

INTERVIEW

All Photos by Dan Pitman (Facebook.com/sofocuseduk) and Fossils Stuff



MARTIN RYE: THE RIGHT FRAME OF MIND

With the launch of the new Revo range of frames, Fossils Stuff founder Martin Rye is looking to be ahead of the FPV pack in 2017. Ian Collen grabbed him for a chat to find out more about this unique design...

It was a little under a year ago when we last featured Martin Rye, founder of frame-maker Fossils Stuff and subsequently the Fossils Racing team (more on that back in Issue 04). But the drone world moves quickly and after 12 months of manufacturing the original HDPE (high density polyethylene) frames, Martin realised that they were no longer competitive enough to win races. Although they are robust and certainly quick in the right hands, he found them to be a little too heavy to compete against the newer and lighter carbon frames.

With this in mind, Martin set himself a task to design a carbon frame that would be truly competitive. As usual, copying what was already out there was not an option and something different, lighter and more aerodynamic was required. And so the Revo series of frames was born late last year after nearly six months of continuous testing by the Fossils Stuff team of highly skilled pilots.

Key to its success is the unique vertical arm design which reduces drag to an absolute minimum. Martin believes that the airflow leaving the propellers has not been considered fully in current multirotor designs, which led him to produce a frame that is both aerodynamic in forward flight and greatly reduces the drag under the thrust column.

The greatly improved aerodynamics means a more agile platform, improved acceleration and cornering stability, while the frame's very low drag coefficient has the added bonus of increasing efficiency, resulting in less current draw and therefore longer flight times. The Revo series also uses a

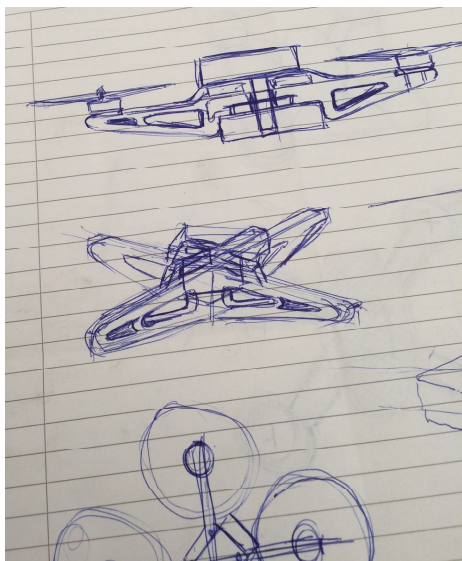
revolutionary rigging system to stiffen the frame arms. The rigging is tightened using the on-board tensioner, allowing each individual to fine-tune the frame for optimum performance and strength.

The Revo is available in three sizes at the moment, with the Revo 4, 5 and 6 coming in at 180, 210 and 240mm respectively. All are supplied with custom aluminium motor mounts designed to accept any '2XXX' series motor. ESC's can be installed on the arms or, for a super clean build, via a 4-in-1 ESC under the FC whilst still being protected by the optional stack cover.

With the Revo range due to have launched by the time this issue went on sale, we spoke to Martin to find out more about the evolution of its frame design.

YOUR PREVIOUS FRAMES HAVE PROVEN SUCCESSFUL ENOUGH, SO WHAT MADE YOU REALISE YOU IT WAS TIME FOR SOMETHING NEW?

To be competitive at the leading race events it was quite clear that Fossils Stuff had to move on. Although the HDPE frames are tough and fairly quick they were never going to compete directly with the leading lightweight carbon frames. The idea of making the arms vertical had been in my head for some time. The reason that the Gravity range of frames had cutouts in the arms was to aid airflow through them. This vertical arm design had only been considered by a few fringe manufacturers in the US and definitely was not being tackled by any of the UK manufacturers. The biggest



problem that we had to overcome was the flexing of the arms on impact.

