

# FRAMEGAME

TEXT & PHOTOS BY DAVE STOCK

## As the FPV drone scene expands,

better and faster craft emerge. Propellers, motors, flight controllers, and speed controls all fulfill the need for speed. But it's the airframes that hold all of the components together that are seeing the biggest evolution. And while the established names continue to dominate, there's an undercurrent of independent makers arriving who are building fast, strong, tournament-winning frames. Nowhere is that more apparent than in the United Kingdom. It was, after all, a UK-designed frame that helped Luke Bannister and his team win at the World Drone Prix in Dubai. His KC250 frame, designed by Craig Leong, was the result of a meaningful collaboration with some of the UK's top pilots, including Bannister, Chi Lau, and Brett Collis. This, it would seem, was key to its success.



Rewind a year and it was the cheap, often Chinese-made, frames that flooded the market. Made of poor, flimsy material, the aircraft wouldn't stand up to today's racing demands or close-proximity flying. They flew, sure, but lacked the refinement of rigorous, real-world testing. As the scene grew, competitive piloting called for match-winning frames. It was the pilots themselves, backed up with a wealth of flight experience, technical know-how, and anecdotal data, who were best placed to know what they expected from a frame, and they weren't afraid to tell the manufacturers.

Take Matt Denham, for example, a pilot from Sussex, England. Noticing performance issues on his Team BlackSheep Gemini hexacopter, he took it upon himself to troubleshoot solutions. "Flying would be a handful when the craft turned," he explains, "so I started off drilling holes in the canopy, which helped with the airflow and improved the flight characteristics." When others experienced the same issue, Raphael Pirker, owner of Team BlackSheep, took note, culminating in a collaboration between Pirker and Denham. "[Pirker] started to ship loads of spare parts to basically play with, crash, bend, and modify to look for solutions," he says. Denham now designs frames for the U.S. frame company Armattan and considers strength to be a key factor. "I want something people can crash and get straight back up, time and time again," he says—and other pilots agree. "A broken frame will spell the end of a session, and that's no fun," says Richard Hartley, a first-person-view (FPV) pilot from Portsmouth, England.

