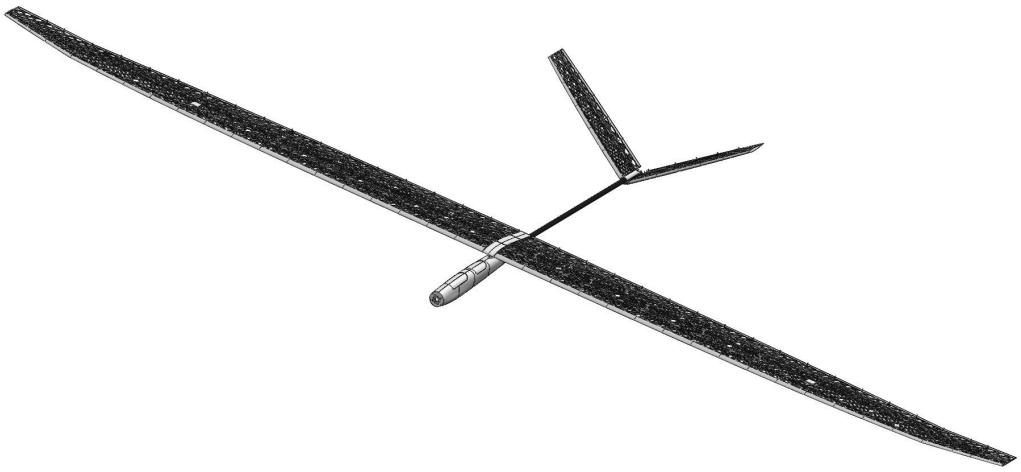
KRAGA

Roa II build guide 1.0

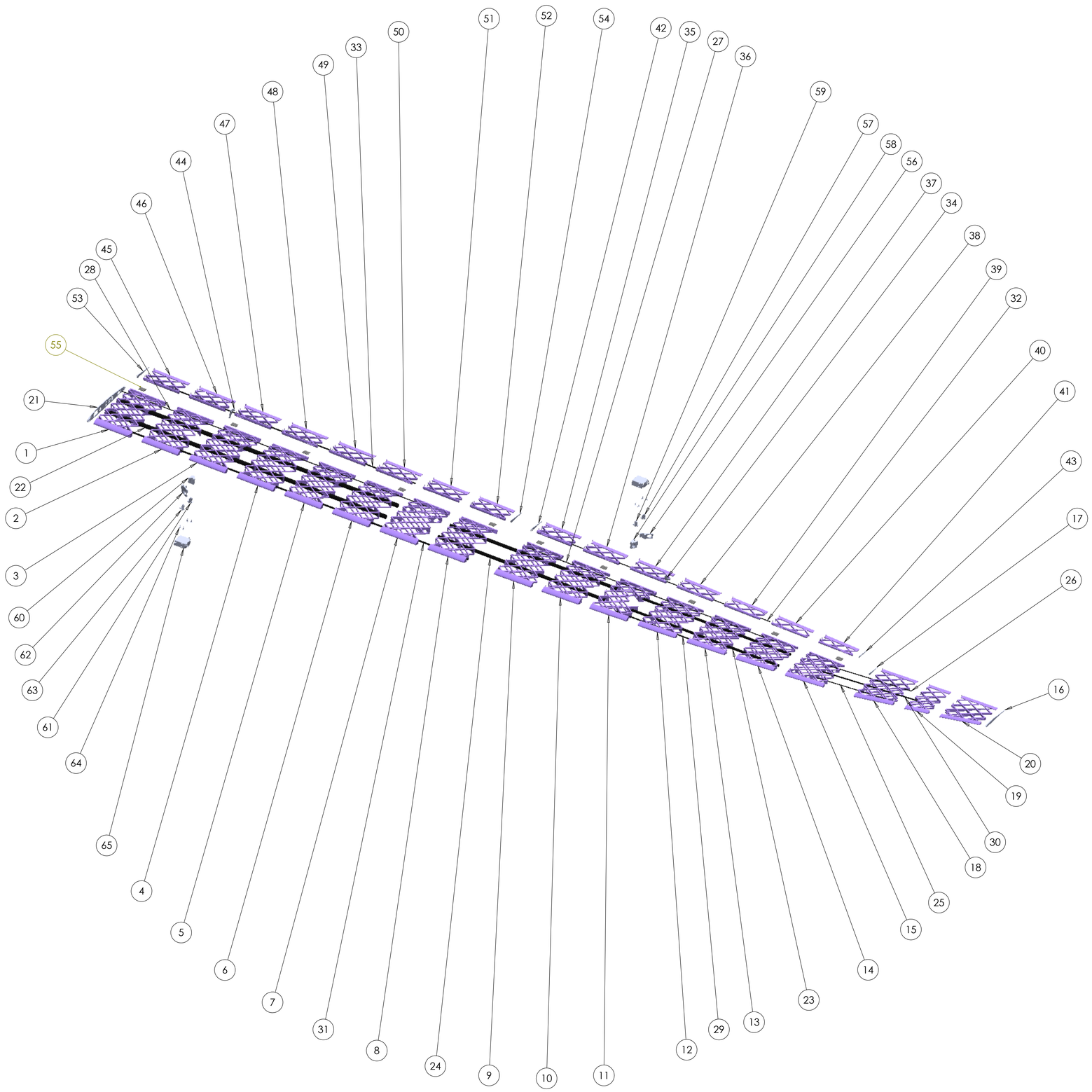


Please do not share files that you bought

Development of a new plane and support of the old ones is very time consuming. Only with your help I can focus fully on this project and spend some quality time with my family.

