The Gobbler F3B design

by Fritz Bien and Dwight Holley

The Gobbler was named after a most noble American bird, which is a native of New England, the Meleagris Gallopovo. As Benjamin Franklin pointed out, the Gobbler is a bird truly worthy of being our national bird, "unlike the eagle who is a scavenger and a killer." The Gobbler F3B is a design in which we wanted to make a plane, which can be produced in a finite amount of time by one builder in his basement. Since we in New England are blessed with a relatively long building season, our F3B ship includes such niceties as sealed hinge lines, etc. Because of the poor travel conditions during our building season, and the long commute required to assemble our building team (three to five hours between team members in non gas crisis conditions) the Gobbler was to be designed by telephone and fabricated from relatively standard stock materials by one builder. With these constraints in mind, we started to design our state of the art F3B sailplane. Note that we were willing to use new building techniques provided that we could build one off the line prototypes using that technique.

We don't pretend to be expert designers who get the design right off the building board ". and it flew perfectly on the first flight and maxed every time since," as we so often read in the magazines. Instead, we took the philosophy that if we were to get a sailplane ready for the contest, we'd better start building. Unforeseen things always crop up in any new


Dwight Holley won the 1981 F3B championship

design, such as insufficient wing rod rigidity, too long or too short of a tail moment, poor roll co ordination, tail slip, etc., which are easier to solve after trying a prototype. Our goal was therefore to build a series of intermediate 'one off the line' designs where these things can be varied before casting the design in glass or other more exotic materials. We hope, some day, to arrive at a ship in a form we want to mass produce. In the mean time, conventional building techniques are still the most viable in producing an aerodynamically true and mechanically sound 'one off the line' sailplane.

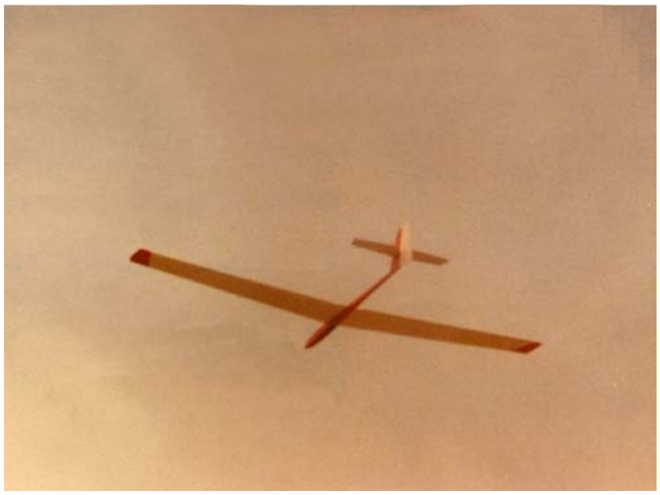
Any sailplane, or airplane or other mechanical device, for that matter, is an optimization of a lot of tradeoffs. These tradeoffs were fairly easy to analyze in view of the FAl F3B rules, and their solution would make any system engineer's heart glad. The design philosophy of the Gobbler was started several years ago by analyzing the then current designs, re-analyzing the rules, and iterating. We heard stories of Europeans turning sub 10 second speed runs, compared to our then current crop of 12 sec. to 13 sec. speed runs. Our distance event was completed in 3.5 minutes while their faster airplanes were turning 2.5 minutes. Our 6 minute duration flights were maxing out at such altitudes that we could make 10 minutes. Our spot landings were always better than the Europeans, etc. Our launches were taking up one half of the available tow-line because of the wing flex. From these observations, we re-analyzed the rules, and made our trade offs not to produce the ultimate sailplane for one task, but one to win the contest by scoring high consistently in all three tasks. We felt that if flown with average concentration, the airplane must be able to get 90% of a perfect score. This does not mean that we have an airplane which, when flown by an expert, on a good day, will get the top score. The contest is not won by the single fastest flight, or best landing, or longest distance. It is won by not making any mistakes which would put you out of competition. We found it rather easy to design a racer, which when flown perfectly on the step, will turn an eight-second speed run, but off the step would turn a 13 second run, or crash. The heat of the competition would put enough strain on the pilot to make him blow at least one flight in these conditions. In the Gobbler, we sought to design a ship that would fly consistently, giving up that ultimate speed.