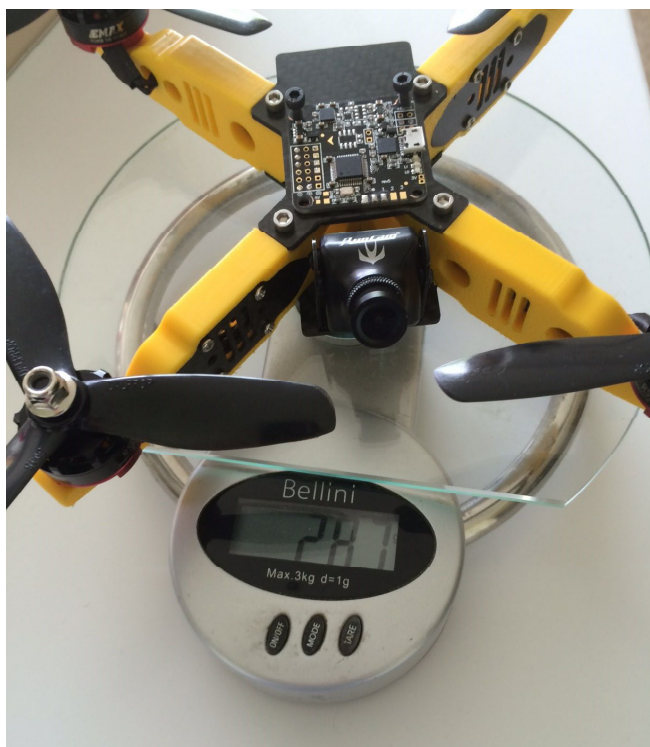
My main business is manufacturing fuel water and waste tanks for the leisure marine industry and so I have seen a lot of rigging over the years and have a basic understanding of how this can strengthen a component incredibly. As a keen paraglider and paramotor pilot I am also well aware of the materials used in the paraglider rigging system, which is essentially Dyneema. Many dinghies and large racing yachts also use this incredible material for both sheets and mast rigging.

Original tests were done with nylon-coated stainless steel wire, 0.7mm in diameter. Each wire had something like 30 separate strands but unfortunately the crimping system was expensive and the tensioning method was not something your normal drone pilot would want to do. The breaking strain of the stainless wire was only about 40kg whereas the breaking strain of 1mm diameter Dyneema is in the region of 250kg. The Dyneema was an obvious choice of rigging material to retain the arms in their set position due to its flexibility, light weight and incredible strength. It is also much cheaper than the stainless system and can be simply tied with a knot!

HOW DIFFICULT WAS IT TO FIND THAT PERFECT BALANCE BETWEEN WEIGHT AND PERFORMANCE FOR THE REVO RANGE?

It has been incredibly difficult to achieve that strength-to-weight ratio. The target weight had always been 100g for the Revo 5 (with 5-inch propellers). I was well aware that the rigging system was going to add weight but actually it contributes less than 3g to the overall weight. Top pilots are flying frames weighing 300g all up so it has been a challenge to meet this.

The actual benefit to the vertical arms is not so much the improved aerodynamics in forward flight but rather the incredible gains in reducing the drag under the thrust column. This is just a total waste of energy on a conventional frame with flat arms. We have found that the Revo accelerates quicker off the line, is faster down the straight (testing has shown top speeds of 100mph on a standard 4S setup) and probably the biggest benefit is the extended



battery life. Testing has shown that batteries are coming down cool and still have between 20 and 30 percent left in them, compared to flying the FSGX 210 with a similar setup and similar flight times.

Everything in the design process gets tested, checked and tested again, but little beats getting it up in the air.

HOW HARD IS IT TO MANAGE THE AERODYNAMICS WHEN PILOTS ARE LIKELY TO BE ADDING THEIR OWN KIT TO THE FRAME?

Trying to create a frame with the vertical arms and make room for all the equipment has been a challenge. The only saving grace is that since the start of the Revo development, equipment (such as receivers, the vtx and flight controllers) has been getting smaller and smaller. The latest receiver



from Furious FPV weighs 1.4g, has a 1km range and is the size of a postage stamp.