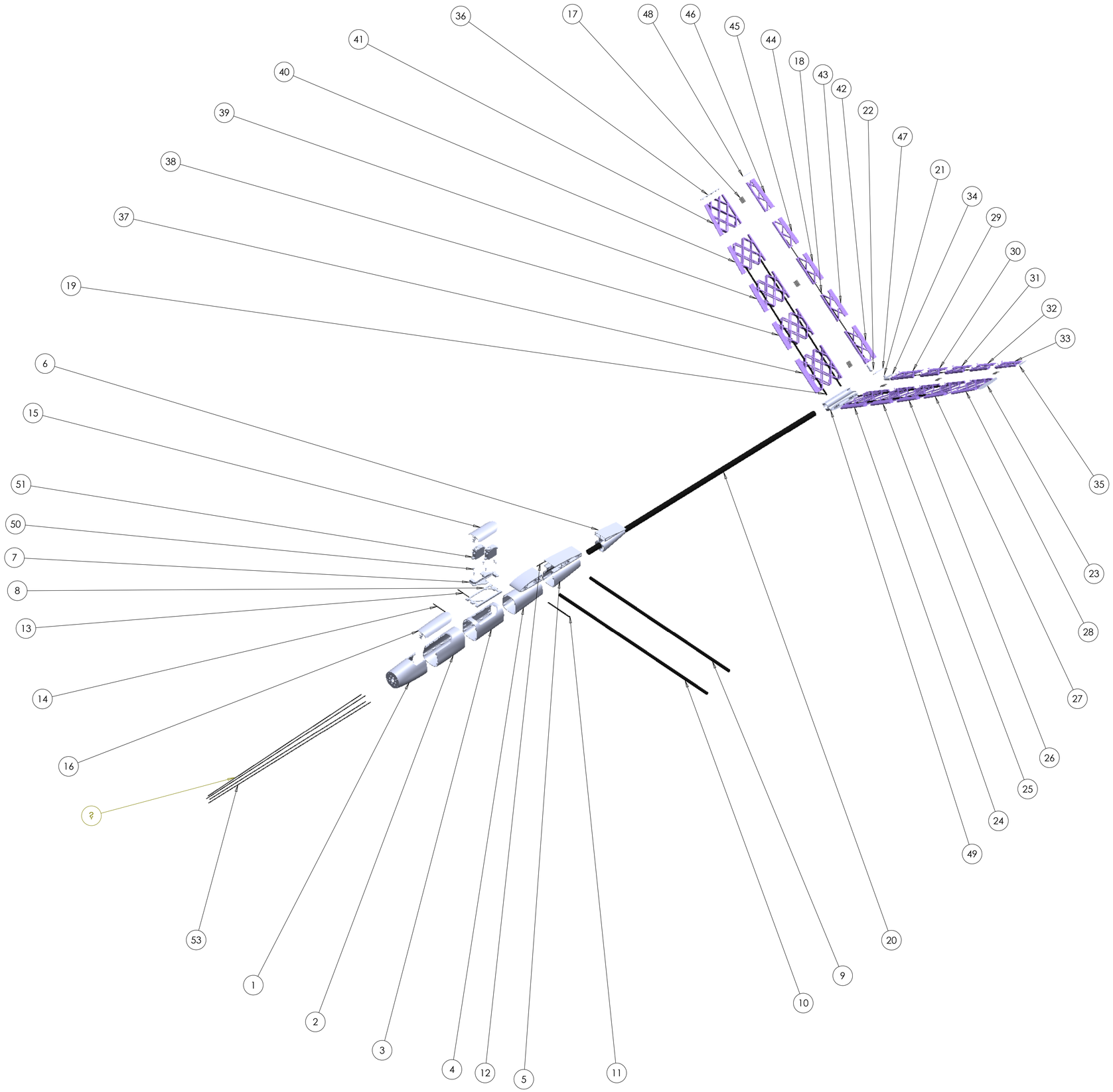
support@kragamodels.com

KRAGA Roa II - wing L



ITEM NO.	PART NUMBER	PRINTED AS	QTY.
1	wing_L_0	shell	1
2	wing_L_1	shell	1
3	wing_L_2	shell	1
4	wing_L_3	shell	1
5	wing_L_4	shell	1
6	wing_L_5	shell	1
7	wing_L_6	shell	1
8	wing_L_7	shell	1
9	wing_L_8	shell	1
10	wing_L_9	shell	1
11	wing_L_10	shell	1
12	wing_L_11	shell	1
13	wing_L_12	shell	1
14	wing_L_13	shell	1
15	wing_L_14	shell	1
16	wing_tip_endcap_L	solid	1
17	wing_ail_innercap_L	solid	1
18	wing_tip_L_0	shell	1
19	wing_tip_L_1	shell	1
20	wing_tip_L_2	shell	1
21	wing_root_endcap_L	solid	1
22	10x8_745	-	2
23	6x4_404	-	2
24	8x6_442	-	2
25	2x1_193	-	1
26	2x1_218	-	1
27	2x1_660	-	1
28	2x1_809	-	1
29	3x2_230	-	1
30	3x2_266	-	1
31	4x3_985	-	1
32	2x1_587	-	1
33	3x2_680	-	1
34	ail_horn_L	solid	1
35	ail_L_0	shell	1
36	ail_L_1	shell	1
37	ail_L_2	shell	1
38	ail_L_3	shell	1
39	ail_L_4	shell	1
40	ail_L_5	shell	1
41	ail_L_6	shell	1
42	ail_root_endcap_L	solid	1
43	ail_tip_endcap_L	solid	1
44	flap_horn_L	solid	1
45	flap_L_0	shell	1
46	flap_L_1	shell	1
47	flap_L_2	shell	1
48	flap_L_3	shell	1
49	flap_L_4	shell	1
50	flap_L_5	shell	1
51	flap_L_6	shell	1
52	flap_L_7	shell	1
53	flap_root_endcap_L	solid	1
54	flap_tip_endcap_L	solid	1
55	hinge	-	10
56	ail_rem_servo_mount_L_B	solid	1
57	ail_rem_servo_mount_L_B_glue_on	solid	1
58	ail_rem_servo_mount_L_F	solid	1
59	ail_rem_servo_mount_L_F_glue_on	solid	1
60	flap_rem_servo_mount_L_B	solid	1
61	flap_rem_servo_mount_L_B_glue_on	solid	1
62	flap_rem_servo_mount_L_F	solid	1
63	flap_rem_servo_mount_L_F_glue_on	solid	1
64	screw_M2x8mm	-	8
65	HS-85MG	-	2

KRAGA Roa II - fuselage

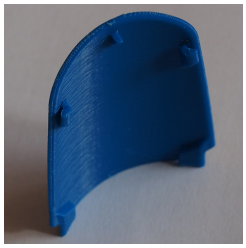


ITEM NO.	PART NUMBER	PRINTED AS	QTY.
1	fuse_0	solid	1
2	fuse_1	solid	1
3	fuse_2	solid	1
4	fuse_3	solid	1
5	fuse_4	solid	1
6	fuse_5	solid	1
7	servo_plate	solid	1
8	servo_plate_holder	solid	1
9	8x6_485	-	1
10	8x6_515	-	1
11	3x2_75	-	1
12	2x1_68	-	2
13	2x1_45	-	1
14	2x1_48	-	1
15	canopy_b	solid	1
16	canopy_f	solid	1
17	hinge	-	6
18	2x1_362	-	2
19	4x3_374	-	4
20	14x12_785	-	1
21	tail_horn_L	solid	1
22	tail_horn_R	solid	1
23	tail_main_endcap_L	solid	1
24	tail_main_L_0	shell	1
25	tail_main_L_1	shell	1
26	tail_main_L_2	shell	1
27	tail_main_L_3	shell	1
28	tail_main_L_4	shell	1
29	tail_mov_L_0	shell	1
30	tail_mov_L_1	shell	1
31	tail_mov_L_2	shell	1
32	tail_mov_L_3	shell	1
33	tail_mov_L_4	shell	1
34	tail_move_root_endcap_L	solid	1
35	tail_move_tip_endcap_L	solid	1
36	tail_main_endcap_R	solid	1
37	tail_main_R_0	shell	1
38	tail_main_R_1	shell	1
39	tail_main_R_2	shell	1
40	tail_main_R_3	shell	1
41	tail_main_R_4	shell	1
42	tail_mov_R_0	shell	1
43	tail_mov_R_1	shell	1
44	tail_mov_R_2	shell	1
45	tail_mov_R_3	shell	1
46	tail_mov_R_4	shell	1
47	tail_move_root_endcap_R	solid	1
48	tail_move_tip_endcap_R	solid	1
49	tail_mount	solid	1
50	screw_M2x8mm	-	6
51	HS-85MG	-	2
52	2x1_518	-	2
53	2x1_535	-	2

Printing

You need to use two printing methods to print all parts:

1. Solid parts (fuse and accessories). Use dense infill. This is common way of printing objects and these parts should be printable on every printer.