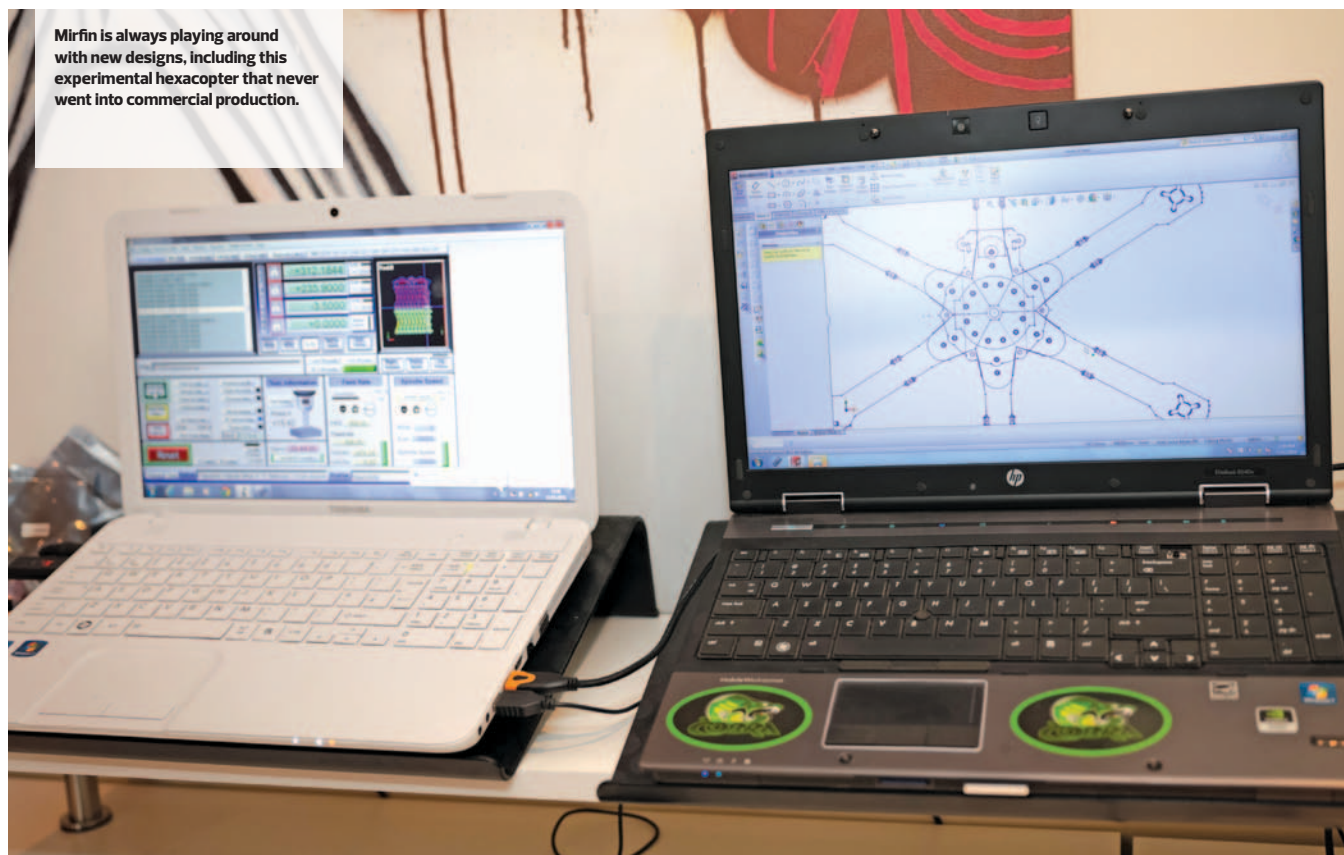
### Strength Is Key

For Stefan Mirfin, owner of the UK company Thug Frames, it's a distinct identity that makes his products unique. "I oversee what I do—the brand is me," he says, explaining how his thrill-seeking skater-snowboarder attitude comes through in his frames. But toughness is paramount. "I'm a flier, first and foremost, and I've broken enough of my own gear to know what it's like. I'm looking for a nice amount of durability, although concrete always wins in the end," he says with a smile. Mirfin puts most of his effort into researching, tweaking, and specifying the materials that will create the toughest frame possible. Always willing to experiment, he was an early adopter of 3D printing, notable in his early frames. Nowadays, it's carbon fiber that provides the right balance of strength and weight. "It's knowing your materials—that's where the expertise comes in," he says. Over the last year, for example, he's moved from using twill fiber to a heavier-press monofiber, allowing more carbon material to be laid down in thinner sheets. To illustrate the advantage, he shows me his latest incarnation next to an older, much thicker example: "They're about equal strength," he assures. And that's not all. "There's as much strength in the small tweaks, too." Carbon fiber has lines, or grain, much like the grain of a tree, and weak points can occur along these. For the latest version of the popular THuG180, Mirfin looked at all of the joining angles and grain and considered the forces being applied. "There isn't an angle here that isn't thought about," he says. "Everything has



**Left:** Stefan Mirfin at the Thug Frames studio in Kent, England. Mirfin recently relocated to give his workshop and equipment more room to meet the growing demand. **Right:** Thug Frames' specialist CNC machines cut carbon-fiber frame parts 24 hours a day.

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Mirfin is always playing around with new designs, including this experimental hexacopter that never went into commercial production.

been tweaked to try and improve strength."

Mirfin's range is constantly evolving; he's already on to version five of the popular THuG180, and older lines are discontinued to make way for improved designs. "If I think of a better way to do something, I'm going to do it, even if I think I've only improved it by a nanobit," he says, although he's careful not to alienate current customers. "I try to keep the basic bolt pattern the same, so people can swap the plates around." Mirfin's on-site production facility means older parts can be cut to order and new ideas and designs created and tested quickly. "I can design, cut, and prototype within 24 hours," he says.