This is the same with the other components, so actually the choice of equipment that will fit the Revo is vast and pilots should have no trouble fitting any of their preferred equipment. I am sure there will be people modifying their Revos, adding accessories and 3D printing – all sorts of stuff, just like they do with any other frame which I think is fantastic. I really like seeing what people come up with, as was the case with Gravity frames.

HOW MUCH OF WHAT YOU DO IS BASED ON THE SCIENCE AND TECHNOLOGY – AND HOW MUCH IS JUST TESTING OR TRIAL AND ERROR?

To be honest it is a bit of both. Gut feel plays a huge part but computers can help immensely. We modelled the airflow over the arms of a conventional frame and the Revo, and the difference was astounding. The flow was extremely turbulent under the conventional frame whereas the Revo showed a beautifully smooth linear flow – and all this was done without a wind tunnel!

We also modelled the Event Horizon tubular arms using this method and, again, a round tube proved far

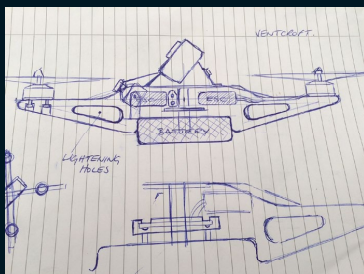
more efficient than a flat plate. Component weights can be calculated very quickly in Solidworks allowing you to alter the design to achieve the target weight for each component.

Finite element analysis (FEA) also helps with individual component design and also with the assembled product. You can exert forces to a particular part of the frame and see where the weak spots are. The Revo was not possible to run through our cut down version of FEA due to the way it was constructed. I'm sure a more expensive version would do it but the cost was too prohibitive so we had to rely a lot on trial and error.

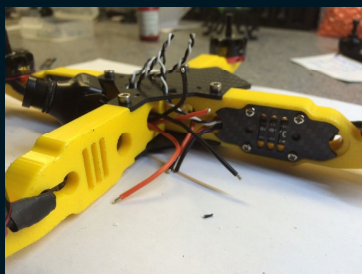
HOW FAR AHEAD IS SOMETHING LIKE THE REVO COMPARED TO YOUR FIRST FRAMES? AND WHAT MAKES THE BIGGEST DIFFERENCE?

The Revo is way ahead of all the other Fossils Stuff frames. The team pilots have all said it is a completely different animal and are reluctant to go back to their FSGX 210 frames. When they do revert back they have all commented how sluggish the FSGX is compared to the Revo. The main reasons are the lighter weight of the frame due to the use of carbon sheet, better aerodynamics and increased stiffness due to the rigging system.

REVO: THE EVOLUTION OF DESIGN



The Idea



Creating a Prototype



The First Model



HOW EXACTLY DOES THE RIGGING SYSTEM WORK?

The rigging system works by tensioning a 1mm diameter Dyneema line around the outside of the frame using an on-board tensioning post. Basically the line is threaded around the frame through pre-drilled and chamfered holes (chamfering the holes helps the line slip while tensioning and prevents chaffing of the line) and finally passed through the lower hole of the tensioning post and then tied together.

Using a 4mm drill or pin through the top hole of the post the line can be tensioned by rotating the post and then locking off with an M2 bolt. The arms then have to be straightened and the line is then tensioned again. This process is repeated until the line is extremely taut. You can actually pluck the line and hear a noise similar to a stringed instrument!

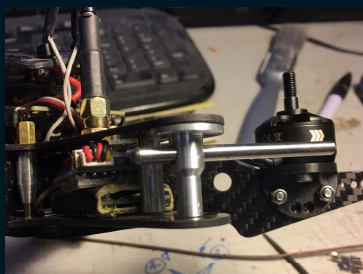
Once the line is tensioned it is locked up by passing an M2 nut and bolt with plain and fibre washers through the outermost holes and then tightened. Once rigged, the arms are completely locked up they and cannot flex at all, giving an overall feel of complete rigidity to the whole frame.