2. Shell parts (wings). Use 0% infill and no horizontal surfaces (thickness of the shell is one layer). Only this way you can achieve required weight of the plane.

You can check what method to use on what part in bill of materials table.

Other recommended printing settings:

- Nozzle size: 0.4 mm
- Layer thickness: 0.19 mm
- Rafts: yes

You can use any material you like, only limitation is high temperature from ironing when covering assembled parts. Heat from the iron can deform the parts. Although I was not able to damage any part and I tried to cover many materials (ABS, PLA...), please test film covering on your testing part.

One of the goals when designing KRAGA models was to use minimal or no support during printing. Removing support after printing is big pain and you can easily destroy your part. That is the reason why you should use default orientation of all parts during printing. There are only a few parts from whole plane which require support, the rest of the plane should be support-free.

I strongly recommend to mark every printed part with it's name (I'm using masking tape for that). There are many parts in this plane and from each part there is also mirror side which can easily cause confusion during assembly.

I also recommend to print parts in bulks, especially smaller parts like ailerons or moving section on the plane tail. Otherwise there is not enough time for material cooling in each layer and you might end up with rough layers, ugly edges or print fail.

Preparation for assembly

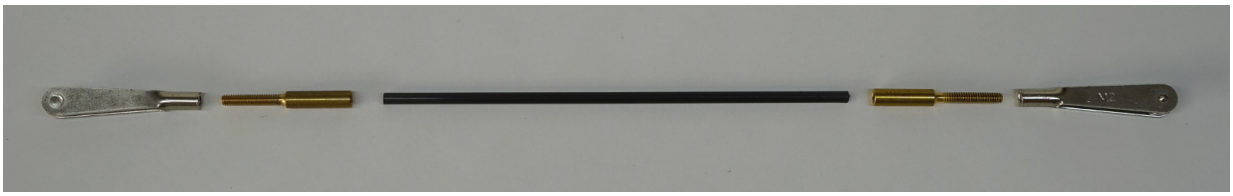
KRAGA Roa II plane consists of parts that are printed and parts that you need to buy separately (they are not included in sold product) – carbon tubes and pinned hinges.

List of required parts:

	dimensions	count
carbon tube	⌀ 2x1 mm ↔ 1 m	10
carbon tube	⌀ 3x2 mm ↔ 1 m	5*
carbon tube	⌀ 4x3 mm ↔ 1 m	4
carbon tube	⌀ 6x4 mm ↔ 1 m	2
carbon tube	⌀ 8x6 mm ↔ 1 m	3
carbon tube	⌀ 10x8 mm ↔ 1 m	4
carbon tube (woven)	⌀ 14x12 mm ↔ 800 mm	1
covering film	↔ 4 m	1
pinned hinge	↕ ↔ 16x28x1.2mm	26
folding propeller	13 x 8 in	1
spinner	⌀ 45 mm	1
screw	M2 ↔ 8mm	22

⌀ 2x1 mm – means tube with outer diameter of 2mm and inner diameter of 1mm
* 2 pieces of 3x2 mm carbon tube are meant to be used for tail linkage with threaded couplers and metal clevises

And of course you need all the common accessories like clevises, push rods (horns are printed so you don't need those) and servo extension cables (2 pieces of 90 cm cable for aileron servos). One way how to make custom pushrods is using 2x1 mm (or 3x2 mm) carbon tube glued into threaded couplers and screwed into metal clevises (picture below).



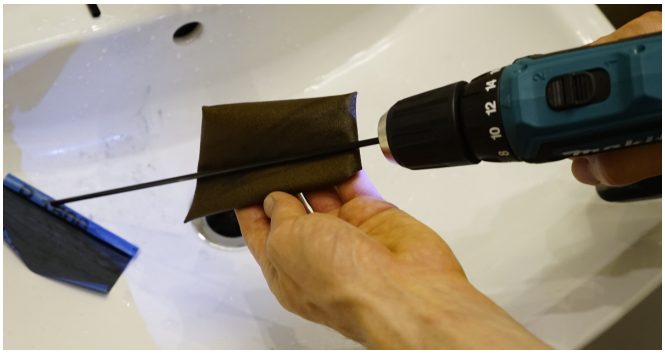
Next step is to cut carbon tubes and rods into smaller pieces, which will be used as spars, joiners or boom of the plane. Don't forget to mark every piece to avoid confusion during the assembly.

Carbon spars		
part	dimensions	count
Wing section 1:		
Main carbon spar	⌀ 10x8 mm ↔ 745 mm	4
Secondary main carbon spar	⌀ 8x6 mm ↔ 442 mm	4
Front alignment carbon spar	⌀ 4x3 mm ↔ 985 mm	2
Rear alignment carbon spar	⌀ 2x1 mm ↔ 809 mm	2
Wing section 2:		
Tertiary main carbon spar	⌀ 6x4 mm ↔ 404 mm	4
Secondary front alignment carbon spar	⌀ 3x2 mm ↔ 230 mm	2
Secondary rear alignment carbon spar	⌀ 2x1 mm ↔ 660 mm	2
Wing tip:		
Wing tip front carbon spar	⌀ 2x1 mm ↔ 193 mm	2
Wing tip middle carbon spar	⌀ 3x2 mm ↔ 266 mm	2
Wing tip rear carbon spar	⌀ 2x1 mm ↔ 218 mm	2
Wing surfaces:		
Aileron carbon spar	⌀ 2x1 mm ↔ 587 mm	2
Flap carbon spar	⌀ 3x2 mm ↔ 680 mm	2
Fuselage:		
Fuse top carbon spar	⌀ 2x1 mm ↔ 518 mm	2
Fuse bottom carbon spar	⌀ 2x1 mm ↔ 535 mm	2
Fuse pod carbon spar	⌀ 2x1 mm ↔ 68 mm	2
Fuse servo plate carbon spar rear	⌀ 2x1 mm ↔ 45 mm	1
Fuse servo plate carbon spar front	⌀ 2x1 mm ↔ 48 mm	1
Carbon woven boom	⌀ 14x12 mm ↔ 785 mm	1
Wing alignment joiner	⌀ 3x2 mm ↔ 75 mm	1
Wing joiner carbon tube front	⌀ 8x6 mm ↔ 515 mm	1
Wing joiner carbon tube back	⌀ 8x6 mm ↔ 485 mm	1
Tail:		
Tail main carbon spar	⌀ 4x3 mm ↔ 374 mm	4
Tail mov carbon spar	⌀ 2x1 mm ↔ 362 mm	2

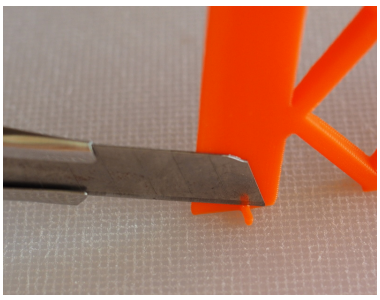
TIP: How to cut carbon spars. Wrap masking tape around carbon spar and mark cut position. Use rotary tool or X-ACTO fine saw to cut the spar.

