No 108 2021

# HALE HALL MODEL CLUB NEWSLETTER

## March 2021

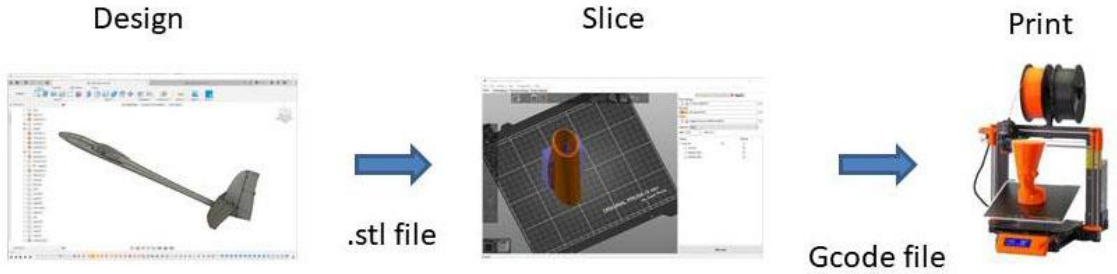
Welcome to the March Newsletter. This month I document my journey into the wonderful world of 3D printing.

## Fantastic Plastic

For the past 18 months or so I have been experimenting with designing and 3D printing slope soarers. I have always been interested in 'gadgets' and have had a CNC router for a long time. I was present at Hale Hall when Steve Lacey flew his 3D printed Spitfire, from 3Dlabprint (I think), it flew well until the wing parted company with the fuselage! However I was still sufficiently inspired to investigate the possibility of 3D printing an aircraft. Eventually I was tempted into the next new technology of 3D printing. My printer, a PRUSA MK3 arrived in kit form which, due to other projects, stayed in its box for over a year. I know our illustrious Chairman Jack has had a printer in a box for much longer than that, so I don't feel too embarrassed at that lack of progress! The build was very straight forward, simple step by step instructions, and to my amazement it worked beautifully first time!

### The Process

There are 3 steps required to produce a 3D printed part. The shape is designed in 3D software which then outputs an STL file. This is then 'sliced' to convert the solid shape into a series of very thin layers for the 3D printer (I am using 0.15 mm for each layer) and creates G-code which is used by the printer to control the X,Y,Z movements.



## The Design

Next I needed a design to print. My initial research discovered a few companies that sell gcode (the instructions / code that tell the printer what to do) for a range of aircraft designs but I decided to have a go at designing my own from scratch, it couldn't be that difficult, could it?

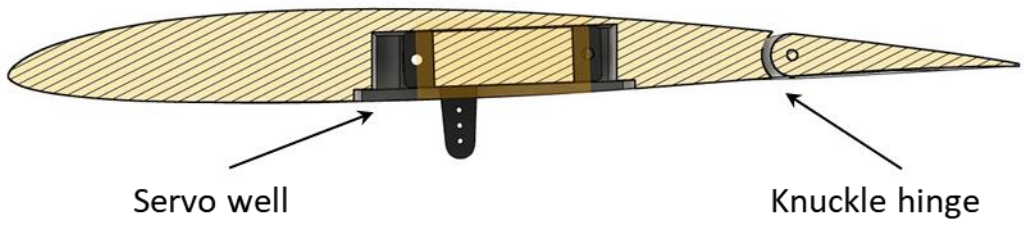
To make things easier I decided to start with a glider, mainly to avoid the complication of having to design a motor installation. To increase my chances of success I decided to 'steal with pride' and base my first design on an existing model. I chose the Sword 2 from X Models, a fully moulded aerobatic slope soarer , mainly because I thought it looked cool! It has a 1.9M plug in wing, flaps, ailerons and an all moving tailplane.

My first requirement was to be able to design the structure in 3D. After some time surfing the Web I found Fusion360. It is a full feature 3D design suite that is free for 'hobbyists' with only minor limitations. I was fairly proficient at 2D design (using Autocad), but was quickly to find out that designing in 3D requires a completely different approach. It took me many hours to get to the point where I could spend my time designing rather than fighting with the software. Slowly the terms loft, extrude and shell became familiar. The Fusion360 Website does have some very good step by step tutorials which were a great help in learning the basics.

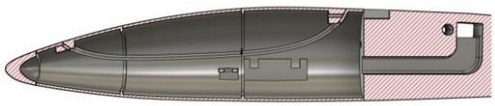
The print volume of my printer is approximately a 20 cm cube which means the structure can't be printed in one go, it has to be built up from smaller sections. I decided to scale wingspan down to 1.5M, this results in 4 main sections for each wing half. I was able to obtain a 3 view plan of the Sword from the instruction manual which I then imported into Fusion360. This was then used as a template to create the 3D design.

