

Peter Jenkins - B J Craft Anthem with TMCR, Part 1

Introduction

The B J Craft Anthem is a 2-metre class aerobatic aircraft designed to the FAI F3A specification by a South Korean B J Park. Park has been the S Korean F3A champion many times and represents his country in the FAI international competitions. I have had 2 other designs of his, the Agenda and the Element which is my current F3A competition machine. In both, I used a contra drive system produced by an Austrian, Ralph Schweizer, called the RS CRS which uses an in-runner motor driving through an epicyclic gearbox to turn 2 output shafts in opposite directions. The reduction provided by this gearbox arrangement is a 13.5:1 ratio allowing the in-runner to produce a maximum prop RPM of around 4,500 turning a front prop of 22 x18 and rear of 22 x 20 inches.

The CRS requires the gearbox to be greased every 50 flights via a greasing point mounted on the front of the gearbox. This does require the props to be removed. At 150 flights, the gearbox must be removed, cleaned, checked for wear and any worn washers or gears replaced, and then regreased and refitted. This means the whole motor/gearbox assembly must be removed from the aircraft and loses the fine tuning of the thrust line necessitating a couple of flights afterwards to re-establish these settings.

Adam Dębowski is a Polish F3A pilot who has designed and manufactured two very useful items. The first was an ESC that maintains a set motor speed called the D3. The FAI has cleared the use of the feature for international competition. The D3 then will hold whatever prop speed your throttle stick has commanded for straight and level flight and during any climbing or diving even if you don't move the throttle setting. The effect of this is to enhance the ability to fly at a constant speed. The other item is a twin motor contra rotating motor (TMCR). As the name implies, there are 2 motors mounted on the same axis driving in opposite directions each with its own D3 ESC. The great advantage of the TMCR is that the motors are both outrunners and so do not need gearing down in order to turn the propellers at around 4,000 RPM max. Being outrunners, there is no maintenance required which was a big attraction to me. The other big attraction is that outrunners while obviously needing cooling are not as critical in this area as the in-runner is.

B J Craft Anthem

The Anthem is built to meet the FAI F3A specification, that is, wing span and fuselage length must not exceed 2m and the weight must not exceed 5,000g. No flight assistance is allowed, other than as I've already mentioned, an ESC that provides proportional braking (the D3 fits this rule), the use of rates, expo, switches to achieve certain set control positions (e.g. snap roll). That means no gyros and nothing that will perform a pre-ordained series of control inputs or any timing device.

The Anthem follows the practice first seen by the current World Champion, Christophe Paysant-Le Roux (CPLR for short) in his design of a couple of years ago which is a swept wing. That is not just the leading and trailing edges but the mean chord line is swept backwards.

Why a swept wing? Well, the theory is that the aircraft becomes more stable in yaw. That is why some swept wing jet fighters have the wing arranged with anhedral to reduce the stabilising effect of their more highly swept wings. The reason wing sweep causes this effect is that as the aircraft is yawed, the forward going wing presents more of its span to the airflow travelling chordwise and

thus increases lift and drag. The rearward going wing experiences a slight loss in lift and drag as a result of an increase in spanwise and reduction in chordwise airflow.

What the designer also claims is that there is now no need to have any difference in the side thrust set up for single or twin contra prop designs. It will be interesting to see how powerful is this effect in flight!

The Anthem is only the second 2m F3A airframe that I have bought new since 2012! The others have all been second hand and have had the advantage that, apart from fitting a different motor to the original, the rest of the airframe is flight tested. This time, I took the decision to buy the aircraft in September 2022 and placed an order with Bondaero who are the UK agents for B J Craft. Due to the Corona Virus lockdowns in China this order didn't appear until mid-February 2023! Chris Bond, the owner of Bondaero, handed over a large quite heavy box with the Anthem inside it.



The photos show the box as it was handed over to me and with the lid removed. The aircraft is made in China (isn't everything these days!) and had been shipped by airmail from Hong Kong. Thankfully, there was only a slight scuff mark on the plywood.

As you can see, the whole lot was extremely well packaged with the fuselage supported by an attachment that ran through the wing tube and was bolted to the sides of the box. This serves



to prevent the box being squeezed and the contents damaged.

So, the first job was to unpack everything, check for damage and to ensure that everything was there. I was delighted to find no damage whatsoever and everything appeared to be there.

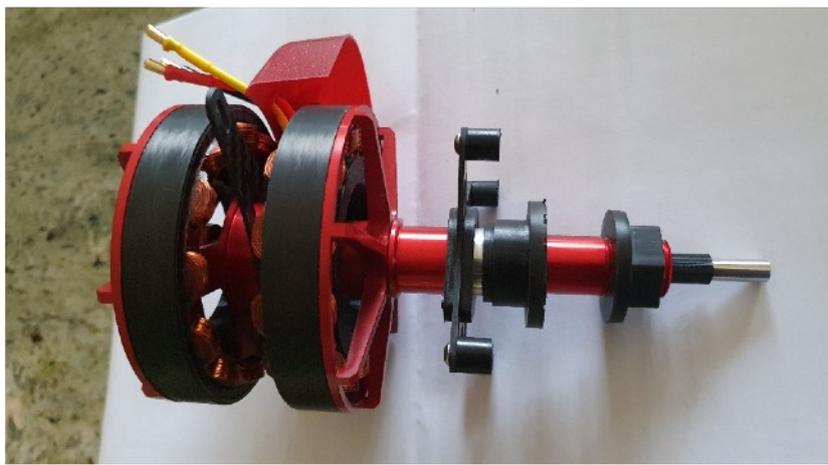
That having been said, there were 2 sheets of plywood with laser cut parts some of which were marked with their function but others unmarked. So, after trying to figure out what these bits were for, I had to admit defeat and call Chris Bond to get him to tell me what the ply parts were for.

