

Canadian Control-Line Endurance Record

3 hours 28 minutes 25 seconds

Established September 9, 2017

photos by Doug Blackmore, Chris Hubbard, Janek Zalewski, and Sara Ricketts



Len Bourel (pilot, left), Doug Blackmore (flight engineer, right)

Commentary by Doug Blackmore:

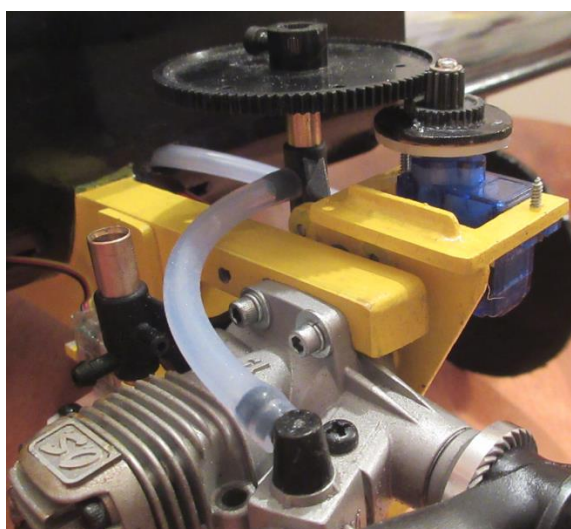
The idea behind the endurance event is to keep the plane in the air as long as possible without refueling. The engine size is restricted by total displacement, and there is a four pound (64 oz) gross weight limit.

Two days before the official flight, we had a pair of uncommanded engine shutdowns. This filled me with dread and disappointment at the prospect of repeating the failed attempt of September last year. To make matters worse, the night before had forecasted 18 km/h winds gusting 27 for our flight on Saturday. I did not really consider canceling because too much effort had gone into coordinating the participation of everyone, but I was not looking forward to the flight.

Things started looking better on Saturday morning when the forecast had turned for the better, now at 14 km/h gusting 20. When we got to the field, the actual conditions were better still, about 9 km/h with only occasional gusts to 15. It was beginning to look worthwhile to launch an endurance attempt.



It was a long 16-month journey getting to Centennial Park for this flight. I had set an endurance record with my son Daniel in May 2016 and have since tried a variety of "improvements" to extend that two-and-a-half hour record. After exhaustive research and testing, I rejected most of the improvements.



OS 15 LA rigged with RC needle valve.

The OS 15LA engine goes quite rich as you reduce the throttle. Since the previous record was set without a flight-adjustable needle valve, this was the biggest opportunity for improvement. I tried the Perry remote-controlled needle valve last year but it was too sensitive on the 15LA. This year, I decided to use the manufacturer's needle valve and rig a radio-controlled mechanism to adjust it in flight. Of all the improvements considered, the RC needle valve is the only one that had a hope of setting a new record.

Testing was constantly plagued by random engine shutdowns. It was thought that the engine might be getting too cool or too lean. The fuel that provided the best chance was the same Omega 25% nitro glow fuel used to set the prior record.

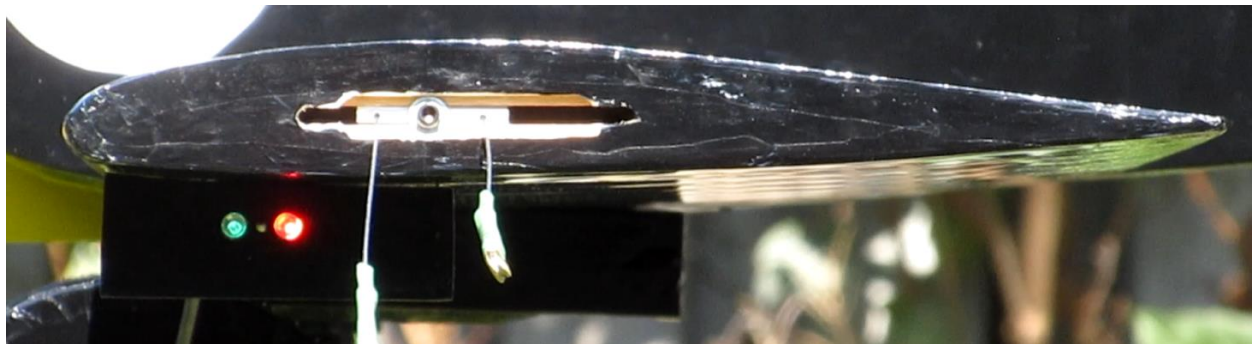


Bumble Bee



Black Wasp

The new plane is called the Black Wasp. It is based on last year's Bumble Bee, but slightly larger in order to reduce the risk of stalling/crashing as the Bee did during tests. To keep the weight down, the Wasp runs without a muffler, and the heavy Du-Bro clunk tanks are replaced with aluminum beer cans. The RC needle valve servo was modified with an extra lead for motion indication - LEDs at the wingtip show green for lean and red for rich.