The easiest method we saw to insure consistency is to pre-program all of the events in the pilot's head, the airplane, and the transmitter. Cutting down the variables to remove the weakest link, we tried to concentrate on the airplane and transmitter. We thus came to the conclusion that we needed camber variation in the airfoil and control mixing in the transmitter.

The control functions for this multitask airplane thus required elevator for pitch control, landing control in the form of an arresting hook or shark's teeth, camber variation, and yaw and roll controls.

Since the speed range of our multitask ship should be large, the ratio of yaw to roll on any turn cannot be optimized for all conditions with only rudder and dihedral (or polyhedral). While independent aileron and rudder controls can be used, this separation of controls means there is one more thing which must be programmed into the pilot's head. Using up some of his random access memory space which could be better be devoted to reading the air, the turn location, watching other pilots, pretty girls crossing the field, etc. Coupled ailerons and rudder (CAR), however, have the same disadvantages as precisely designed rudder/polyhedral ratios. That is, as you slow down, the coupling ratio changes with speed. By mixing in the transmitter, an addition of separate rudder to CAR is possible, particularly for those slow speed conditions where there is plenty of time to think. We thus can have our cake and eat it too. At high speeds, the rudder and aileron coupling allows for a single movement co ordinated turn, which does not require undue co-ordination on the pilot's part. At low speeds, the added rudder brings the Gobbler around without fear of a snap roll.

The airfoil of the airplane is very important, though not in the same sense as many modelers think. While it is nice to have low drag and high L/D, the main contribution to drag in a 10 second speed run is normally not the wing' s profile drag but the tail's induced drag while holding the wing at minus 4 degrees to obtain nearly zero lift coefficient. The Swiss solved this problem by shifting the c.g. back so that the tail does not have to overcome as large a negative moment. This works, except that the airplane becomes unstable and must be flown to perfection. 0ur solution was to employ camber-changing flaps, 25% of the chord width, to reduce the moment coefficient com-mensurate with the shift in the wing's center of pressure. This is not a new solution, nor a unique one, but definitely in the spirit of the Gobbler design.



Dwight flying his Gobbler at the 1981 F3B championships.

The aspect ratio is a tradeoff between wing strength and roll rate versus high lift to drag ratios during the distance and duration tasks. The induced drag is nil during the speed run, and was not a factor. Low aspect ratios, those below ten, were considered too inefficient for the anticipated wing loadings. We need good L/D in not only the distance task, but duration, because our anticipated loadings were too high to play 'floater'. Our only chance at maxing out was to cover enough airspace until we could find sustaining lift. We want to be able to then return to the field in time, without undue loss of altitude. The aspect ratio of 13 is therefore a compromise between good glide ratio and a rigid wing. The tip chord was also a compromise, we wanted good roll response as in pattern ships without 'Kwik Fli Wobble', yet high enough Reynolds numbers at the tips to prevent tip stall at low speeds. The added gain in reducing induced drag was not an important consideration. The final wing configuration, among all these nebulous tradeoffs, was finally decided by trial and hacksaw.

Once the aspect ratio, root chord, tip chord and span were fixed, we started looking at airfoils. The ones of particular interest were the Eppler series 193, 205, 211 and 214. These airfoils provide interesting design tradeoffs between maximum perf-ormance ease of handling, performance in task, and ease of construction. This last point is much more important than most people realize, as an airfoil with great theoretical perf-ormance, manufactured poorly, is often much worse than a simple airfoil made precisely. The Eppler 211 was discarded because of it's difficult to reproduce trailing edge. The tradeoffs between Eppler 193 and 205 were like comparing apples to oranges, so both were tried. The 205 is a superior airfoil if flown near optimum. In turbulent air, its recovery from being upset is worse than for the 193, and in the absence of some positive feedback loop, would offer worse performance in rough air. In calm air, however, the lower profile drag should prove an advantage.