Ultimately, I decided to go with a different battery tray, wing incidence adjusters, tail wheel and main wheel axles. More on them later.

The issue with B J Craft is that they don't provide any instructions on the sequence of putting the model together other than the blurb describing the aircraft that gives a CG range. A call to someone else who had built and Anthem elicited that the setup should be: level the fuselage so that the Tail plane is at 0 deg, Wing at 0.7 deg and motor at -1 deg.

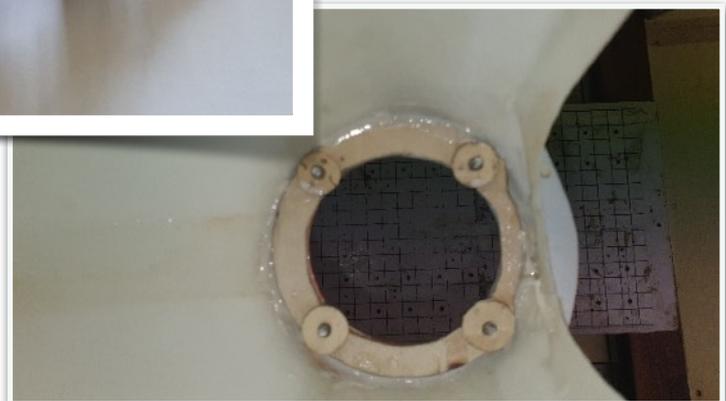
So, the next task was to set out all the processes that I needed to go through to assemble the aircraft and install all the equipment into it ready for the maiden. This required the 3 major elements to be dealt with: the fuselage and canlyser; the 2 tailplanes and the 2 wings. I decided to start with the fuselage.

Fuselage



The first job was to fit the motor into the fuselage. As I mentioned earlier, the motor consists of 2 outrunners driving through concentric shafts.

There are 2 ESCs that are fed by the same 10S LiPo pack and drive each motor. The motor is mounted



using the provided nose mount using rubber bobbins that you can see behind the rear prop driver. The front prop driver is slid onto the front shaft once the rear prop is installed. There is a rear mount which you can just see between the 2 motors and this is bolted to a ply former that I made and glued into to the fuselage. The thickness of the ply former has to be gauged by providing a 2mm gap between the spinner backplate and the fuselage nose ring. This required a degree of fettling so that everything lined up once it was bolted into place.

The next task was to reinforce the undercarriage mounting plate with carbon fibre cloth to cope with the long undercarriage legs that a 23 inch prop set require. Once that was done and dry, I was able to crack on with making and fitting the rear motor mounts and gluing them into place. I find the easiest way to do this is to bolt the motor into place with the side supports bolted to the rear mount, or in this case the mid mount before gluing the ply mounts in place. I use Hysol for this as it has thixotropic properties (doesn't run) and left it overnight.



Next, I set up the Tx memory and bound the Rx. I have a JR XG11 Tx and decided to use the Xbus capability to reduce the cable run to the rear mounted rudder and twin elevator servos to a single cable. I had a 4 way convertor, of which I only needed 3 leads, to which to connect up my non-Xbus servos. Adam Debowski recommended that I use separate channels for the 2 ESCs. This sounded like a good idea since the XG11 supports a dual channel for

twin motors. However, I just couldn't work out how to get the 2 channels linked to my 2 throttle curves! There's a guy on RC Universe who is an absolute glutton for punishment on how to do this stuff with the JR XG11 Tx. A quick call for help and just over a day later back came the suggestion of how to do this.

While I was waiting for this advice, I soldered both ESC battery input cables into two 4mm bullet connectors thus wiring them in parallel. I also soldered 3mm sockets onto the two sets of 3 phase output wires on the ESC. The motors already had the 3mm plugs soldered to them.

A good deal of button pressing later, I had the 2 motor channels connected to the throttle curves as well as the motor hold working on both motors. I then set up the Rx, an Rx battery and switch, and plugged in the 2 servo leads from the 2 ESCs into the appropriate twin throttle channels. Now the moment of truth! Connect everything up and see if the motors work and then work out if they are going in the right direction! Thankfully, the ESCs armed and gave off the required tones to indicate a successful arming. Of course, it was too much to hope that the motors were going in the correct directions! The rear motor must turn clockwise while the front motor must turn counter clockwise. So, swapped over a couple of the 3 phase wires and all was well. I then put the correct colour coding onto the six 3 phase wires so that I wouldn't have this problem again.

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