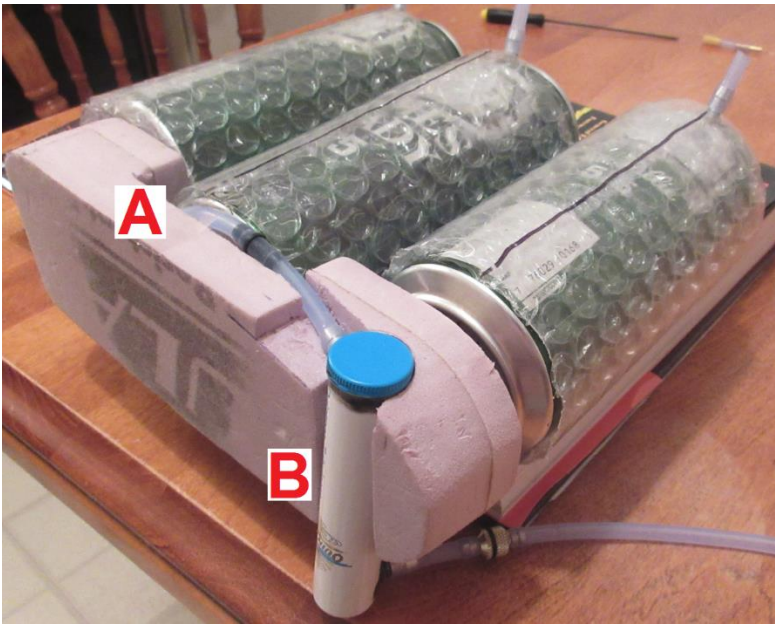


Green and red LEDs under the wingtip indicate needle valve motion: green for lean, red for rich.

Len and I had a quick test flight a week before our record attempt just to confirm the leadout guide position and check the tank plumbing. A small leak was found in the centre tank so I rebuilt all three tanks with new beer cans. Chris Brownhill test flew for me two days before the record attempt when we had two uncommanded engine shutdowns. It could have been the return of random shutdowns, but it was also possible that the tank's fuel outlet became uncovered in turbulent conditions. To eliminate the problem, I hastily installed a bubble trap made from an aluminum cigar tube. It can trap three quarters of an ounce of air while keeping the engine running.



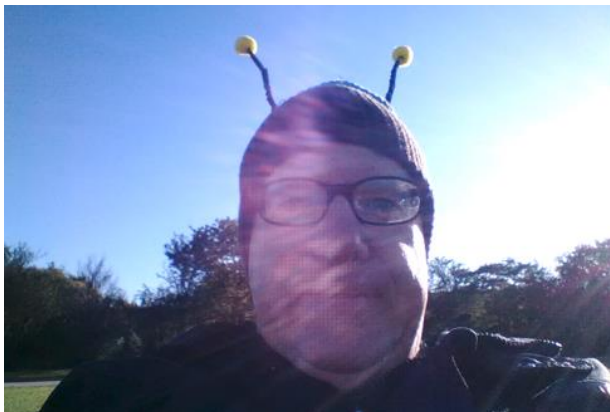
Parallel plumbing provides a smooth fuel level drop of all three tanks simultaneously.



A: Centre tank feeds the bubble trap. It is offset from the other tanks to make it the one that empties last.

B: The bubble trap holds three quarters of an ounce and is plumbed between the centre tank and the engine. It is purged of air just before starting the engine.

We arrived at 7:00 AM to beat the wind on the Saturday of our official flight. The new rules allow for up to four team members, so Chris and Len could have taken turns flying, but Chris was officiating the event and not available to fly. For the first time, I gave the Black Wasp a full load of fuel and we began our record attempt with a bubble trap never tested in flight. Of course we were both wearing our fashionable antenna!



Doug Blackmore



Len Bourel

I recorded video of the launch, but when taking another photo I discovered a memory card error. I had lost the footage and could take no more camera shots. I am very glad to have the photos and video taken by Chris Hubbard and Janek Zalewski.

Within ten minutes of the launch, Len asked me how long it had been; we had a long way to go! I was sat on the upwind side of the centre so as not to interfere with any wind dynamics Len had to deal with. This meant I could not see just how difficult his task was. As the flight went on, the wind became more gusty and unpredictable. On at least two occasions, the plane almost crashed. However, Len's superior piloting saved the day.



Len Bourel flying the Black Wasp during the record-setting flight.

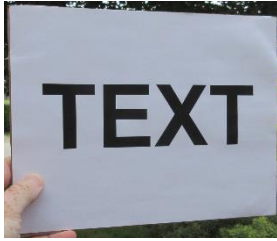
My job was no easier. I was in constant conflict over how lean to set the mixture. Too rich a setting wastes fuel and will not set a record; too lean risks killing the engine. Many times we heard the engine stutter, including once when the engine started to spin down. Each time, my remedy was to hit the "rich" lever on the transmitter to keep the engine alive. We settled into a routine of me asking Len if he could handle less speed. I would reduce the throttle and let the engine settle on the new fuel pressure. Then I would correct the mixture, always testing "rich" first. If "rich" caused the engine to speed up, then we were too lean. If not, I would adjust to the "lean" side and find the right balance. Our lap time was eight seconds for the last hour and a half of the flight. At any given throttle setting, the mixture needs to be rechecked periodically because of the leaning effect of the dropping fuel level. I was also using my pitch pipe to monitor the engine's RPM.