### 3D-Printed Frames

Carbon frames are popular in the FPV world, and you'd be forgiven for thinking that all frames were made out of the sleek, ubiquitous black material. But in early 2015, born from a sequence of happy coincidences, Fossils Stuff's Gravity 250 was born. For Martin Rye, owner of Fossils Stuff, it was the depressing list of nondescript, cheap, and flimsy-looking frames from China that got him thinking, "There's got to be another way." Meanwhile, the CNC (computer numeric control) machine, used for his day job producing water, waste, and fuel tanks for marine applications, was regularly sitting unused. "So I designed a 250, and the bloody thing flew!" he exclaims, still surprised at his debut success. Around the same time, FPV pilot Chris Weston noticed that a new frame maker had popped up right in his neighborhood, and a few phone calls later, a formidable team was born. "We got on really well, and that's where it all started," says Rye. After giving Weston a

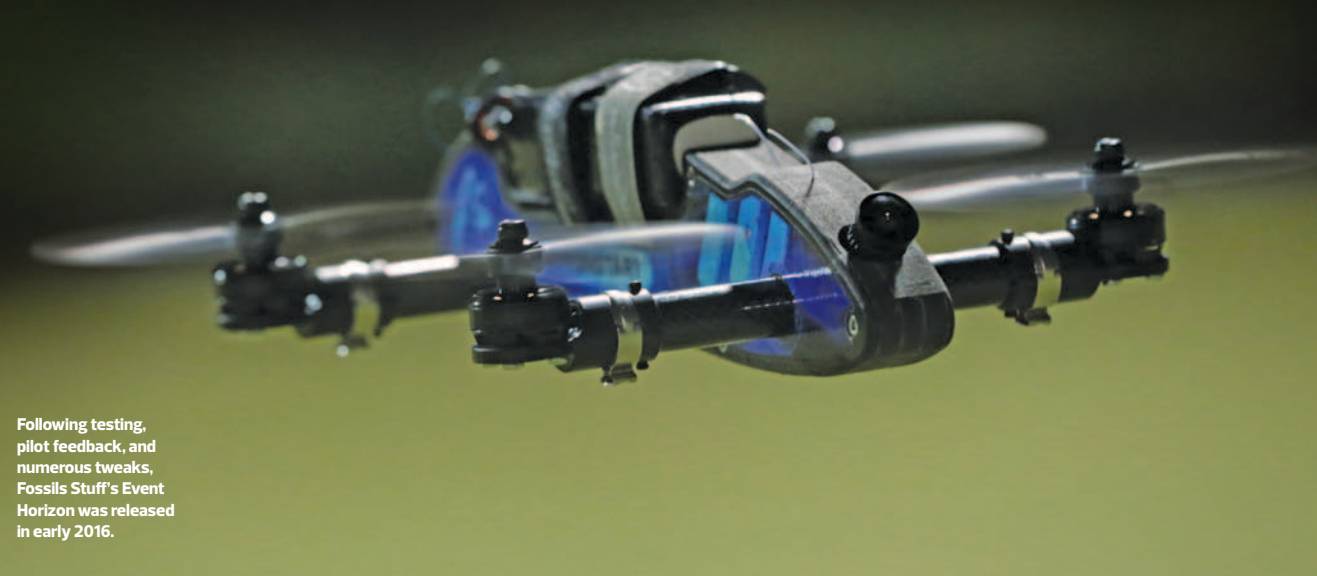
Martin Rye, owner of Fossils Stuff, watches closely as his CNC machine cuts Gravity 280 frames.

frame to test, he incorporated Weston's advice and feedback into the designs, and the Gravity MK1 was born. To produce the frame, Rye looked no farther than his own storeroom. "We had a load of surplus material in the warehouse from a job: sheets and sheets of black and yellow composite HDPE [high-density polyethylene] plastic." The material gave the already unusual frame its distinctive color but had another advantage, too: It was incredibly strong. "It's almost certainly stronger than carbon," says Rye, and "that's where we came up with the idea to do a lifetime warranty." Getting a broken frame back isn't seen as a negative. "The people who are breaking them are the ones flying them extremely hard. And they're the ones I want to be breaking them. We quickly discover where the weak points are," he says, helping him to design something even tougher.

### Racer Sponsors

To get more real-world feedback, frame makers sponsor pilots and race teams, supplying them with frames, parts, and their newest technologies or prototypes. This not only ensures that the companies' names and frames are on the flightline but also gives each company pilots who are ready and eager to test the newest design to destruction, generating useful data and advice. "Without their feedback, I'd be totally stuffed," says Rye of Team Fossil pilots Weston, Tony Marchant, Jonny Banton, and Simon Martinez. Mirfin, who also sponsors a team, agrees: "They do a lot of testing, mainly to get a good feel for durability versus weight. They'll say, 'Change this, tweak that,' and I'll listen—tweaking the things to how I like it, of course." Fossils Stuff saw the benefit of this real-world testing