Fusion360 has the facility to create airfoil profiles, which made the wing design much easier. I chose the RG15 profile which is commonly used for aerobatic gliders. Slowly over several months a design evolved. The basic shape was relatively simple, the majority of the time was taken creating the detail; plug in wings, knuckle hinges, canopy attachment, all moving tailplane mechanism etc. The wings are plug in with a carbon tube joiner.

To allow the model to be printed the fuselage, wings and tailplanes were all split into separate parts small enough to fit on the printer bed. This resulted in about 35 separate parts.

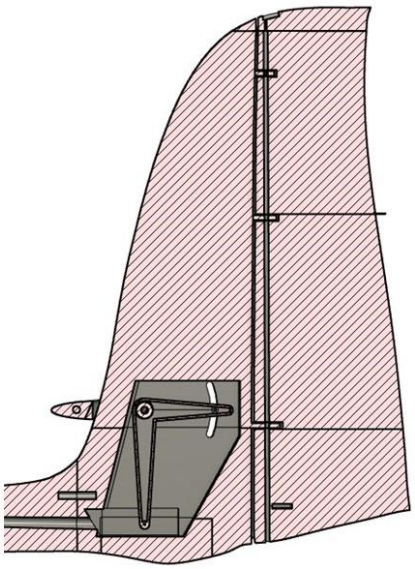



Wing cross section



Front fuselage cross section

Wing fairing



All moving tailplane mechanism

## The Slice

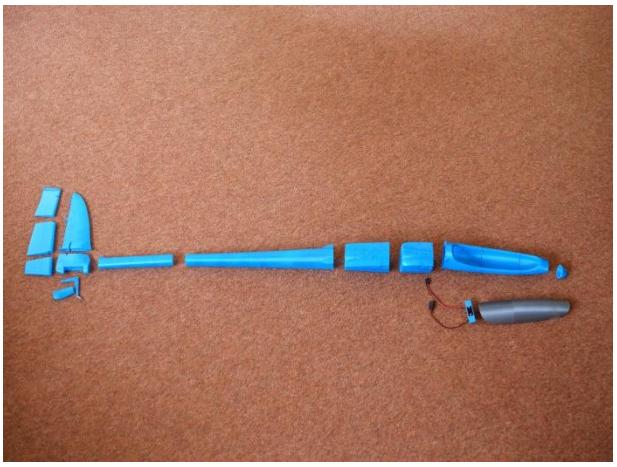
The next step was to slice each part to create the G-code instructions for the printer. I use the PRUSA slicer software which is provided free and works well with their printers. There are other options; I have used CURA for some other projects.

There are many software settings which have a significant effect on the final print strength and weight. This was another 'learning experience' that took some time to get to grips with. The plastic used for 3D printing is relatively heavy when compared to our conventional building materials, balsa and ply. I was concerned that the finished model was going to be too heavy, partly the overall weight of the structure but also the amount of lead required to achieve the correct Cg. Luckily the Slicer program gives an accurate prediction of the finished weight of the parts and even the time it will take to print and the cost of materials! So after I had done an initial 'slice' of all the parts I was able to put together a spreadsheet to estimate the overall weight and crucially how much lead would be required to achieve a sensible Cg. The results were not encouraging with a very high wing loading and half a church roof required in the nose! This required a significant re-design, a longer nose and changes to the rear end. That combined with some changes to the slicer settings, mainly the percentage of infill used, resulted in a more sensible wing loading of 15oz / sq ft and an all up weight of about 2.3 pounds.

## The Print.

So after many months I was now ready to start printing the final design. Now I hit the next major disadvantage of 3D printing – the time taken for each print. As an example each wing panel or a fuselage section took about 4hrs to print! Combine the print time with a few print failures and the total time was in the hundreds of hours. Some people leave their printers going overnight, I haven't reached that level of confidence yet so, with printing only during the day, it took weeks from start to finish. Total material cost was about £30, including all the print failures.

A pile of failed prints!



The fuselage parts ready for joining

Eventually I had a kit of parts and glued them together using Gorilla glue clear, a bad decision that would come back to haunt me. The radio was installed and, after many months, it was time to commit to flight!

The finished article.

As the model was completed last year opportunities to fly it have been limited. To date there have been 4 breakages and 3 only flights! First 'flight' was a hand launched glide at Hale Hall which went OK. Second flight, another hand launch which, due to the slippery surface of the plastic, pitched up and broke a wing joint. Next I fell over on the way up to Parlick which resulted in a broken fuselage and more wing joint failures. The model made it to the top of Parlick in one piece on the next

outing. The wind was fairly strong which unfortunately resulted in another wing failure as it was caught by the wind as it was carried out for a launch.

