

# Electro Combat Kick-Off

*Paper for the eCombat Kick-Off meeting 5-7/7 2013 in Munich, Germany*

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## **Intro:**

This paper is meant to kick-start the debate at the eCombat meeting in Munich. Pilots might find some of the viewpoints published here controversial or even provocative. They are. The intension is to start a debate!

## **Background:**

The latest development of rechargeable batteries has made it possible to replace internal combustions engines by electro motors on control line combat models. Duration and weight is still a challenge but pilots have shown the first eCombat models that were capable of flying against internal combustions engines on an equal footing.

Electro combat could solve some problems with noise and might be a way forward for control line combat. The question is now how to handle eCombat and traditional combat with internal combustion engines (icCombat).

We could allow the two engine types in the existing combat class (F2D) or we could make a new class for eCombat.

## **Do we need a new class for electro combat?**

If we try to mix eCombat with icCombat in the existing F2D class there will be a competition between the two technologies. Even if a new set of rules are set up to match the two technologies on an equal level all pilots will try to find ways to develop their favourite technology. As soon one of the technologies get a little ahead of the other, most pilots will start to use this technology. The winner in this battle between eCombat and icCombat will dominate the F2D class for the future. The losing technology will fade away.

Historically we saw a similar struggle between glow and diesel combat back in the late 70s. In just a few years glow engines replaced diesel engines as the dominating technology. Diesel engines are still legal in F2D but have not been used for decades.

The point here is that the winner takes it all. If we mix eCombat and icCombat in the F2D class we will get a short fight between the two and after a few years one of the technologies will be dominant and the other will be obsolete (for F2D).

After all the problems with introducing shut-off systems, 6 mm muffler outlet and stop-at-will systems it is clear that the F2D class is quite fragile. A big change in technology will drastically reduce the number of pilots. On an international scale it will probably divide the F2D class into local classes with different sets of rules (e.g RusCombat).

### **A brand NEW class for eCombat:**

Every class reflects the available technology at the time that class was introduced. Control line model flying was developed and grew popular in the 50s and 60s when miniature engines became available but before the development of microelectronics made radio control the most popular hobby.

Combat have gone through a lot of changes since then but basically it is a sport based on technology from the 50s and 60s.

Now that we are about to start a new class it is important to consider what the technology of today makes possibly and, maybe even more important, what young pilots will find interesting.

It would be easy just to copy the old F2D Combat class and replace the combustion engine by an electro engine. We will get a new class but we will also inherit some of the basic problems from the old class. In a few years it will probably only be the same group of old pilots flying combat with electro engines. No new pilots and all the same problems as we have had with the declining number of pilots in F2D.

If we want eCombat to be more than just a side show for old F2D pilots with noise problems we must rethink the class. To make eCombat a class for the future we must radically rethink combat. Only if we come up with a brand new class we will have a chance to make eCombat popular.

### **Where to start:**

Here are some comments to kick start the process of radical rethinking combat.

In the first part you will find some observations and thoughts on pilots, models and equipment.

In the second part we will take a closer look on the way we are running competitions.

## **Part 1: Pilots and equipment**

### **Pilots:**

First thing it takes to make a class is pilots. We could cannibalise pilots from F2D but they are too few and too old! We could also try to restart some ex-pilots. They are also few and old but they would bring more people into the sport. The only really good source for new pilots to eCombat will be young people. Young pilots are the only way to grow eCombat to more than yet another combat class.

### **Skills:**

Combat as we know it today is very demanding. Pilots must be able to handle engines, set up ball bearings, adjust compression, repair models, make lines, trim models, start and adjust engines, etc.

Young pilots do not have these skills. This is just a fact. It makes no sense to blame them or to wish that they had learned more in school.

We must bear this fact in mind when set up the new class. If it will not be possible to fly this new class without being both a skilled craftsman and an electro-mechanical engineer we will have no young pilots in the future.

### **Quick results:**

Most of the experienced pilots' today spent a whole winter to build their first model. Young pilots do not have this persistence. They are used to have quick result after a very short preparation. If they have to spend too much (boring) time on preparations before they can go and have fun they will find something else to do.

To attract young pilots the distance from the first interest in eCombat to flying the first heat should be very short. Probably only a couple of days!

### **Cost:**

The cost of equipment is not a big issue for young pilots. If they find something they like they will also find the money for it.

The low prices of models and equipment may even be a problem. Only expensive equipment gives prestige among youngsters.

### **Ready to fly models:**

To attract young pilots to eCombat it must be possible to buy ready to use equipment. Most youngsters hardly know how to use a screwdriver but for sure they know how to use a credit card.

How do we design the new class to promote ready-to-fly models?

First we must avoid the class to be a competition on building advanced models in exotic materials. A class where you only have a chance with the latest model design will scare away manufactures.