Work outside or in room with good ventilation. Use breathing mask to avoid inhaling carbon dust! After cutting wipe out carbon dust from the spars using wet tissue.

TIP: Carbon wing joiner tubes on the fuselage should fit into spars in the wing. Sometimes the fit is too tight or you cannot insert joiner tubes into wing spars at all. You can use drill and wet sandpaper to make joiner tubes thinner. Use breathing mask to avoid inhaling carbon dust!



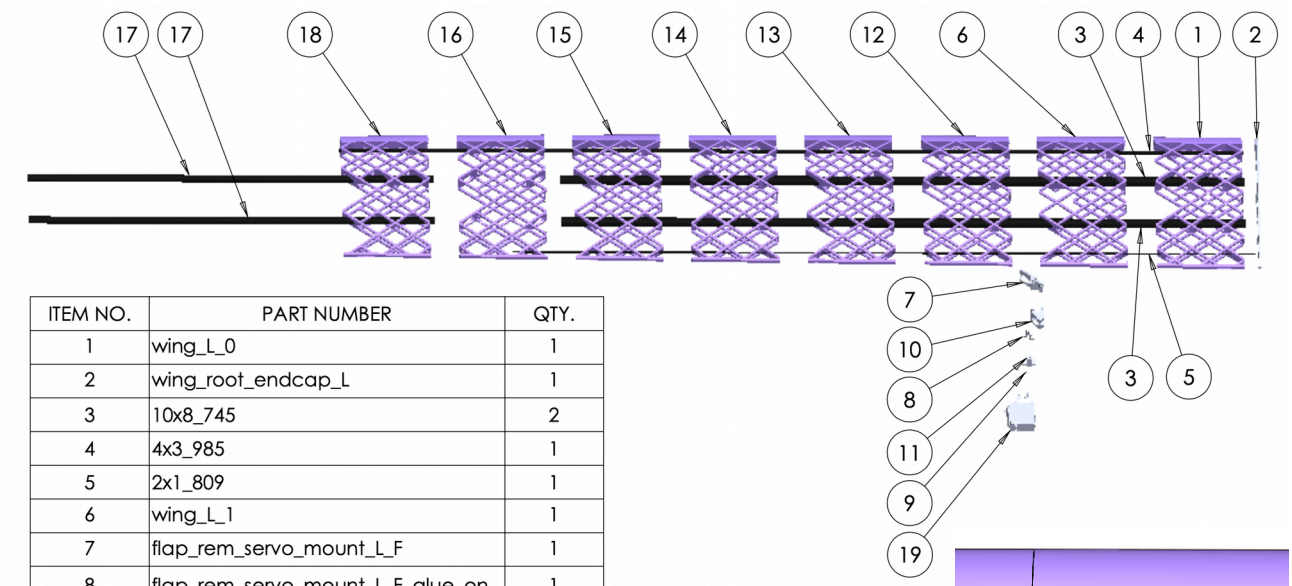
Remove support legs from all parts. Also sand all sharp edges and printing imperfections to avoid covering foil damage.



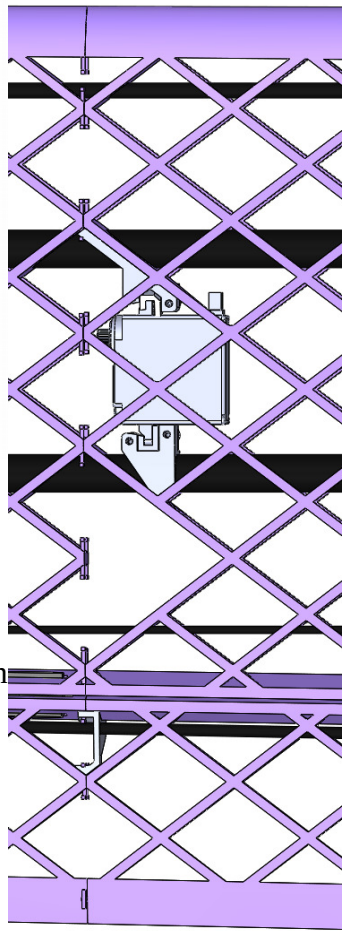
Assembly

This assembly guide will describe always left side of the plane when it comes to symmetric parts. I recommended to use medium viscosity CA glue. You can use CA glue accelerator for faster curing time. Dry fit all the parts before gluing them together. Wing parts in assembly drawings have printing support legs visible, please ignore it, these legs should be removed before plane assembly.

Wing section 1



ITEM NO.	PART NUMBER	QTY.
1	wing_L_0	1
2	wing_root_endcap_L	1
3	10x8_745	2
4	4x3_985	1
5	2x1_809	1
6	wing_L_1	1
7	flap_rem_servo_mount_L_F	1
8	flap_rem_servo_mount_L_F_glue_on	1
9	screw_M2x8mm	4
10	flap_rem_servo_mount_L_B	1
11	flap_rem_servo_mount_L_B_glue_on	1
12	wing_L_2	1
13	wing_L_3	1
14	wing_L_4	1
15	wing_L_5	1
16	wing_L_6	1
17	8x6_442	2
18	wing_L_7	1
19	HS-85MG	1