It was close to going in the bin at this point but I decided to give it one more chance. I decided that Gorilla glue clear does not bond to plastic well so I broke all the joints and reassembled using thin cyano. This seems to give a much stronger joint so hopes were high for the next trip. A smooth launch off the east face of Parlick was followed by an excellent flight. No trim required, handled nicely with a good turn of speed. It has flaps and ailerons so I have set up crow brakes to help with the landing. I had several aborted landing approaches, eventually getting it right with a relatively smooth landing. But yet again, despite the gentle arrival, the rear fuselage cracked. As a temporary measure I have strengthened the rear fuselage with carbon tow, I hope that will provide enough strength to achieve a launch, flight and landing without damage. I am now waiting for our release from lockdown to give it one more try!

Using some of the experience from the Sword design and build I have also created a flying wing. Based on the X2 by Colin Waite, called the XP (P for plastic!) Wing span 750mm with split rudder airbrakes. This has been much more successful. It is great fun to fly, fast and manoeuvrable and so far has not suffered any breakages. I did learn another lesson when I left the wing in the back of my car with the boot open in direct sunshine. The result was a twisted buckled wing!! Luckily the wings are removable so I only had to print one replacement. Both my models now have reflective carrying bags to protect them from the sun.

## Conclusions

Well what have I learnt over the past year or so?

- You can produce a successful model using a 3D printer.
- Learning to design in 3D is time consuming, but satisfying.
- The materials (I use a plastic called PLA) are relatively cheap, about £20 per Kg.
- Printing the parts takes a long time.
- The correct weight / strength balance is difficult to achieve. 3D printed models will generally be heavier than conventional construction. Small models are more practical.
- PLA has a low melting point – beware of direct sun!

## The Future

The fuselage design of the Sword is not strong enough for a practical model so I have designed a new fuselage (new name ‘Fusion’ as it was designed in Fusion360) which I hope will be more robust. I have finished the printing and just need to glue it together. It will use the existing wings initially, although I have a new design for the wing to reduce weight and improve its rigidity.

Fusion kit of parts

Fusion Fuselage

During the long hours of lockdown I have also started the design of a Hunter, also destined for the slope. It may be some time before this one sees the light of day!

## Other projects

I have mentioned in a previous Newsletter that I was working on some dummy engine designs for Bob's SE5a. These are now complete and installed on the model. They were printed in black PLA, Bob has painted them matt black and added some 'weathering' with pencil lead.

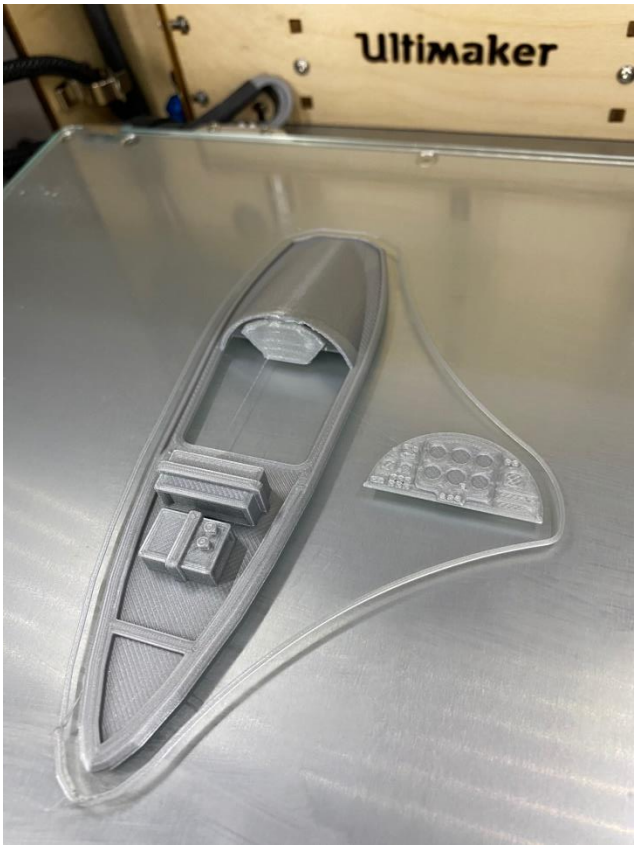
## Members Projects

There are several other club members with 3D printers. Jon Wiggall sent me some words and photos for some of his projects.

*For some nostalgia I have built a Kiel Kraft Phantom Control Line model over lockdown. I used my 3D printer to make a simple cockpit and pilot for the model. The cockpit and headrest is designed from scratch in CAD - I use both Fusion360 and SketchUp. The instrument panel and pilot torso are free downloads from thingiverse, just sized for my application.*

*The model is small, so layer printing is at 0.1mm, generally through a 0.4mm nozzle but for the pilot I used a 0.25mm nozzle. Use a light filling aerosol primer to help hide any layer lines, then paint / airbrush as required.*

*The learning I have gained from experimenting with 3D printing I plan to use on larger model aircraft projects in the future.*






Some excellent prints Jon. I remember the Phantom well, looks great.