DOES SOMETHING LIKE THE REVO SHOW THAT DRONE RACING IS VERY MUCH A SERIOUS BUSINESS, WHERE EVEN SMALL CHANGES CAN MAKE A BIG DIFFERENCE – AND THE TOP PILOTS WILL ONLY WANT THE VERY BEST?

Absolutely. I liken the Revo series of frames to Formula 1 technology. Once the Revo starts to prove itself on the race track then I am sure top pilots will want to fly it. If they don't fly the Revo, then they'll be flying something similar as I'm sure the design will be copied or developed by other manufacturers. The rigging is a bit time consuming but the added benefits far outweigh this. Someone may come up with a variation of it but I am convinced we will be seeing more vertical arm designs before long.



Developing the Design



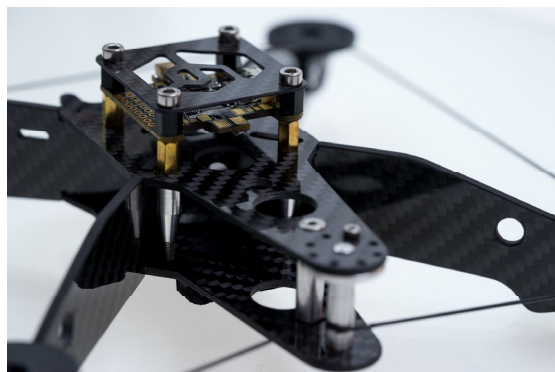
Testing and Tuning



Ready to Fly!



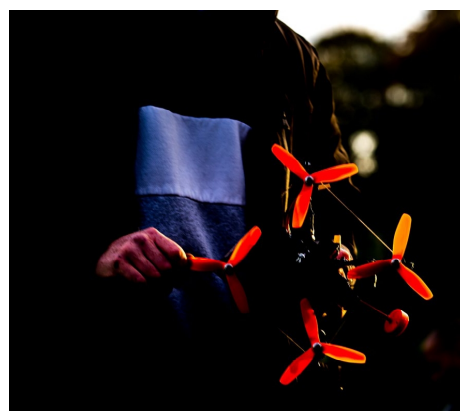
The rigging system can be fine-tuned on each frame to ensure optimum performance.



HOW MUCH OF YOUR INSPIRATION AND MOTIVATION COMES FROM YOUR PILOTS? NO DOUBT THEY'LL HAVE PLENTY OF THOUGHTS ON WHAT THEY'D WANT OR NEED TO GO FASTER!

The Fossils team of pilots always want to go faster! I am not sure they do much for my inspiration or motivation but they are absolutely critical to the development of what pops out my head. Without them I would have no feedback and would not be able to identify the weak points of any of the frame designs.

They are all far better flyers than me and they know what is required of a frame. For example, the Revo arm design has been through probably four or five iterations until we came up with the design we have now. I was constantly being sent photos of broken arms and the discussions in the Fossils Think Tank would be endless on how it could be changed and improved.



SO WHAT'S NEXT FOR YOU, OR FOR THE RACING SCENE IN GENERAL, IN 2017 AND BEYOND?

I always have lots of ideas floating around in my head. I think the next frame will be a long distance cruiser with a 15-minute flight time. I think that will be popular with non-racing folk and we hope to have something out in the next few months. I will also be working on a wing design or two but am just waiting at the moment for the specifications to be finalised for racing. Wings are going to be even more popular this year as they are cheaper to build and offer just as much excitement as quads.

I have also been working on a laser shoot-'em-up system that can be fitted to wings but that is still in early development – though we have achieved a range of about 30 metres in bright sunlight which is more than adequate. There is also a Revo 3 on the drawing board which I am hoping to have ready for this year's indoor winter flying.

You can find out more about the Revo range, and the wider range of Fossils Stuff products, by heading to its website: www.fossilsstuff.com.