Doug Blackmore on the transmitter during the record-setting flight.



Pitch Pipe



We kept in touch with the officials via text messages. We could send text using our phones, then hold up a big "TEXT" sign to draw attention. It worked quite well.

At around two hours and five minutes, within 20 minutes of the previous record, we had another engine burp. We suspected we were running low on fuel. It is difficult to describe the anxiety at this point, being so close to setting a new record. It was not too bad for me because I already held the previous record, but this was Len's first record attempt. His piloting never wavered, but I could tell the anxiety was mounting for him. At the moment we passed the old record, Len did not believe it. It took a *full minute* to sink in that *he* held the new endurance record!

We expected to run out of fuel at any moment. It would not have been worth all the effort unless we beat the old record by at least 15 minutes. My anxiety was dispelled as we passed two hours 45 minutes. The next target was an even 3 hours. As we hit that one, we were amazed to be still flying. The next target was 3 hours 27 minutes in order to surpass the old record by a full hour. The minute leading up to that got quite hairy!

The wind was picking up and the engine was running roughly; I could not settle the engine with mixture adjustments. This was it. The turbulence was sloshing the fuel around the main tanks, uncovering the fuel outlet, and filling the bubble trap with air. When we passed the 3:27 target, we knew 3:30 was unlikely. The engine spun down for good and we landed at 3 hours 28 minutes and 25 seconds, bettering the prior record by 1 hour 1 minute and 29 seconds. Considering how negative I felt the night before, it was truly amazing to be sitting in the centre with Len, holding such a definitive record. I could hardly believe it myself.

03:28:25

Len sat down to recover from his 1800 lap ordeal while I retrieved the plane. Post flight inspection showed less than a quarter ounce of fuel left - just the dregs of unusable fuel from the low points of the fuel tubing.

The Bumble Bee record set last year was not difficult to execute - it was a calm day and only the throttle to manage. *That* record was achieved on the bench with a good design and build. The same *cannot* be said of the Black Wasp record. The Black Wasp had an incremental design improvement but the execution was far more difficult. Len expertly kept the plane in the air under very difficult wind conditions at extremely slow airspeeds for well over three hours, the longest



Endurance team: Doug Blackmore (L), Len Bourel (R)

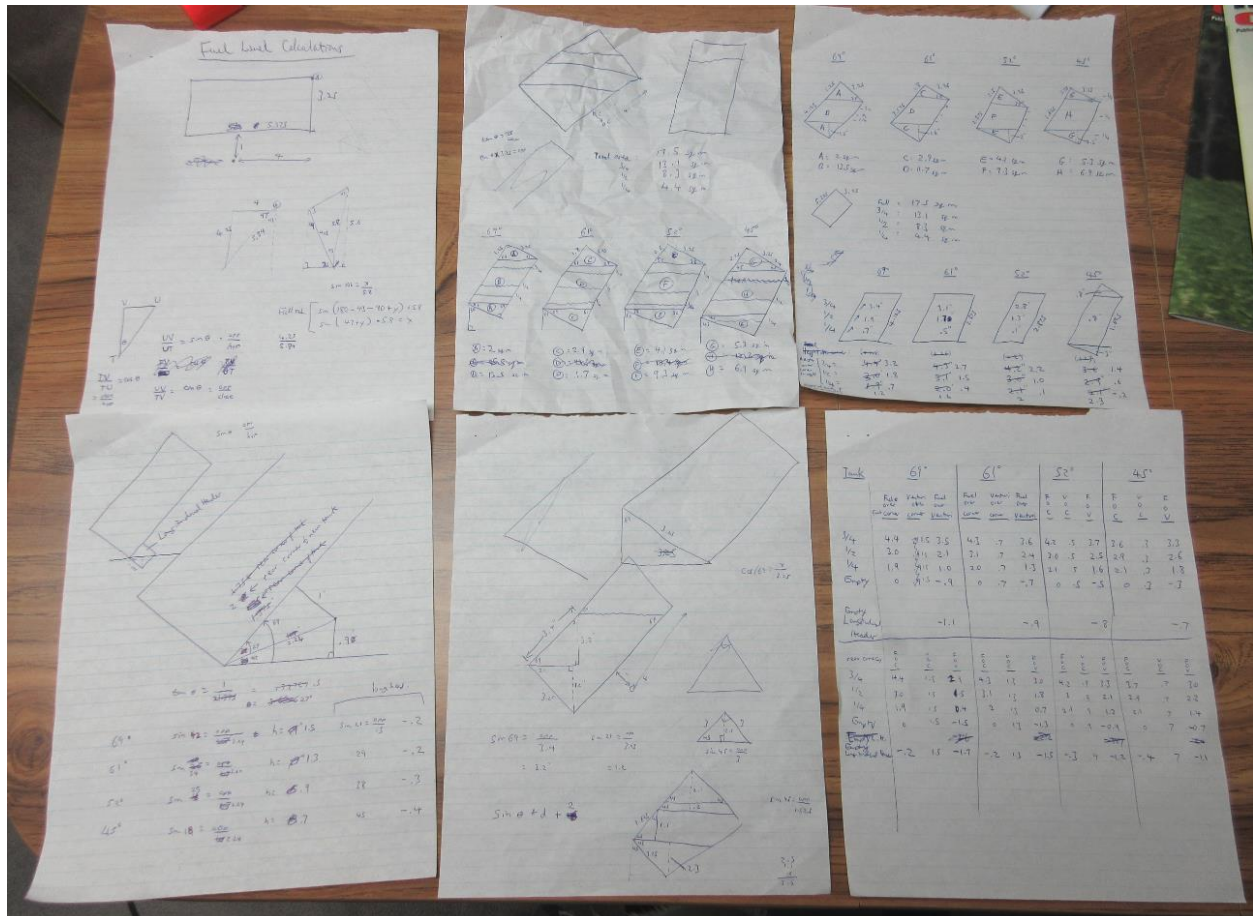
flight of his life. Keeping the engine running with radio control throttle and needle valve was also quite challenging for me. The new record is a true team effort with each of us performing critical and difficult tasks.