Jon has also printed some parts for his Tamiya RC cars.

*RC Cars and 3D printing*

*I played a lot with Tamiya RC cars in my teenage years. Recent re-releases of some of their iconic models has rejuvenated my enthusiasm for these amazing scale models and allowed me to relive my youth on St Anne's beach!*

*I have used my 3D printer to make scale details such as air and oil filters, petrol caps, jerry cans, license plates and more.*

*For those interested, my Tamiyaclub showroom can be found here:*

*https://www.tamiyaclub.com/showroom.asp?id=50506*

No 108 2021



Some quality prints Jon. Love the jerry cans!

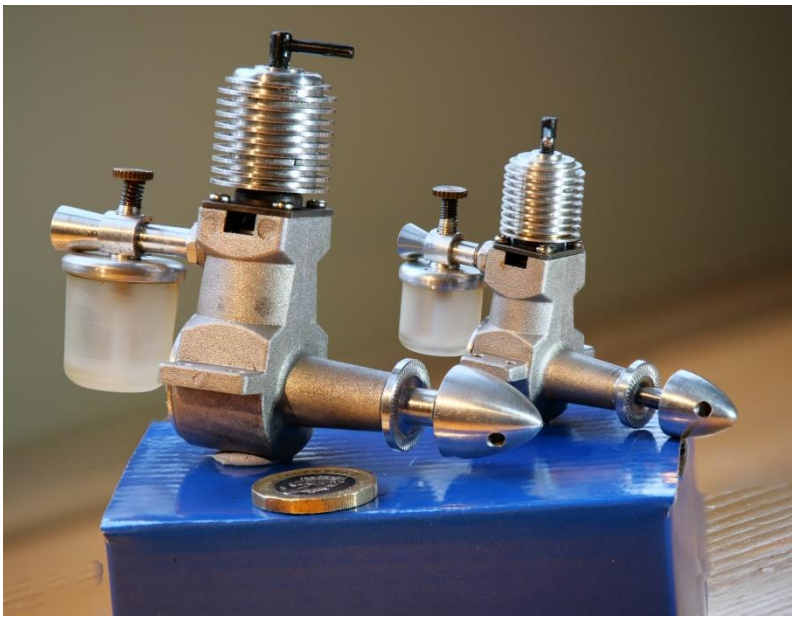
### Did you know?

For the PRUSA printer many of the parts are 3D printed, there is a factory with dozens of printers all printing parts for new printers. All a bit Sci-fi, the rise of the machines!!

## Curiosity corner

Well how did you do?

Although the engines look old they are in fact quite recent, manufactured around 2010. They are affectionally known as ‘Boddo diesels’, replicas of the original Mills diesel, produced for the legendary David Boddington. The larger engine is 1.3 cc and the smaller 0.5cc. Both start easily and run well, you can’t beat that intoxicating smell of diesel fuel!



# What's on.

## BMFA webinars

The BMFA webinars, 'in the air tonight', are continuing. Upcoming events include:

23rd March - An introduction to RC helicopters and helicopter competitions
30th March - Classic Aerobatics with Martyn Kinder
13th April - An introduction to Glider GPS Racing Part 2
20th April - An introduction to F5B Glider Flying

You can find the link here:

https://itat.bmfa.uk/

There have recently been several cancellations and date changes for events/shows this year:

- **June 26th** Blackpool & Fylde Radio Controlled Model Society Fly-in. 10am – 5 pm at the Weeton field.
- Cosford Large Model Airshow at RAF Cosford. – **CANCELLED for 2021**
- **August 7th – 8th** LMA Elvington Show
- **September 3rd – 5th** Weston Park Model Airshow.

# Parting shot.

So that is the end of another newsletter, I hope you found it interesting. Thanks to all contributors.

For future newsletters I would like to include as many of your projects and especially first flights as possible. So please document the occasion with few photos or contact me and I will try and come down with my camera. I do have some ideas for future articles, but the success of the newsletter will only continue if you, the members, provide me with some copy. Anything aircraft related will be more than welcome, days out, trips, build logs, full size or something for the Curiosity Corner.

Don't be shy; if you don't fancy writing a full article, just send me few notes and I will do the rest.

If you have any suggestions on subjects to be included in the Newsletter, drop me a line.

In these days of data protection we need to ask members if they have any objection to be included, either by name or photograph, in the Newsletter. If you do not wish to be in the Newsletter please let me know.

You can contact me at andy.holden56@btinternet.com

Stay safe, let's hope we resuming flying soon.