

A New Age of

## EMPIRE

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The bicycle is one of the most enduring designs of the last 150 years. Few products can have changed so little since the initial production run. Show a Victorian a modern car and he'd be non-plussed but excited. Show the same industrious chap a modern bicycle and he'd probably jump on and ride it. Or claim it for Queen and Country as was the Victorian MO. Either way it would be obvious what it was, how it worked and what it was intended for. Unlike a BMW X6.



Empire Cycles

[www.empire-cycles.com](http://www.empire-cycles.com)

## Global Phenomena

Such is their ubiquity that everyone can call to mind the image of a bicycle — from the Dutch gliding around in suits and skirts sat upright, to mud-covered downhill bikers charging down impossible slopes, and all variations in between. Two wheels, driven by a chain with a saddle in the middle all mounted on a tubular frame of two triangles and front forks. Nearly everyone imagines one of the above when you mention ‘bike’. But there’s one person that sees something quite different, and he’s putting some novel production methods to the test to make it a reality.

Chris Williams dreams of bringing bicycle production back to his native UK — but to do so will require something beyond the traditional tubular frame that would be so recognisable to the Victorian.

Nearly all commercially available bicycles on sale today are manufactured in the Far East, specifically China and Taiwan. The predominantly steel or aluminium frames are made up of hydroformed tubing with rough external welding that offers the requisite strength for the cheapest price. Even higher-end bikes follow the same construction methods with tweaks to the design to allow for easier marketing.

Chris Williams: “Even experts can’t tell the make of a bike just from the frame. Without the paint, stickers and peripherals all frames are virtually identical and made in the same way from the same materials. And nearly always this manufacture takes place halfway around the world.

“My dream was and is to bring bicycle manufacture back to the UK. We have a glorious manufacturing past and present but we’re totally underrepresented in this area. The problem comes from being price competitive with lower-cost economies in the Far East. It’s simply not possible to compete like-for-like with the higher energy and labour costs here in the UK.”

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Figure 1. A full-size bike incorporating the 3D printed prototyped components

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### Natural Attraction

There seems to be a natural link between engineers and cycling beyond the design, development and manufacture of the bicycles themselves. Empire Cycles is housed within Merlin Engineering, general and precision engineering company established in 1969 and like most engineering companies you will find one or more mongrel cars in the car park (where someone has dropped a short-block Chevy V8 into a Triumph Herald for example) and a row of neatly parked mongrel bikes set for use in a variety of on- and off-road scenarios.

So how does Chris plan on making a world-class bicycle at a competitive price in the UK? By changing up the way the frames are made for a start. His first project as Empire Cycles came about as a result of his work on cast swing arms while working for a motorcycle company designing motocross bikes. In motocross, cast aluminium parts are bolted together to create simple yet strong frames that can easily take the punishment the relentless riders subject them too.

With all this in mind Chris started Empire Cycles off with another bike that is subjected to repeated wanton violence — a downhill bike known as the AP-1. Envisioning a frame with an adjustable wheelbase and high single pivot like a motocross bike Chris set about designing the front end and rear swing arm in single pieces of cast aircraft-grade aluminium. The bearings have also been upgraded to needle rather than ball/cartridge style as they can take up to five times the load...

In the spirit of adventure that embodies all fledgling empires, Chris had to move from design to cast frame in one fell swoop — meaning the first bike was the first prototype and first production piece. Chris rode the unproven AP-1 into battle and: "...it rode killer." The design certainly caused a stir and many doubters had to try the thing for themselves. Without fail they came back impressed.

One of the issues with a cast frame is image. Bike aficionados may remember a series of cast magnesium frames made by another UK company, Kirk Precision, in the late 1980s. From scare-mongered worries that riders would be consumed in a ball of white-hot fire should friction build up (showing both a propensity for status quo bias and a fundamental misunderstanding of reactive metals chemistry) to the unfortunate fact that the frames didn't ride particularly well and were more fragile over time than their contemporary tubular counterparts meant that the Kirk cast efforts are now little more than museum curios.

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The AP-1 went on to be ridden to victory by junior national champion Lewis Buchanan, and receive a 'Best in Show' at Eurobike, a coveted Red Dot Design Award and 'Component of the Year' in the 2011 Cast Metals Industry Award. Not bad for a first attempt and certainly enough to dispel the fears of even the most ardent doubter.

The second bike in the Empire stable is the MX-6 EVO, which takes on a second manufacturing technique, CNC machining. Still in aluminium and still adhering to most of the motocross design language, the MX-6 EVO thankfully had a slightly more standard development process including extensive prototyping thanks to Merlin Engineering's Stratasys uPrint 3D printer.

When I heard that the bike had been prototyped with 3D printing I was initially dubious — in my head I saw a 1/10th scale model of the frame that at best would have some movement and at worst would effectively be a small statue of a bike. What greeted me at Empire was, in fact, exactly this. Chris explained: "I thought it would be fun to make a scale model of the frame in the printer if only because I could. In fact, when playing around with component geometries it's quite useful because of the perceived limitations. The weakness compared to the cast or machined metal parts means that very small forces can be used to deform the components and see where any weak spots are. While you would never dream of using this for validating a design it's a useful tool when you're at the stage of throwing ideas around."

Thankfully this is where the prototyping started, not finished. The next parts to be printed were full-size prototypes of sections of the soon-to-be-machined frame components. Chris used these ABS prototypes to mock up a full-size frame and then a full-size bike (which is displayed at TCT Show + Personalize) to use for promotion, testing and to help raise capital for the production run.

Tony Anderton, MD at Empire Cycles' manufacturing partner, Merlin, explained: "We have a long history of traditional precision and production engineering and invested in a 3D printer as a way of complementing and expanding our offerings to our clients. When Chris mentioned that he wanted to use the system to prototype a bike I was initially a little sceptical, but the printer may as well be running so away he went."

As is often the case for owners of 3D printers Merlin Engineering don't need to use it 24/7 so now offer out time on the machine to anyone looking for their own ABS prints. The uPrint has a useful 203 x 203 x 152 mm build volume and can build with soluble supports that are easily 'washed' off revealing the final printed structure. For companies like Merlin bring a printer in-house starts to make sense as soon as the build time can subcontracted out to other companies or interested individuals.

It was once said that "the sun never sets on the British Empire". Could this new 'British Empire' be a brave new dawn for cyclists around the world? [\[1\]](#)



Figures 2, 3 & 4. Closeups of the 3D printed components integrated with the extruded frame sections