I must mention the contribution of Chris Brownhill. Although he did not get to fly the record-setting flight, he did most of the research flying with me throughout the summer, testing fuel systems, without complaint. Without this help, the design of the Black Wasp would have been seriously delayed, and I thank him sincerely for all that he did.

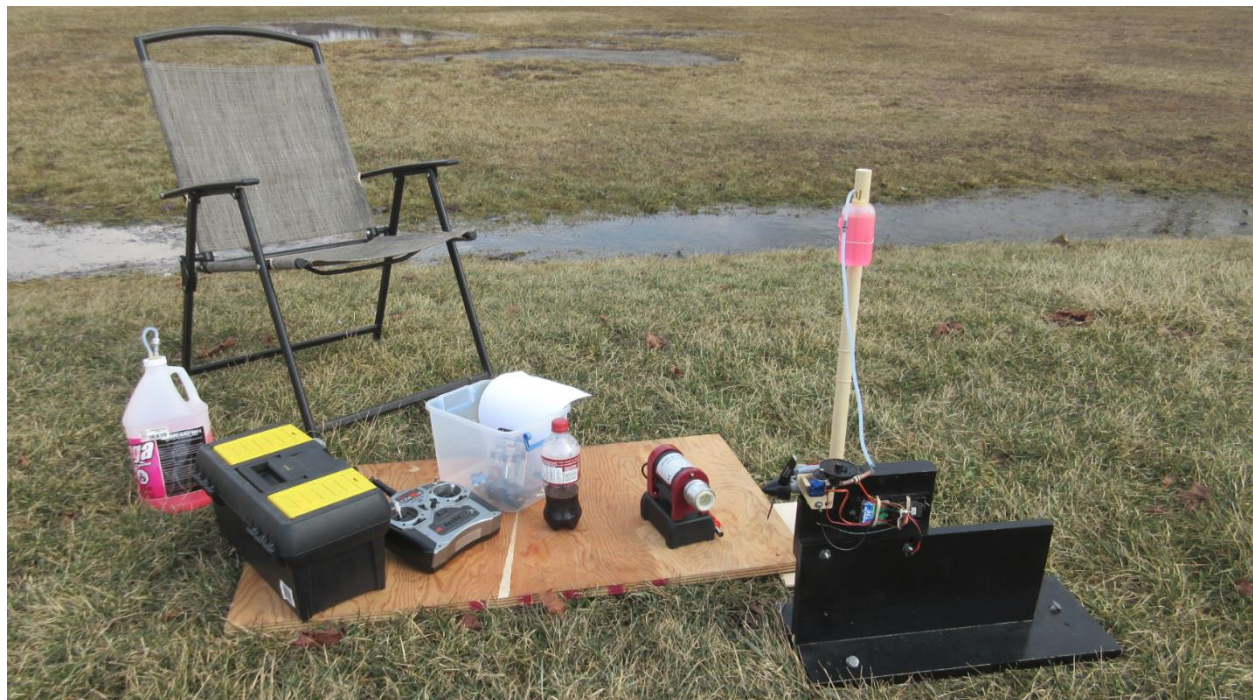
Thanks also to Juan Barrada and Chris Hubbard for time keeping. Finally, I am grateful to have a friend like Len to share this experience and the endurance record.