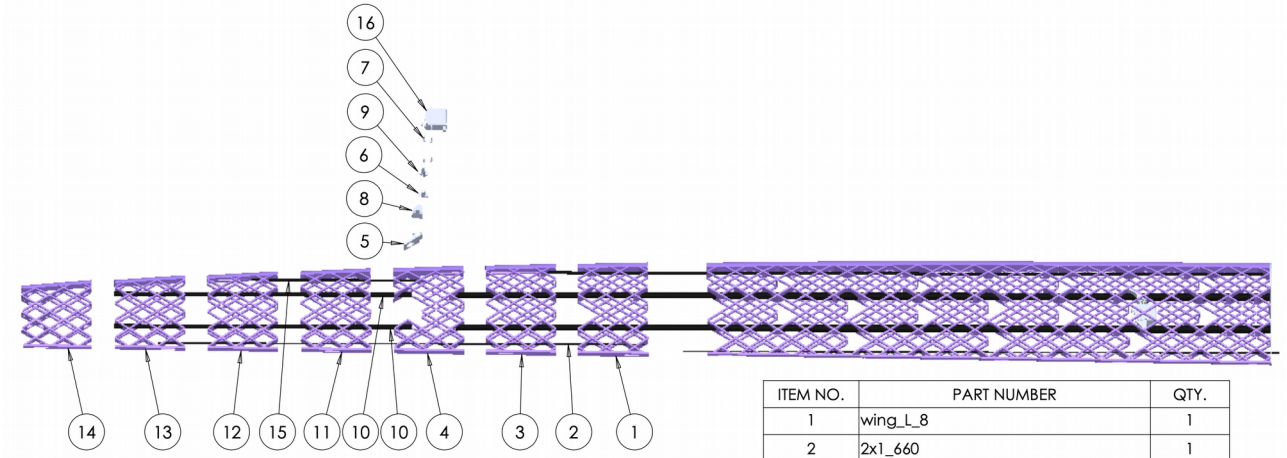
Assembly first section of left wing as sketched above. Main spars (10x8_745) and front alignment spar (4x3_985) should be aligned flush with base of wing_root_endcap_L part. Rear alignment spar (2x1_809) should protrude 1 cm from wing_root_endcap_L part.

Before adding wing_L_7, prolong main spars by inserting secondary main spars into main spars 8 cm deep and secure the spars in place with CA glue.

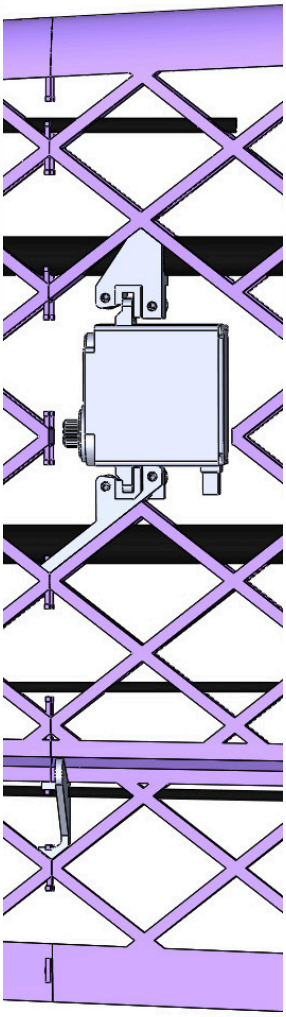
When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts.

When assembling flap servo mounts, notice that screws are screwed in from bottom side of the wing. It is strongly recommended to pre-drill the screw holes. Servo has to be glued to flap_servo_mount_L_F_glue_on and flap_servo_mount_L_B_glue_on parts.

Wing section 2



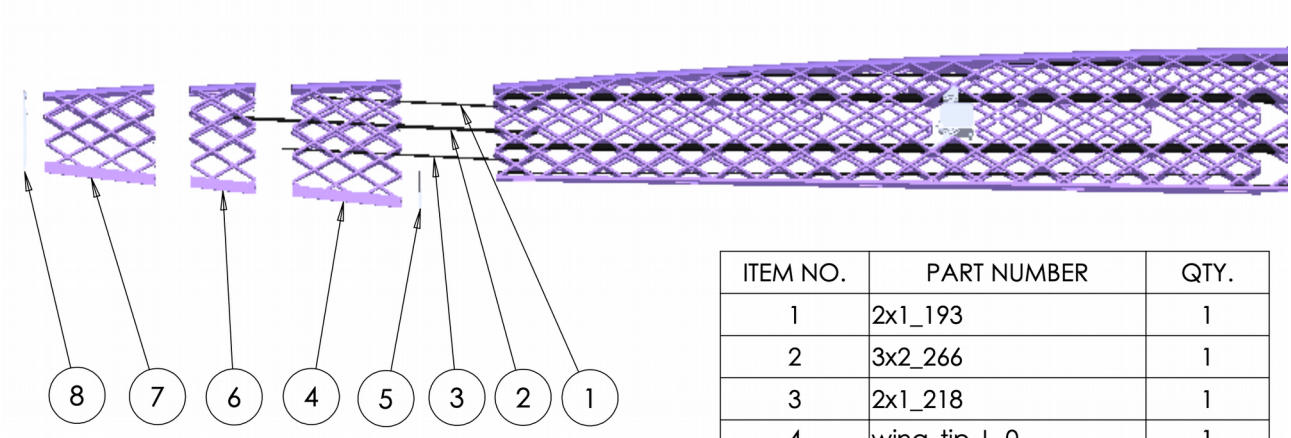
ITEM NO.	PART NUMBER	QTY.
1	wing_L_8	1
2	2x1_660	1
3	wing_L_9	1
4	wing_L_10	1
5	ail_rem_servo_mount_L_B	1
6	ail_rem_servo_mount_L_B_glue_on	1
7	screw_M2x8mm	4
8	ail_rem_servo_mount_L_F	1
9	ail_rem_servo_mount_L_F_glue_on	1
10	6x4_404	2
11	wing_L_11	1
12	wing_L_12	1
13	wing_L_13	1
14	wing_L_14	1
15	3x2_230	1
16	HS-85MG	1



Assembly second section of left wing as sketched above. Before adding wing_L_11, prolong secondary main spars by inserting tertiary main spars into secondary main spars 8 cm deep and secure the spars in place with CA glue.

On the left picture you can see detail of aileron servo installation.

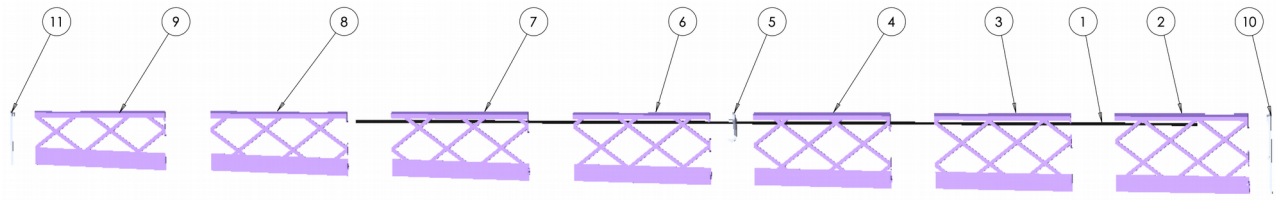
Wing tip



ITEM NO.	PART NUMBER	QTY.
1	2x1_193	1
2	3x2_266	1
3	2x1_218	1
4	wing_tip_L_0	1
5	wing_ail_innercap_L	1
6	wing_tip_L_1	1
7	wing_tip_L_2	1
8	wing_tip_endcap_L	1

Assembly left wing tip as sketched above. When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts.

