RENISHAW
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Building the first metal 3D printed bike frame

The project

Renishaw and Empire Cycles have collaborated to design and manufacture the first fully functioning metal 3D printed bike frame out of titanium alloy.

The main focus of the project was to optimise the seat post bracket; however there are many examples that can be taken from this project that demonstrate the capabilities of this technology.

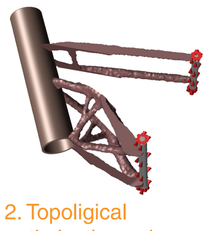
Empire Cycles

Empire Cycles is a unique British bike designing and manufacturing company in the North-West of England. Passionate about using great British engineering to create elite products, the Company offers innovative designs to the world's mountain bikers and downhillers.

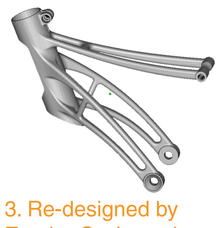
Topological optimisation

- From the Greek word - Topo meaning way or path, literally the optimum load path.
- The seat bracket was topologically optimised, reducing its weight by 44%

1. CAD model of seat post designed for aluminium alloy casting.



2. Topoligical optimisation using Altair's solidThinking Inspire™ 9.5 software.



3. Re-designed by Empire Cycles using the optimised CAD model as a template.

Multiple components consolidated

- A key advantage of additive manufacturing is that it is not constrained by the same design rules as conventional manufacture.
- This means that multiple assemblies can be made in one piece.

Original aluminium seat post with seat clamp to secure the seat in position.

Additively manufactured titanium seat post with seat clamp incorporated into the build.

Mass customisation

- Bikes can be tailored to the rider's size, height and riding style simply by adjusting the 3D CAD drawings.
- Individual branding is easily incorporated into the builds.
- This type of customisation can be applied to all areas of industry.

Internal strengthening features

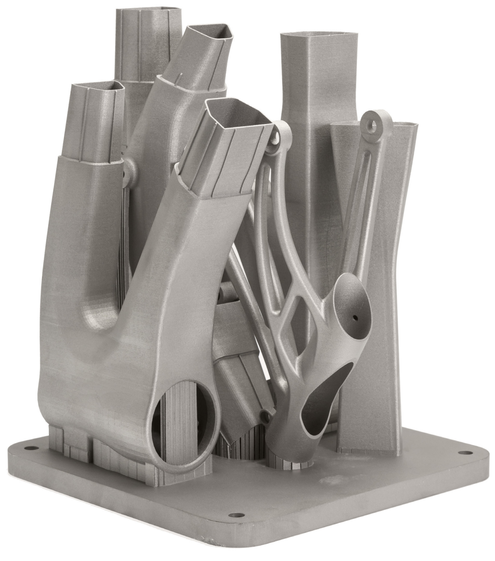
- Internal bracing and webs can improve strength by applying 2D lattice work or 3D structure.
- Aim is to emulate bone-like structures (birds in particular) which have optimum specific strength.

Machining

- Just as with casting or forging, AM parts can be machined in order to achieve the surface finish required.
- In this case the head stock was machined to allow for the tight fitting tolerances.

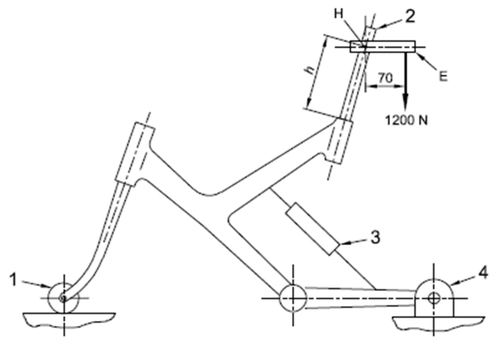
Build 'kit'

- The design was constrained by the size of the build chamber so a build 'kit' for the bike frame was produced.
- The build kit was designed so that it could be fabricated in a single build with minimal support structures, reducing the amount of waste material produced.
- The frame weighs 1400 g, compared to 2100 g for the original aluminium alloy frame - an overall weight reduction of 33 %!



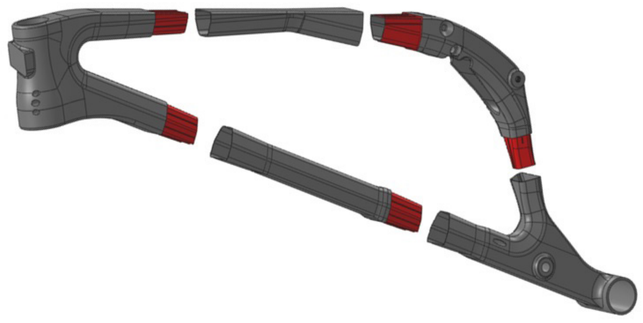
How strong is it?

- Titanium alloys have a high ultimate tensile strength (UTS) of more than 1100 MPa when processed using additive manufacturing, and near perfect densities are achieved; this is better than casting.
- The bike's additively manufactured seat post bracket was tested using mountain bike standard EN 14766 - testing continued to 6 times the standard without failure!



1. Free running roller.
2. Steel bar.
3. Locked suspension unit or solid link for pivoted chain-stays.
4. Rigid, pivoted mounting for rear axle attachment point.

Frame assembly



- 3M advised on a high strength 2-part epoxy developed specifically for titanium.
- Ribs were incorporated into the design to optimise the glue gap.