Chris Brownhill (L), Janek Zalewski (C), Juan Barrada (R)



Trigonometry calculations for an early prototype aluminum tank.



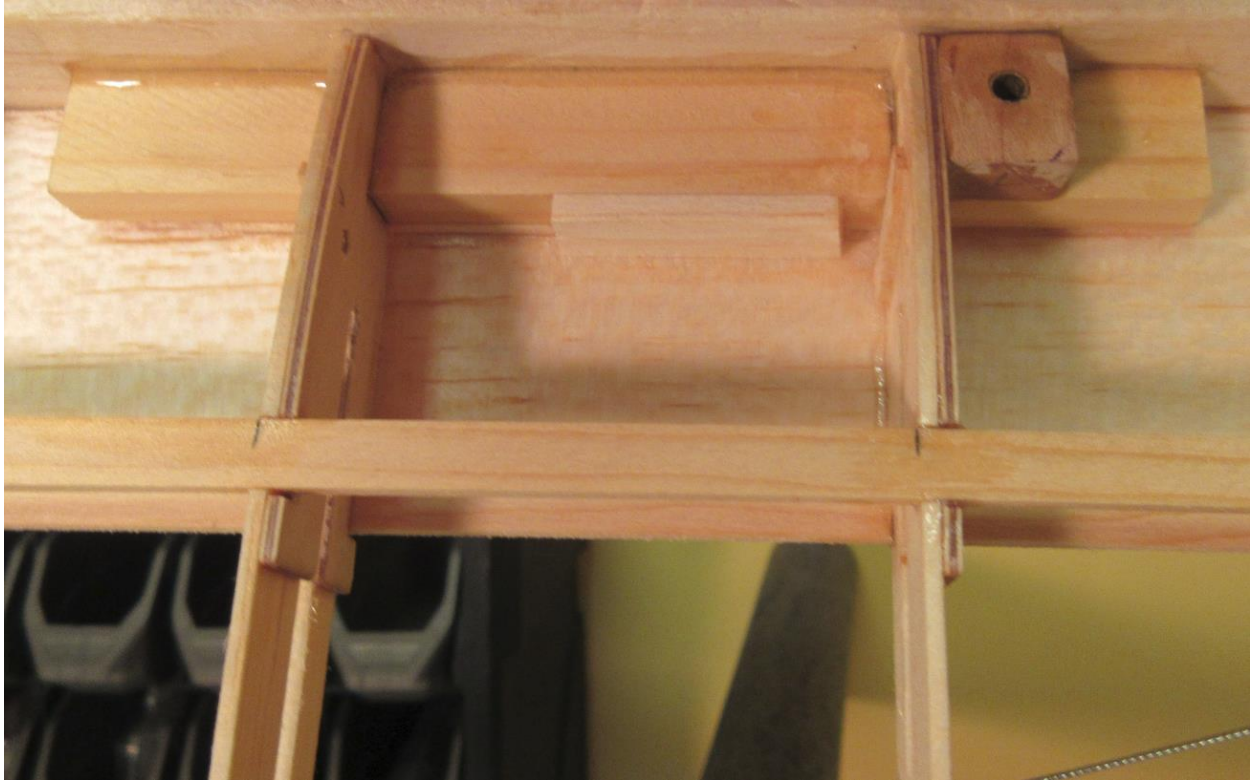
Spring tests of the new RC needle valve setup.



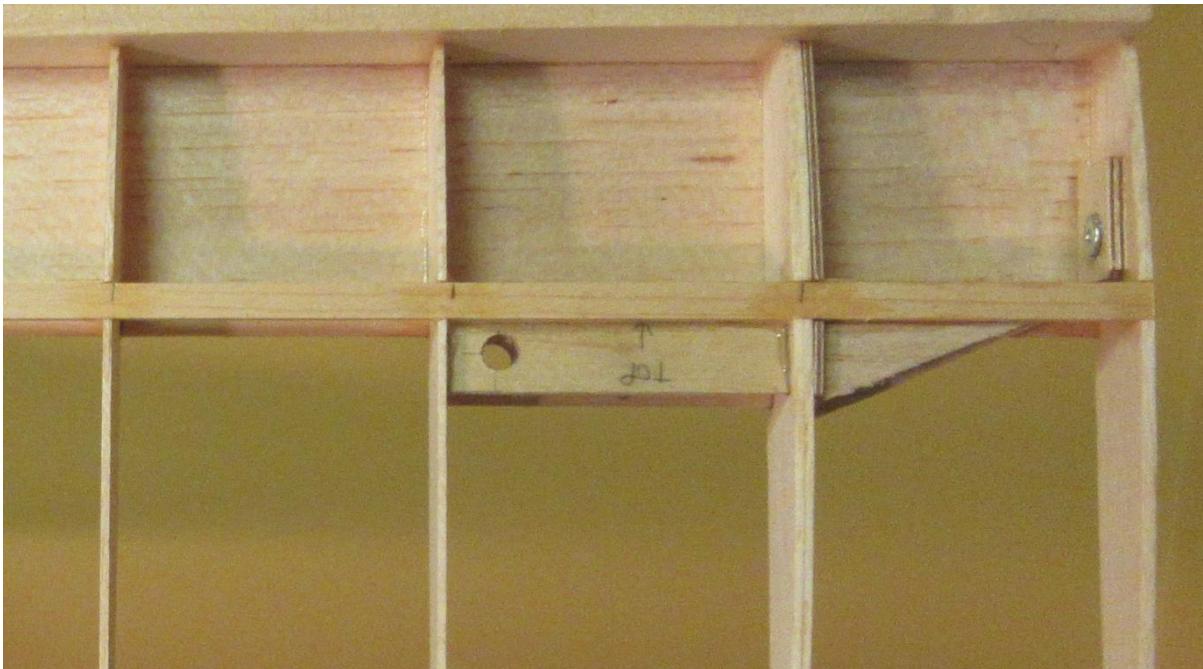
A home-made manometer measuring muffler pressure.