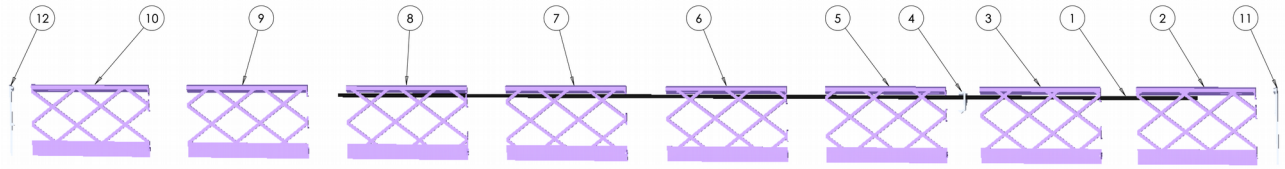
Aileron



ITEM NO.	PART NUMBER	QTY.
1	2x1_587	1
2	ail_L_0	1
3	ail_L_1	1
4	ail_L_2	1
5	ail_horn_L	1
6	ail_L_3	1
7	ail_L_4	1
8	ail_L_5	1
9	ail_L_6	1
10	ail_root_endcap_L	1
11	ail_tip_endcap_L	1

Assembly left aileron as sketched above. Don't forget to insert ail_horn_L part between ail_L_2 and ail_L_3. Aileron horn should stick out from the top side of the wing. When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts. Put also a bit of glue on trailing edge where all the aileron sections are touching each other.

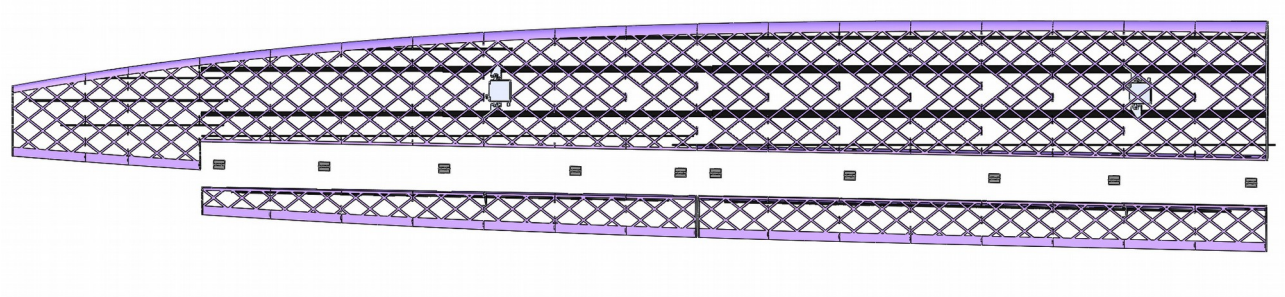
Flap



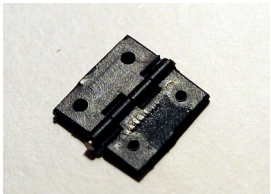
ITEM NO.	PART NUMBER	QTY.
1	3x2_680	1
2	flap_L_0	1
3	flap_L_1	1
4	flap_horn_L	1
5	flap_L_2	1
6	flap_L_3	1
7	flap_L_4	1
8	flap_L_5	1
9	flap_L_6	1
10	flap_L_7	1
11	flap_root_endcap_L	1
12	flap_tip_endcap_L	1

Assembly left flap as sketched above. Don't forget to insert flap_horn_L part between flap_L_1 and flap_L_2. Flap horn should stick out from the bottom side of the wing. When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts. Put also a bit of glue on trailing edge where all the flap sections are touching each other.

Aileron and flap to wing



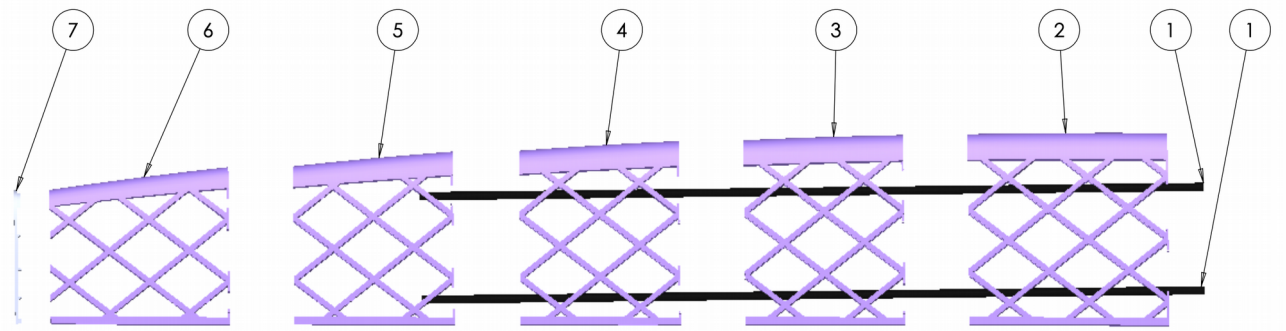
To complete wing assembly attach aileron and flap to the wing.



Hinge slots are not deep enough to fit whole hinge length. Shorten all hinges as shown on the picture. It has no benefit in terms of added stiffness of rigidity to use whole hinge arm length as only small hinge area is in contact with the wing.

Be very careful when using glue near pinned part of the hinge. First insert the hinge into hinge hole and then apply the glue from inner side of the wing. Do the same when gluing aileron to hinge. First insert all hinges into hinge holes on aileron/flap and then apply glue from inner side of aileron/flap. Make sure that aileron and flap have enough space for moving from every side. There should be a gap of minimum 1 mm on each side of each moving surface.

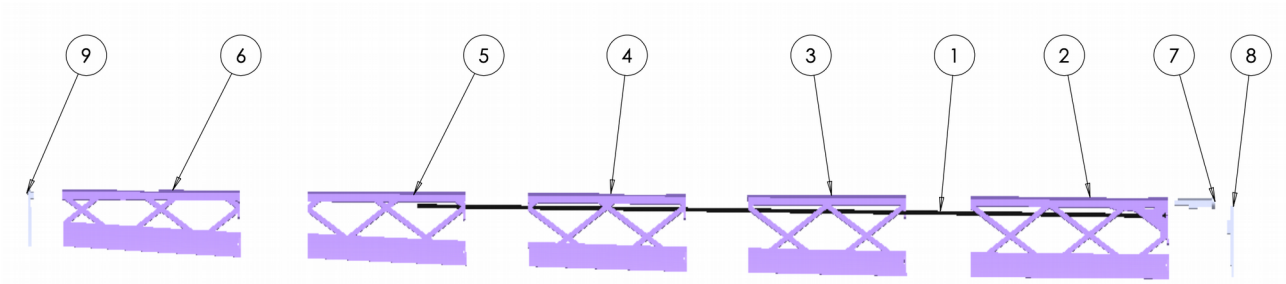
Tail main



ITEM NO.	PART NUMBER	QTY.
1	4x3_374	2
2	tail_main_L_0	1
3	tail_main_L_1	1
4	tail_main_L_2	1
5	tail_main_L_3	1
6	tail_main_L_4	1
7	tail_main_endcap_L	1

Assembly left main tail as sketched above. Tail wing uses inverted airfoil. Carbon spars should protrude 16 mm from base of tail_main_L_0. When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts.