The airfoils such as the Eppler 214 reach their drag crisis at moderate positive lift coefficients even with a six-degree negative flap setting. The under camber cusp makes the airfoil excellent for distance ships, but poor for speed ships. We didn't trust our analysis so we built one Gobbler using the Eppler 214 anyway and found that it did indeed lack the acceleration of the Eppler 205 and 193 equipped Gobblers, lending some conf-idence to our analysis techniques.

The next most important portion of the Gobbler design is the tail. The tail volume was chosen to be about 0.49, with an aspect ratio of six. This proved more than adequate for the Eppler 193, but was a little small for the Eppler 205. We are currently enlarging these tail surfaces to decrease the induced drag during speed runs. The location of the horizontal tail has been studied with respect to stability and drag, and will be presented in a separate article. The vertical tail was designed so that it was large enough to be effective together with the three and a half degree wing dihedral and proportioned to 'look nice'. We did some posteriori analysis on this surface and found it adequate.

The fuselage of the Gobbler is of conventional plywood and balsa construction with the Sagitta type canopy to get at the radio. Hence, there is a tradeoff between minimum frontal area, minimum form drag and ease of construction. Squarer shapes are easier to construct than round ones, but suffer somewhat in the form drag and wetted area versus volume. Since the fuselage is only a few percent of the total drag, all the savings in the world could only change performance by less than 1%. Much more important, then, is the maintainability; the ease of access to the radio and ballast box. Our reasoning thus took the following argument: the form drag on the best sports car is 0.34, the worst family wagon is 0.45, the total drag increase for a sailplane using these different coefficients is 0.01. Since landings are worth 217 points out of 1,000 in the duration task and 1% in drag coefficient is worth five points in speed (0.5% in velocity), it pays to have a good skid which could guarantee a +/- 0.5 meter stopping error, saving a possible 50 points while risking five in speed.

With all these design parameters worked into our design, we proceeded to draw up the Gobbler. When we were done, it looked like a very conventional ship, no sweepback as on the Algebra, no fancy glass work as on the Spartakus, no molded wings as on the F1AF, no fancy tail booms, but a basic sailplane of 113 inch span and 3.5 kg/sq. meter loading, with nearly identical moments as the average of all the top placed sailplanes in the World Championships Obviously the other teams also did their homework!

The special gimmicks we had going for us were in the mixing radio (a much modified ACE Silver Seven) which gave us a camber changing airfoil, together with coupled aileron/ rudder/flap and our super landing skid for Sacramento's hard earth. The Gobbler's aerodynamics was as good as all of the machine-made sailplanes (better than the Dassel) and what we had sacrificed in building time we made up in the ability to change and hopefully improve the design as we go along. Like the Mark V Spitfire, the Gobbler was designed as an interim developmental ship, but may in the long run be the most successful of our series. We hope to continue to improve this breed of bird.

A report, written by Ed van Buren, appeared in "Model Soaring" Volume II, Issue III - January 1982, throwing more light on the pilot and the model.

"The American team looked like a small army. With veteran manager Dan Pruss leading, the assembly of vans, tents, pilots and toy airplanes set up headquarters a few doors down from the Swiss. The U.S. team was a real mix of personalities. First came Dwight Holley, a quiet Northeastern lithographer who tended to stay by himself, watch every flight, and demand absolute silence during his flights. Then there was Don Edberg, age 24, from California. He didn't volunteer much information about anything to anybody and was harassed incessantly during his flights by everyone within shouting distance. I left a complete flight of Don's in the video tape for two main reasons. First, I wanted to show how much time is spent standing around in F3B, and second, to record the unbelievable amount of chatter surrounding not only Don, but disbelief at the coaching by members of the U.S. team during Carl's flights. Not to say this contributed in any way to performance or lack thereof, but it is interesting to note that Dwight commanded his flights totally from start to finish, tolerating little outside influence from anyone during the flights.