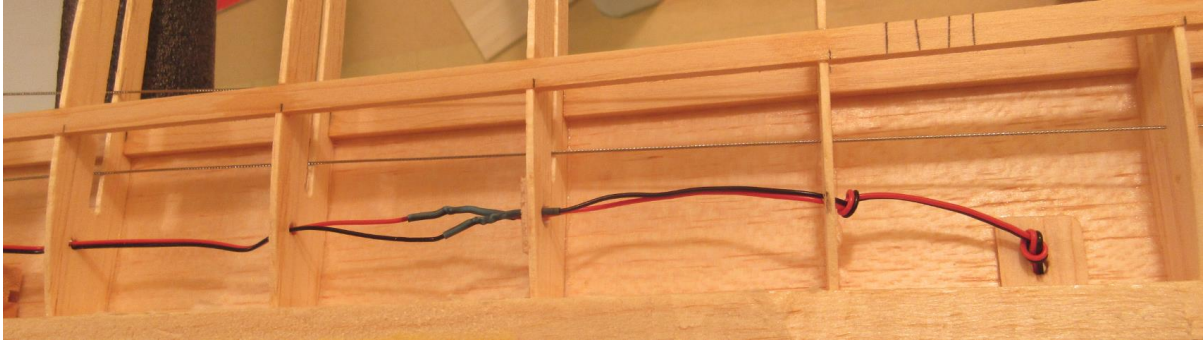
Design testing of horizontal cylinders plumbed in various ways.



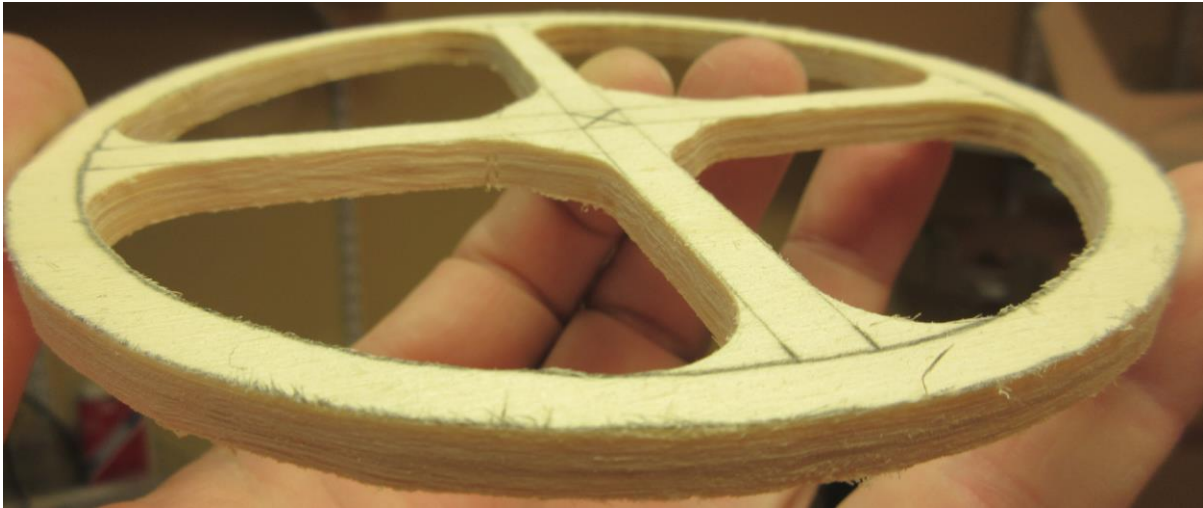
Plywood rib doublers strengthen the landing gear block installation, but only as far back as the spars. In endurance, you cannot afford to carry any extra weight.



As with the Bumble Bee, the Black Wasp has a double plywood mount on the outboard wing, drilled to accept a screwdriver as a handle for the forty-pound pull test.



Leading edge wiring for the lean/rich LED indicators.



Custom made wheels: 2 layers of 1/8" Lite Ply, laminated at right angles.