Manufactures will only be able to pay for the developing of a new model design by selling a high volume of that model. If there is a chance that a model will be outdated by a new design before they have sold enough to cover their costs they will find this class to be too risky for they business.

A simple way to keep the model design stable could be to set a fixed size and a minimum weight.

More background information on the relationship between pilots and equipment manufactures can be found on this page:

<http://www.f2d.dk/noise/noise2013.htm#equip>



### **Keep it simple:**

eCombat will be an technical sport but with some smart regulations in the rules it will be possible to tone down the importance of the equipment. If we want eCombat to focus on flying dogfights we must try to reduce the focus on equipment.

### **Low tech engines and batteries:**

To prevent the eCombat class from evolving into a race on high tech engines and advanced batteries the rules must be designed to keep the equipment simple.

If a super advanced high tech engine have no or only a very small advanced to a simple off the shelf engine the motivation to develop and use expensive engines will be small.

The maximum power input to the engine can be limited by an electronic device. If the electric power input is limited the power output will be nearly the same for the cheaper engine as for an expensive high tech engine.

The total amount of energy that can be used from a battery can also be measured and restricted. This will make it possible to use batteries that have lost some of their original capacity. As long as a battery can deliver the maximum power for the required time it will make no difference if it is brand new or used.

### **F2D models rebuild for eCombat:**

Some pilots would like to use rebuild F2D combat models for eCombat. At the moment that would make it easier to get models and maybe it even would be possible to use the same models for eCombat and icCombat.

But this will only be for a very short period of time. Soon models will be designed and build specific for eCombat. When we set up new rules for eCombat it will be important to make the rules for the models so they match the need for electro combat. Our aim should be to make a new combat class, not to recycle F2D models.

If pilots are allowed to bring more models to a match (see later) there will be no need to build strong models that can withstand mid-air collisions. If one models gets damaged the pilot will land it and take up the next model. This type of "use and throw away" models can be built very simple and cheap.

The "use and throw away" style will probably provoke many old pilots. But we are not making a class for old pilots. I'm sure young pilots will be ready to adopt the idea of disposable models.

### **Variable speed:**

A radio-controlled on-board engine control allows the pilot to vary the speed of his engine as he is flying. This speed control can be used for two different purposes.

First it can allow the pilot to economise the energy stored in the battery. By lowering the engine power (low flying speed) a pilot can get more air time from his battery.

The variable speed can also be used tactical in a fight. By changing the flying speed a pilot can make it more difficult for his opponent to make cuts.

The capacity of batteries is undergoing a rapid development. The capacity of LiPo batteries have probably gone up by more the 10 % per year for the last couple of years. An even more drastic change may come with a change in battery technology. Zink-air batteries or fuel cells may double the capacity of batteries in a near future. It is difficult to predict what the future will bring but one thing is sure: The energy/weight ratio for batteries will change a lot in the future. The high weight and low capacity is a problem at the moment and regulating speed to economize do make sense for now. In the future this problem will be reduced by the development in battery technology.

If we base the rules for eCombat on variable speed as a way to economize the energy we will link eCombat to an unpredictable development of batteries.

A radical solution would be just to state that we have energy enough! If models run at full speed all the time pilots will have to make short flights before they land and change to the next model. When batteries get better and better the flights can be made longer.

If models are flown at full speed from batteries with a fixed maximum capacity (set by the rules and checked by an on-board regulator) it will result in a maximum flight time for each model. This might divide a match into short periods with combat separated by short breaks for changing models. Somehow similar to an ice hockey match.

If models are flown at full speed from batteries with a fixed capacity it will also have another impact on eCombat. There will not be a race on having the best batteries. As long as a battery can deliver the maximum power for the required time it will be as good as any brand new high tech battery. With a minimum take-off weight the battery weight will also be less critical.

Some pilots may argue that the battery technology could be an interesting challenge in eCombat. But if we want eCombat to be simple and popular among pilots (without a PhD in battery technology) we must keep the focus on combat. The reason for a new eCombat class should be to fly combat. Not to start a competition on developing high capacity batteries.

Variable flying speed as a tactic in the match might seem interesting. I don't think it will bring any good to the sport. The variable speed can only be used defensive to make it more difficult for the other pilot to make cuts or it can be used to trick him into taking all the streamer in one go. I think combat is difficult enough with models flying at full power all the time. Changing speed will not bring more fun. It will only cause more mid-air collisions and less dog fighting.

I might be wrong on this so I look forward to see a match with variable speed.

### **Safety:**

eCombat will have some of the same safety issues as F2D.

- Models flying away will be a problem. Technically the pilot will be able to stop his engine but his reaction time will be too slow to stop the model before it is quite far away. Some smart electronic shut-off systems can detect a line break and have been used in F2D. It would be nice to have these systems as standard equipment in eCombat.
- Models are heavy and fly fast. Pilots and officials must wear helmets

eCombat has some potential risk that we do not have in iCombat.