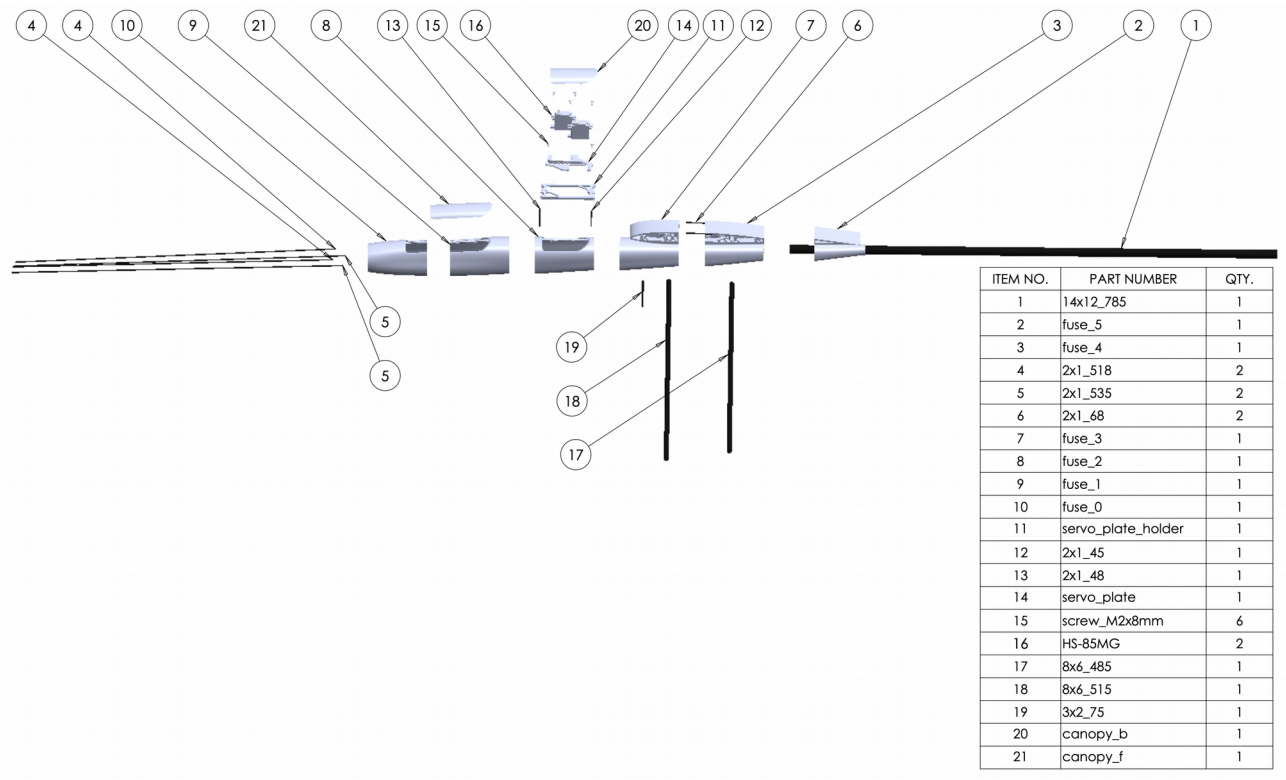
Tail mov



ITEM NO.	PART NUMBER	QTY.
1	2x1_362	1
2	tail_mov_L_0	1
3	tail_mov_L_1	1
4	tail_mov_L_2	1
5	tail_mov_L_3	1
6	tail_mov_L_4	1
7	tail_horn_L	1
8	tail_move_root_endcap_L	1
9	tail_move_tip_endcap_L	1

Assembly moving part of left tail as sketched above. When all the parts are in their position, put glue on contact points where carbon spars are touching printed parts.

Fuselage



ITEM NO.	PART NUMBER	QTY.
1	14x12_785	1
2	fuse_5	1
3	fuse_4	1
4	2x1_518	2
5	2x1_535	2
6	2x1_68	2
7	fuse_3	1
8	fuse_2	1
9	fuse_1	1
10	fuse_0	1
11	servo_plate_holder	1
12	2x1_45	1
13	2x1_48	1
14	servo_plate	1
15	screw_M2x8mm	6
16	HS-85MG	2
17	8x6_485	1
18	8x6_515	1
19	3x2_75	1
20	canopy_b	1
21	canopy_f	1

Start by gluing together boom and fuse_5. Boom should protrude 4 cm from the fuse_5 part. Apply glue from the tail side of the wing. fuse_5 part has tiny channels for glue to soak in along the boom.

Second step is to attach fuse_4 part to the protruding boom. Make sure that all 4 fuse spar leading holes are aligned correctly and secure it to the carbon boom with glue.

Then insert 2 pieces of 2x1_518 into top fuse spar channels of fuse_4 all the way in up to fuse_5 and 2 pieces of 2x1_535 into bottom spar channels of fuse_4 all the way in up to fuse_5. Apply the glue from inner side of fuse_1 everywhere, where fuse spars are visible from the inside of the fuselage. Let the glue leak further into places which are hard to reach.

It can happen that spar leading holes are too tight and it is difficult to insert carbon spars into them. One option is to use ordinary bicycle steel spoke (2mm thick). Cut the head and the thread off, make some kind of sharp edge and mount it into a drill. This way you can drill through all spar leading holes to remove all printing imperfections. Another option is to use metal cable which you can straighten and use in the drill.

Insert 2x1_68 spars into fuse_4 and secure them with the glue.

Continue with rest of fuselage parts. Always put each part in its position and only then apply the glue from inner side.

