F3B Speed

I tend to agree with most of what is being said regarding the flying style. Someone commented on the difference between the models. The modern F3b gliders (eg Radical, Ceres) are flying longer dive times and flatter courses because they have less drag compared to the older style models that dive less, but fly a steeper course. I'd like to add that some models have more "grip" in the turn, meaning (at least to me) that such models can turn tighter for a given drag, ie speed loss. So turn performance is very important, because it is the most energy sapping part of the speed run.

But to look at model setup. Speed performance is heavily dependent on model setup for not only the launch, but also everything after that - **dive performance, straight line speed and handling, roll performance and pitch performance in the turn.**

Dive performance.
The model is flying at near zero lift in a vertical dive, and the Reynolds number is increasing over time as the model accelerates. At zero lift and slow speed, the natural foil probably produces the least drag, once the Reynolds number rises above around 400K (about 100 km/hr) increasing amounts of reflex flap are needed to keep low drag at near zero lift. *Perhaps the model might benefit from only clicking into speed mode as the dive is established or later?* The amount of reflex flap to use is therefore dependent on the flight speed of the model. It is also dependent on the amount of camber in the natural foil. So for high flight speed, reflex might be good, and for high camber profiles (eg 2%) reflex would also be good. The more speed and more camber, more reflex...to a point. Xfoil or its many interfaces can be used to get some idea of the best reflex flap setting.

Straight line speed and Handling
Flying a slight dive line on the straights in the course also gives near zero (coefficient of) lift from the wing, so the comments about reflex flap also apply from above. Also note the comments about the best flap setting to use as speed varies. *Perhaps a smaller amount of reflex is needed in the later laps?*

On the laps, typically small course corrections are required to maintain the correct dive line etc. A pilot wants to make these corrections with precision, so for me I use a substantial amount of exponential on elevator. Because these small corrections only change the (coefficient of) lift by a small amount, and the drag (depending on the profile) doesnt change much so the camber control on the wing is not actuated by small elevator stick movements. I find that the CG is completely un-important for straight line speed performance.

Roll Performance
The model has to roll axially around the fuselage, perhaps with the slightest yaw into the turn, if any. When I say axially, I mean around the fuselage's center line. I use full span ailerons (ie aileron to flap mix) to maximize the roll rate for a given deflection. Differential on the outboard ailerons is set to provide rolling without yaw, or if any, yaw slightly toward the turn direction. Differential on ailerons is about 55% up 45% down. Differential on the flaps is set more to produce the axial roll. Eg if the model is rolling around the bottom wing tip when returning from a 90° bank, less flap differential is dialled up (more down going flap due to aileron mix). This tends to bring the roll axis inward from the bottom tip towards the fuselage. (differential on flaps is around 50:50, or sometimes 40:60)

An added complication is that the amount of differential needed changes as the model speed and attitude change. You may be forced to compromise (ie too much differential at 250 km/hr, and too little at 100 km/hr)

Pitch Performance in the turn.
I commented earlier that the CG is of little importance in flying the straights, but in the turns, the CG is vital. The CG drives the sensitivity of elevator. A rearward CG will require smaller elevator throws for the same turn response. (ie wing Cl) Get this wrong with too much elevator and too rearward CG, and the model will be too unstable. Back off a bit with more forward CG, or lower elevator movement and the wing now works in a lower drag range because you have constrained the Cl the wing can be pulled to.

Step 2, match the exact amount of camber the profile needs to minimize the drag for the wing Cl being commanded by the elevator pull. I do this by looking at turn diameter vs Cl plots to get the Cl, then look at the lowest drag flap setting for the particular Cl needed. In concept I set the model up to do 40, 30, 25, 20, 18, and 15 m diameter turns using a multi point elevator to camber mix to optimize the amount of flap deflection needed for each diameter. This is a starting point, and then modifications to the curve are accomplished through lots of flight testing. The curve for best response is typically very non linear.

Another tip...ever pulled up to have your model exit the turn wiggling in yaw? Add a heap of exponential to your rudder so that a less than pure elevator pull on the stick does not influence the rudder much...wiggly turns fixed.

I'm hinting that the model setup is vitally important. To do this properly, when elevator is pulled, both elevators need to be moved by the same amount (otherwise you get yaw from an elevator pull!) When elevator to camber flap mix is used, the ailerons and flaps need to move by the same amount across the wing, left and right, inboard and outboard (otherwise you get roll from an elevator pull). Rudder needs to be set with differential (otherwise you get a pitch response when you command rudder).The idea is to make the model as easy to fly as possible, and not have the pilot fighting to overcome cross coupling between roll, yaw and pitch when a stick is moved.

Finally, I'd say that for me the launch is close to the hardest part in speed. Everything flows from the launch. A poor height means either a lower dive time, or for the same dive time you have been practicing and then flying the same course to hit the ground on the second lap. A compromise is clearly needed. Necessarily, the dive time and course flown will depend on the launch height. You want to carry as much ballast as the model can be reasonably be launched to, and to do that in less than ideal conditions takes immense skill. The skills involve things as varied as throwing the aeroplane, to weaving it on the line to build maximum tension (circle towing anyone???), releasing at the right climb point and right direction through to an optimal zoom. I wont talk about the winch setup!

Suffice to say, without a good launch, everything else suffers. Work on launch first!

Flying technique...I couldn't resist! With highly ballasted models, once speed is attained, you only scrub speed off by increasing drag. The model setup stuff I talked about above ensures that the base level of drag is minimized through....wait for it....setup! The rest is up to the pilot, he (or she) must minimise the additional drag by applying the correct control inputs and flying the correct course. Dive lines on the straights need to be managed so that higher drag models are dived at a higher angle to overcome the drag. Rolling into the turn scrubs off speed, so the "racetrack course" actually has some merit because it involves less rolling. Turn diameter is a payoff between drag production (ie loss of speed) and the turn time (time spent not heading in the right direction) There is an optimum turn diameter for every type of air and model with a good pilot sensing the "grippiness" of the air and pulling a tighter turn without the usually necessary speed loss penalty.

I mentioned launch earlier, without a consistent entry height, consistent practice on the course can not be made. Pilots will need to improvise their dive times, and once on the course improvise their dive angles and turn diameters to extract just that little more from the air they are in for the launch height they started the entry dive at. Because launch heights are inherently variable, clearly the top pilots work to minimize their height loss on launch and in doing that they minimize the range of improvisations needed.