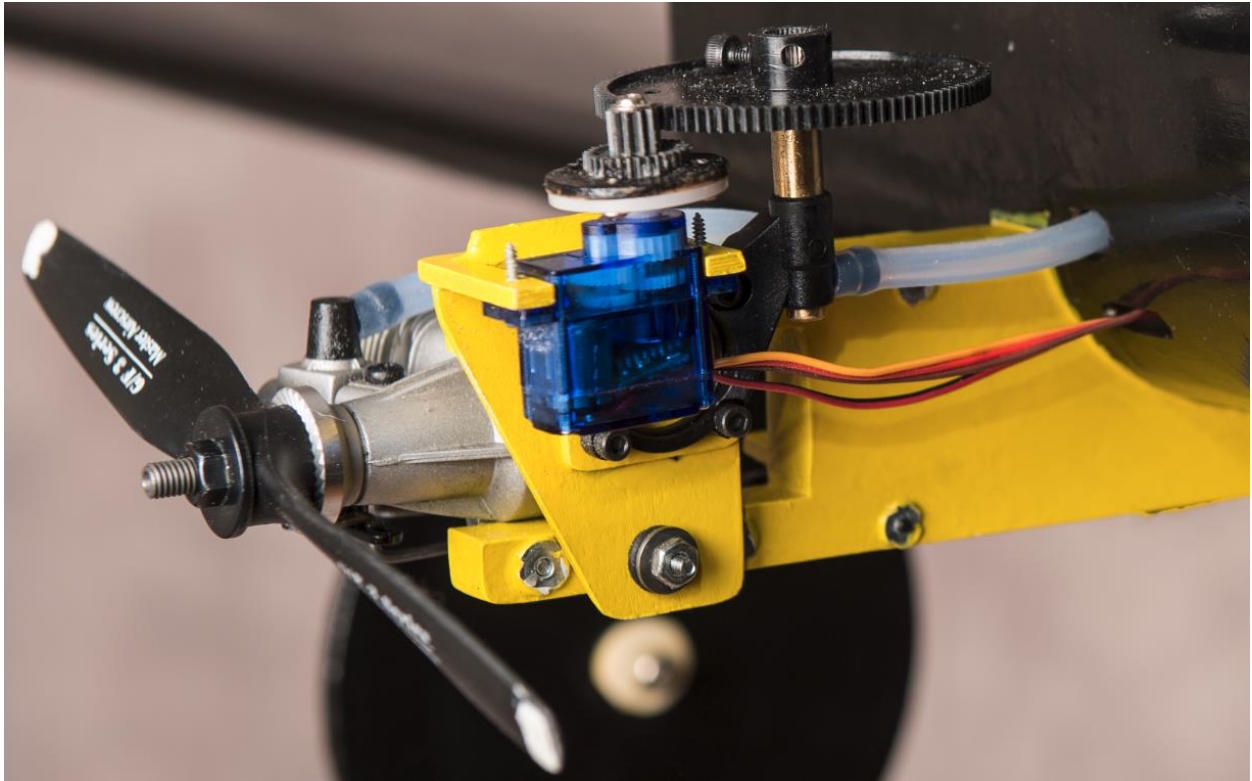
The Black Wasp ready for covering.



The Black Wasp rudder



Balsa Beavers 60-year-old club



The pinion gear is glued to a piece of wood which is screwed to the "robot" continuous rotation servo. It is also reinforced with a self-tapping screw directly to the servo spline. The large driven gear is pressed onto the OS manufacturer's needle valve. The control provided by this setup is much finer than a single click of a conventional needle adjustment.



Bubble wrap makes excellent lightweight packing. No extra weight is carried in endurance, so a "snug fit" is used to hold the tanks in place rather than heavy straps and mounts.



The receiver is tucked discretely under the fuel tank platform.



Bumble Bee vs. Black Wasp



At three hours, the engine burps again. I dive for the "rich" level while Len keeps the plane from crashing.



Doug stretching his legs, walking behind Len.



*Doug retrieves the plane while Len collapses after landing.
"What's the problem, Len? You've only had one flight today!"*



Doug Blackmore (flight engineer, left), Len Bourel (pilot, right)



The Black Wasp



Model Aeronautics Association of Canada

Governing Body for Model Aviation in Canada
under franchise of

AERO CLUB OF CANADA

and

FEDERATION AERONAUTIQUE INTERNATIONALE

This is to certify that

A National *Control Line* Model Airplane Record of

3 Hours, 28 Minutes, 25 Seconds
in Control Line Endurance

at Etobicoke, ON

was established by

Mr. Doug Blackmore #8895 / Len Bourel #14801

Date: *September 9, 2017*

Promulgated at *Burlington, ON* on this *12th* day

of *September, 2017*



[Signature]
President of M.A.A.C.
[Signature]
Secretary of M.A.A.C.
[Signature]
Chairman of Contest Committee

