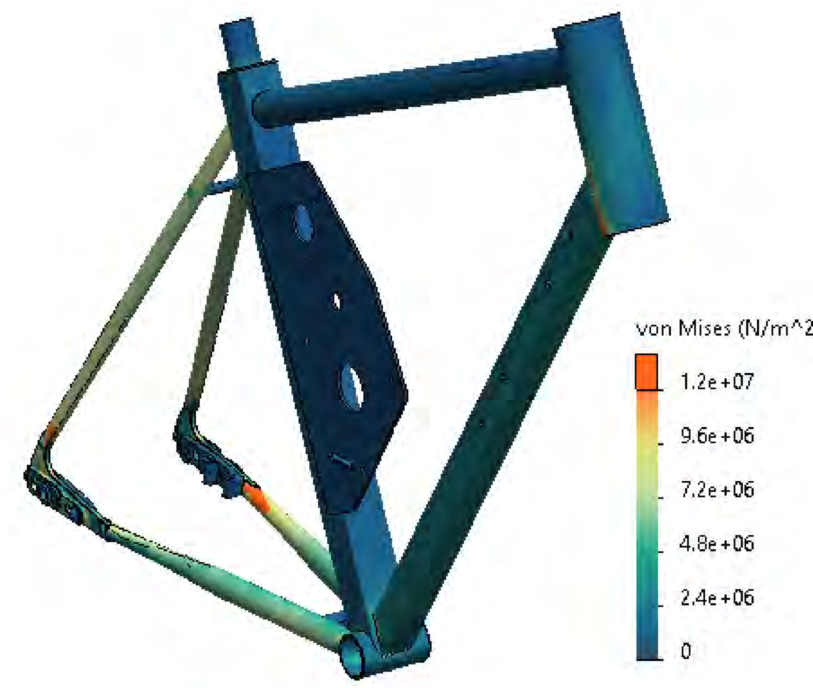
Final frame mass of **5.25 kg** upon delivery, less than the PDS specification.

FINITE ELEMENT ANALYSIS

Analysis performed to assess the stresses and safety factors of the design.



Dropout Backplate

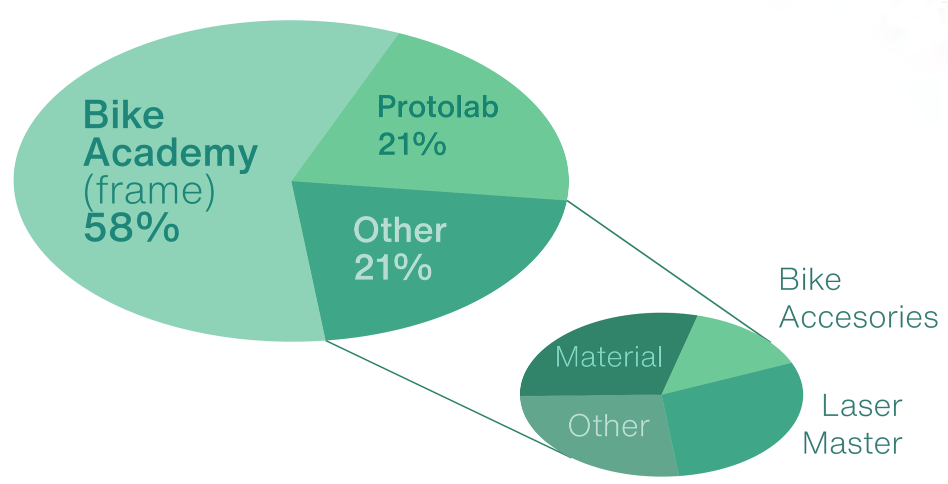


Frame under nominal loading conditions
Peak stress: 2.1 Pa

EXPENDITURE

A rough breakdown of the **overall costs** of designing, manufacturing and testing.

The majority was spent on tubing and self-designed parts (axle, insert, dropouts) bringing the overall cost of the project to **£2834.8**



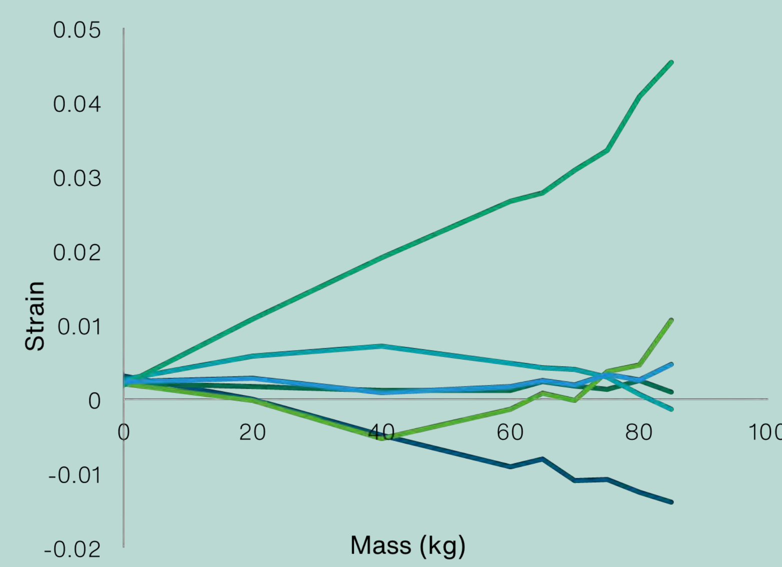
TESTING

Strain along critical components were measured using **straingauges**. The intended **SF of 3 was exceeded** in the **static load case** test, but the dropout joints reduced this locally through cuts in the seatstays and chainstays.

Even though the design load was not exceeded by much, the frame performed well and showed **very little deforma- tion** during static tests.

The frame is shown to be strong at 85 kg, above the design weight. Testing stopped at this point since the stand began to give way before the frame did. The frame also weighed 5.25 kg, less than the 8-14 kg weight range specified in the PDS and less than the 6 kg prediction from the CAD model.

Straingauge locations:



Imperial College London

References:
[1] 2019. Steel Pricelist. 1st ed. [ebook] p.8. Available at: <https://www.framebuilding.com/acrobat%20files/Columbus%202020%20Steel%20Catalogue%20v1%20web.pdf> [Accessed 8 June 2021].