One of the advantages of writing about someone else's I exploits is that you can remain aloof from the goings on as if you are above reproach. well folks, it just ain't so. I failed in at least one respect in covering this event and that was to underestimate Dwight Holley, winner of this 1981 International F3B contest. The man is so self contained he's almost invisible. Dwight has been preparing for this contest for at least five years. In fact, his sailplane, the Gobbler was developed specifically to do battle in Sacramento with the best the world could come up with. I talked to Dwight several weeks after the contest about his win and he attributed it to his ability to maintain his concentration for the whole week of competition. His plane was a team effort design by himself and Fritz Bien. It has flaperons with servos in the wings coupled full time to the rudder. He could, by virtue of his transmitter located coupling, override the rudder fully when needed. The wings were built up of balsa, fully sheeted over an Eppler 205 airfoil. Wingspan was 113.5" and flying weight was 80 ounces for a loading of 11.4 oz./sq. ft. Interestingly, Dwight said he flew unballasted during the entire contest."

Fritz Bien added the following reminiscence in 2004:

Dwight started comp-eting in R/C sailplanes about the same time I did in 1971. We were both flying a Graupner "Cirrus" at the time, mine with ailerons, his just rudder/elevator. He went on to the East Coast Soaring Society to compete in 1975 and dragged me along, kicking and screaming. He had just built a beautiful Maestro from Dodgson Designs, and, with his intensity, made it unbeatable. In 1976, international competition was getting set up and Dan Pruss convinced us to try for the team. This was the era of Apartheid, and the finals were to be in South Africa, so I skipped that round, but Dwight flew, and learned.

The team trials in 1978 were the first time that we saw real competition, and it was here that we learned about the need for a stable platform to compete. Dwight finished in the top 10, and realized that we needed a team, and not just a single individual to compete at this level. He then went about drafting a team, and working on the design of an airplane. During 1979, for the 1980 trials, he was flying a Sagitta donated by Lee Renaud, against each of my new designs, until my design could finally match performance of the future "store bought airplane". The Sagitta was built by Paul Wiederking, another member of Dwight's team.

The prototype for the Gobbler was designed in 1980, but various strength issues as well as the very intense contest schedule kept it under wraps until team selections. We read about your developments across the pond about mixing rudder with aileron, flap settings, etc, so Dwight talked Al Marshall and myself to making modifications to his Kraft and Pro Line radios to do the same. Al came up with the original Op-Amp mixer which was placed between the transmitter pots and the encoder, first having to make stable voltage rails onto the circuitry that was common at that time. This board was wire-wrapped on a perforation board, stuffed with foam tape on to Dwight's transmitter. Dwight flew with a single-stick transmitter with rudder on the knob, so his transmitter had plenty of room.

At the team selection finals, Carl Blake showed up with a Kevlar bagged wing, which was VERY strong, so we thought at the time. We thus worked Kevlar into our build, and started construction on the "World Beater". We couldn't decide which airfoil to use, as there were no wind tunnel tests on any of the new Epplers. We thus built 3 Gobblers, Dwight constructed the E205, Terry Luckenbach was drawn in to build the E214, and I constructed the E193. Dwight used the E205 in the Worlds in Sacramento. I missed that contest because work, of all things, got in the way.

After the Worlds, Dwight's marriage broke up, (as did those of team members Al Marshall and Paul Weiderking), I was only spared because I was still single). He got remarried and turned to electric flight as the next frontier.

Dwight died of cancer I think around 1987, even though my memory for dates is no longer as good as it once was.

- Fritz Bien