3 Hours, 28 Minutes, 25 Seconds

Research Conclusions		
Feature	Disposition	Reason
Fuel formula less than 25% nitro	Rejected	Random engine shutdowns. Omega 25% nitro glow fuel seemed to have the fewest shutdowns.
Propellers: coarse pitch and larger diameter	Rejected	No measureable improvement. Coarser pitches make takeoff difficult or impossible. Original 7-6 prop was used.
R/C leadout guide	Rejected	This was to help increase line tension late in flight when the plane was light on the lines. Rather than waste an ounce and a half on this feature, I decided just to have someone better than me fly the plane - one who is comfortable with little line tension.
Uniflow fuel system	Rejected	This promising solution would have solved a lot of changing fuel pressure issues, but a suitably light and rigid tank could not be found.
Fuel bladders	Rejected	A non-elasticated bladder would collapse unpredictably, sometimes folding to trap fuel. An elasticated fuel bladder resulted in unacceptable changes in fuel pressure as it deflated.
Muffler pressure	Rejected	Carrying the muffler in flight costs more than an ounce in extra weight, meaning carrying less fuel. It also exacerbates the problem of changing fuel pressure, as it produces 0.6 PSI at full power but only 0.1 PSI at 8300 RPM.
One large tank	Rejected	The sloshing of fuel in turbulence caused dangerous fore/aft changes in centre of gravity. It also tended to uncover the fuel outlet.
Multiple tanks in series	Rejected	When one tank empties, that side of the siphon system goes dry and results in a sudden increase in fuel pressure, making the engine go rich.
Powered glow plug	Rejected	The idea was to run 1.5 volts up the control lines for the entire flight in order to keep the glow plug lit, staving off random engine shutdowns. During tests, the engine shut down anyway.
Higher compression	Rejected	The idea was that higher compression would allow lower nitro fuel to be used without random engine shutdowns. During tests, the engine shut down anyway.
Multiple tanks in parallel	Accepted	With three horizontal cylindrical tanks mounted behind one another and plumbed in parallel, there would be one continuous fuel drain affecting all tanks simultaneously. This results in a single gradual decrease in fuel pressure throughout the flight, making needle valve adjustments easier. The tanks also provide baffling against fore/aft fuel sloshing.
RC needle valve	Accepted	This was the only feature with a demonstrated improvement to endurance. On the bench, at 9300 RPM and a leaned out fuel mixture, economy was 7:18 m:s / fl. oz. In actual flight, we achieved 8800 RPM with 8-second laps around the two-hour mark. Fuel economy might actually have peaked at 8 minutes per fluid ounce.

Record Comparison		
Item	Black Wasp September 9, 2017	Bumble Bee May 21, 2016
FLIGHT		
Endurance	3:28:25	2:26:56
Laps	1800 (est.)	1339
Distance	190 km (est.)	135 km
Avg Speed	54.7 km/h (est.)	55.5 km/h
Economy	6:08 m:s / fl. oz.	4:05 m:s / fl. oz.
Takeoff	83 ft.	83 ft.
WEIGHT		
Empty	33 oz.	31 oz.
Fuel	31 oz. (34 fl. oz.)	33 oz. (37 fl. oz.)
Gross	64 oz.	64 oz.
PLANE		
Wingspan	47.5"	43"
Wing Chord	9"	8"
Wing Area	349 in ² + fuselage	298 in ² + fuselage
Airfoil	NACA M12	NACA M12
Length	30"	25.5"
Balsa	Bud Nosen contest-grade (or lighter)	Bud Nosen contest-grade (or lighter)
Spars	1/8" x 1/4" spruce	1/8" x 1/4" spruce
Covering	Microlite	Microlite
Main Wheels	5-inch dia. Double Lite Ply with Microlite	5-inch dia. Single Lite Ply with Microlite
Bell Crank	Brodak 2" nylon	Brodak 2" nylon
EQUIPMENT		
Lines	53 feet from palm side of handle to centre of fuselage	52 feet from palm side of handle to centre of fuselage
Engine	O.S. 15LA	O.S. 15LA
Prop	Master Airscrew 7-6	Master Airscrew 7-6
Fuel	Omega 25%	Omega 25%
Tanks	3 x 473 mL James Ready beer cans plumbed in parallel	16 + 16 + 6 oz Du-Bro clunk tanks plumbed in series
Receiver	Spektrum AR6260 DSM X	Spektrum AR6260 DSM X
Battery	HydriMax Ultra 4.8V 750 mAh NiMH	LOSI Miscr 4.8V 220 mAh NiMH
Throttle Servo	HiTEC HS-35HD	HiTEC HS-35HD
Needle Servo	FiTec FS90R continuous rotation	none
Transmitter	Spektrum DX5e	Spektrum DX5e

Pitch Pipe Tachometer	
Note	RPM
Db	16,630
C	15,697
B	14,816
Bb	13,985
A	13,200
Ab	12,459
G	11,760
Gb	11,100
F	10,477
E	9,889
Eb	9,334
D	8,810