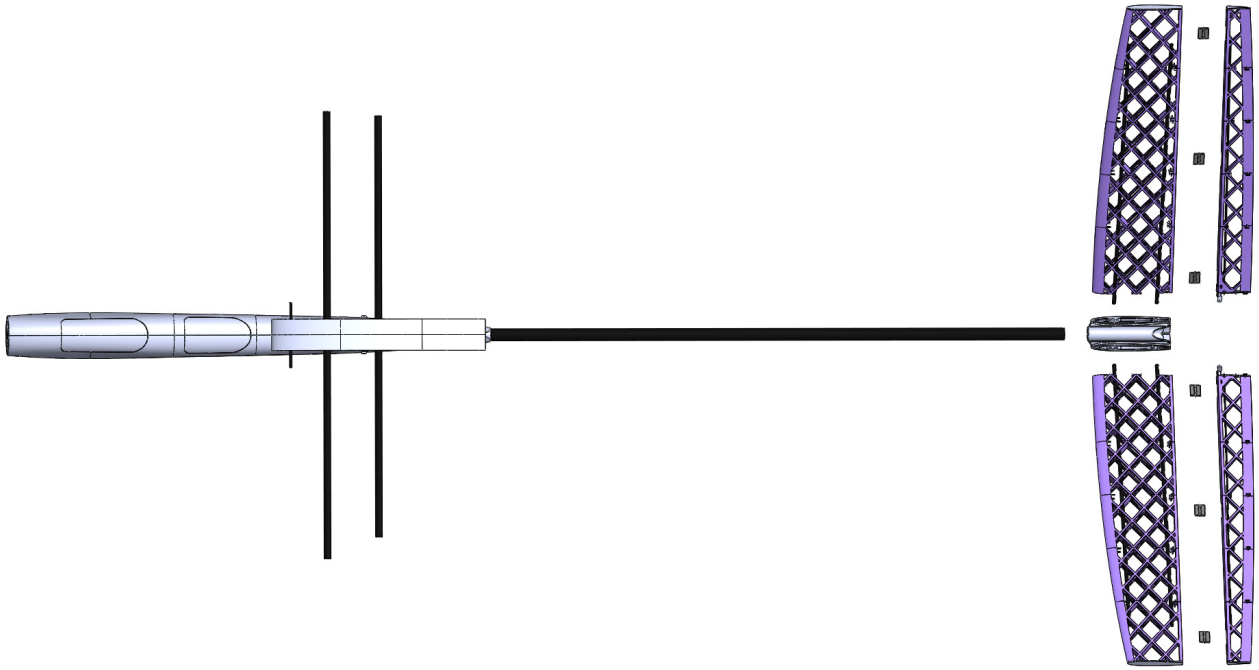
When all fuse parts (fuse_5 ... fuse_0) are glued together, pre-drill screw holes on servo plate holder and insert it into fuse_2. Lead 2x1_45 and 2x1_48 spars through side holes in fuse_2 and holes in servo holder plate. Apply the glue from inside of the fuselage to secure servo plate holder and its

spars in place.

Pre-drill also screw holes on servo plate. It is easier to attach servos to the servo plate before inserting servo plate into the fuselage and screwing servo plate to the servo holder plate.

Make sure, that wing joiner carbon tubes (8x6_515 and 8x6_485) fit into main wing spars, if not, use drill and wet sanding paper as described in the beginning of this guide to make them thinner. You can glue the wing joiners into the fuselage pod permanently or keep them removable for easier transport.

Tail



To complete tail assembly first shorten all hinges and then insert the hinges into hinge slots and apply the glue from inner side of the main tail. Then insert all hinges into hinge slots on moving part of the tail and put the glue from inner side of the moving part. Tip of the moving part should be aligned flush with main part. Be very careful when using glue near pinned part of the hinge.

Before gluing tail surfaces to the tail_mount, dry fit protruding spars of the tail surfaces into tail_mount. Apply the glue on the protruding spars and insert them into tail_mount.

Insert boom into tail_mount. Aline the tail correctly with rest of the fuselage (use joiner rods as helping guide). Then you can apply the glue from the front side of tail_boom_mount. It has tiny channels for glue to soak in along the boom.

Covering

It is important to test film covering on testing part before you start. Covering of 3D printed parts is a bit special because of thermal expansion of plastics. When heating up the plastics it expands a bit. Covering is then actually done on slightly enlarged wing and when the wing is cooling down it shrinks back. But the covering foil does not and that causes wrinkles.

That is why some covering materials work better than other. Some are very stretchy and have the capacity to shrink down even more together with the printed wing as it is cooling down and shrinking and some do not.

I tested couple of brands and in my opinion Solarfilm Lite is the best option for 3D printed planes from Kraga. Unfortunately the company Solarfilm stopped production, so this material is very hard to get. Other good options (which I did not test myself) should be AeroLITE rolls and Coverite 21st Century Microlite.

If you cannot get one of the above mentioned covering materials, then in general lightweight options of covering materials work the best. For example Oralight from Oracover or UltraCote lite.

I strongly advice everybody to use trimming iron instead of standard sized one, because with trimming iron you don't heat up the wing that much.

Another very useful tool is covering film adhesive for example Cover grip from Deluxe materials. When using covering adhesive the foil sticks better and one doesn't have to heat it up that much, what again prevents expansion of the wing.

Finally the technique is also important, but that comes with practice. Covering video guide can be found in how to section on KRAGA web page: *https://3dprintedrcplanes.com/how_to/*

My recommendation is to cover wings after they are fully assembled (center wing, tip wing and aileron are glued together). It is a little bit more demanding but it is definitely worth it. Otherwise you are risking, that when gluing aileron to hinges and hinges to wing tip, glue might leak and spread all over hinge pin which will block the hinge and aileron would get stuck.

The same is valid for tail covering. Cover it after you glued on the moving part with hinges.

Electronics

This is by no means the best way possible how to setup your plane. It is just a brief overview of possible options.

Motor

Turnigy Aerodrive SK3 - 3536-1200kv Brushless Outrunner

I recommend to use motor weighting roughly 110 g, to have no problems setting the CG. You should be able to fit inside motors with diameter up to 37 mm.

Suitable propeller sizes: 13x8.

ESC

Turnigy Plush 60A or similar.

BATTERY

Turnigy nano-tech 1000mah 3S 25~50C Lipo (with roughly 80 g of additional ballast) or Turnigy nano-tech 1600mah 3S 25~50C Lipo

You can choose other battery but keep your size and weight similar to the examples above (up to 150 g). Using these, ESC and battery are installed as much as possible in the front of the fuselage next to each other (parallel config). For heavier batteries you need to put ESC into the front of the fuselage area and battery behind it closer to the servos (series config).

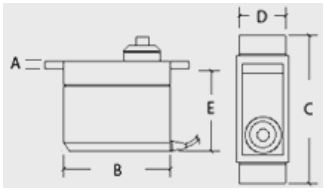
RECEIVER

This depends on your transmitter. Only requirement is to have 7 channels.

SERVOS

Hitec HS 85-MG

It is a reliable analog servo with metal gears for very reasonable price.



Servo mounts will fit servos with dimensions up to:
A = 2 mm, B = 29 mm, C = 40 mm, D = 13 mm, E = 20 mm

Settings and flying

CG

92 mm – 95 mm from wing leading edge measured next to the wing root.

I strongly recommend to use 92 mm for first flight. Setting your CG exactly is very important!

Control throws

Consider these as rough starting point, the season ended before I had time to fine tune the settings and play with flight modes.

Tail: up 12 mm, down 12 mm

Aileron: up 15 mm, down 8 mm

Landing/crow: flap full down, ail 6 mm up, elev 2 mm down

Template for tail zero position

You can print this template, cut it out of the paper and use it for setting zero position of the tail. After printing it should measure 92 mm.

Wings to fuselage attachment

Joiner rods on the fuselage have diameter of 8 mm, carbon spars in wings have inner diameter of 10 mm. To attach wing to the fuselage slide wing on joiner rods all the way in until small fork on the fuselage engages with pin on the wing root cap. This way of wing securing allows wing to detach during rough landing.

Happy flying

Tomas

support@kragamodels.com