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Following testing, pilot feedback, and numerous tweaks, Fossils Stuff’s Event Horizon was released in early 2016.

during the testing phase of its newly released Event Horizon, in which Rye took an innovative and daring approach to aerodynamic design in an attempt to achieve speed advantages. “When quads are flying at their optimum angle, up to 60 degrees from the horizontal, there is a huge amount of cross-sectional area hitting the wind,” Rye explains. “I was holding a Gravity one day, and I thought, ‘Why don’t we flip this onto its side through 90 degrees?’ Everything is still contained, but the cross-sectional area has been reduced. You’ve now got a thin knife going through the air.” To complete the design, Rye then added thin, tubular carbon arms for the motors, keeping a low-profile aesthetic and further reducing surface area.

Early testing, however, threw up issues. “It wobbled,” explained Marchant, referring to a yaw problem when flying at speed. And Rye looked into the possibility that the flat sides and proximity of propellers to the body were causing airflow issues that allowed the rear propellers to stall. This quick, direct feedback meant that Rye could tweak his design and produce a new prototype within 24 hours in his on-site workshop, getting a refined version back out quickly for more testing. “I think that’s a huge advantage,” he says.

**X Marks the Spot**

The latest evolution in FPV drone design is tending toward X-shaped models. For example, Thug’s latest incarnation, the THuGPIG, is a small 180 frame in an X configuration, where both axes are equal in length. X frames have become popular among FPV pilots because they offer better racing qualities



Tom Stanton’s TSX frames were designed for speed and were highly successful in competition.

with reduced weight, better balance, and stronger rigidity. “They’re faster and more agile,” says Mirfin, owing to equally balanced axes and centrally stacked components, which offer a tight center of gravity. But it’s their low weight that gets top pilots most excited. “While a heavier frame is good for freestyle, carrying the weight into the next move [is] less good for racing,” says Luke Bannister. For him, X frames offer the best power-to-weight ratio, giving Bannister competitive advantages on the race



track. Working with two different UK-based X frame makers has already paid dividends for him in competitive scenarios. Tom Stanton’s TSX frame was born out of a drive to gain competitive advantages. “As a racer myself, I wanted something fast and very minimal,” he says. Bannister agrees, “I can still win competitions, even with the added weight of a GoPro,” he says referring to a win at the 2015 UK Drone Show, a race dominated by Stanton’s TSX frames. “Luke Bannister took the win on both days with his TSX250,” notes Stanton, clearly pleased, in a race where three out of four finalists were flying a TSX. But Bannister’s biggest win—and probably the biggest for the sport thus far—was at the World Drone Prix in Dubai earlier this year. Bannister was driving a KC250 frame, designed by Craig Leong, a commercial UAV (unmanned aerial vehicle) pilot, special effects engineer, and 3D helicopter pilot. The frame, also an X configuration, was specified by Chi Lau, another top UK pilot. “Chi asked me if I could design a lightweight racing quad for him, and that is how the KC215/250 came about,” Leong says. While Lau tested the early prototypes, Leong soon gifted frames to other top pilots including Bannister, Brett Collis, and Phil Upton. Collis even used his electronics background to design a lightweight, X-shaped PDB (power distribution board) for the frame, something that is featured on Stanton’s frames as well. Initially, Leong’s frames were aimed at assisting Lau’s competitive chances at the upcoming Drone Worlds in Hawaii, but success came much sooner than expected. As chief engineer for the Tornado XBlades team, Leong was asked to build light frames for Bannister and Lau to take to Dubai, each with alterations to support the required live-transmission HD cameras and to carry an underslung battery. “I knew that Luke Bannister and Chi Lau would do well in Dubai,” he says, but they did better than expected. And to see his own frame cross the line first in the final, “it was a pretty amazing feeling.”

Above: Top pilots require specialist frames. For Luke Bannister, a modified KC250 frame, designed by Craig Leong, helped him come out on top at the World Drone Prix in Dubai.

Below: There’s a KC250 frame to suit every pilot.

**Better, Faster, Stronger**

“People say that frames are just frames,” says Collis, “but this is simply not true.” As competitive racing increases, pilots demand better, faster, and stronger frames. “The industry evolves so quickly, we’re always playing catch up,” says Mirfin. And the best way to create a product that a pilot wants to use, it would seem, is to make sure that there’s a pilot on hand to tell you what you are doing right or, more important, what you’re doing wrong. ✈