- The battery is a heavy component and will be dangerous if it falls off a flying model. Maybe we will need a safety wire to connect the battery to the model and lines
- Batteries may cause problems if they short circuit or get damaged in a mid-air collision.
- A pilot may activate the engine on a model without having the handle in his hand. A model that suddenly takes off from the pit lane without lines will be very dangerous.
- If the pilots bring more models to the circle there is also a risk that a pilot by mistake activates another model than the one connected to the handle in his hand.
- Charging batteries do sometimes cause fire. Manufacturers recommend that you never leave the batteries out of sight during recharging.

### **Technical specifications for the models:**

- Line length, diameter and pull test as for F2D.
- Handle with safety strap and F2D rules for DQ if the safety strap breaks.
- Safety wire between engine, battery and model. Engine and battery must stay connected to the lines.
- The engine power should be limited to a maximum level (e.g. 500 W).
- The maximum amount of energy that can be delivered from each battery should be limited to e.g. 50 kJ (100 seconds at max power).
- A minimum weight at take-off (e.g. 600 g) (Active eCombat pilots may have more realistic values for power, energy, weight, etc.)
- Maybe some restrictions on wing span, wing area, wing load, etc.

## **Part 2: How to run competitions**

Most combat pilots have been flying F2D for so long that they have forgot why we arrange and run competitions the way we do.

Now that we are in the process of rethinking combat we also have to see if we can give the combat event an update.

### **Tournament:**

Combat competitions have for many years been run as knock out tournament. To reduce some of the random aspects from the tournament pilots have been given two lives.

This traditional setup with two lives does have some "problems". Some pilots will be out of the competition after only two matches but good pilots that managed to stay in the competition will typical fly 8-10 matches in a competition. A side effect from this is that good pilots tend to get more praxis from competitions and will be even better at the next event. The not so good pilots will not improve very much by flying competitions.

One way to compensate for this is to let the pilots who are out of the ordinary competition after a few rounds fly a "loser fly-off". This concept was tested in Aalborg this year and got a good response from the pilots.

<http://www.f2d.dk/konk/danish-worldcup-2013.htm#loser>

Maybe we could find another way to balance the number of flights between top pilots and the not so good pilots. One way could be to let all pilots fly 3 or 4 rounds and then only let the pilots with one or more victory continue in the completion.

### **The match:**

A match between two pilots is the core activity in combat. To radical rethink combat we must know what we want from the match. Here is my vision:

*A Combat match should be decided by the pilots' ability to fly their models and make cuts on their opponent's streamer. The most interesting and fascinating part of combat is the tight dog fights where the pilots are using all there flying skills to trace their opponent to make small nice cuts.*

Or to make it short: Two streamers in the air for as much time as possible.

The influence from mechanics should be as little as possible. With on mechanics it will only be up to the pilot to win or lose a match.

The influence from random events (e.g. mid-air collisions) should also be as little as possible. By nature random events are equally distributed between pilots and no pilots will benefit from these events over a longer period of time. But a match decided by a random event is not making combat more interesting or funny. By



letting pilots have more models in a match the influence of a mid-air collision can be reduced.

Here is a vision for how an eCombat match could be flown:

Each pilot brings his models to the circle and mounts them in a starting scrooge. The lines and handles are placed in the circle and all models are ready to take-off. Each model is equipped with a streamer and if a pilot chose to take up a new model he will come up with a new full streamer.

Pilots should be allowed to bring as many models for a heat as they like (maybe with a practical limit of e.g. 5 models).

If a model land the pilot must take his lines and handle out of the centre circle. He doesn't have to take his landed model out of the flying circle. He must only make sure his landed model and lines do not block his opponent from starting with his extra models in the starting stooge.

A pilot will only have to leave the pilot circle to pick up the handle of the next model in his starting scrooge. A "pit stop" after a mid-air collision or after an unintended landing should be possible in less than 10 seconds.

If a pilot have lost all streamer (only string remaining) he should be rewarded a bonus (e.g. 50 points) if he land and takes up a model with a new streamer.

After a match the pilots will have time to clear out there lines and remove models from the flying field.

By allowing pilots to bring multiple models for a match it will not have much influence on the match if a pilot hits the ground or get a model damaged in a mid-air collision. The models do not have to be extremely strong to withstand crashes or hard landings. The models can be kept simple and cheap. With a minimum weight there will be no need to build light and strong models. A super light model would just have to carry some extra weight to full fill the minimum take-off weight.

By reducing the time on the ground we will get more dog fight. The new full streamer on each new model will help the dog fight to continue throughout the whole match

### **Officials:**

To make it easy to run competitions we must reduce the number of officials. A circle marshal and two cut counters should be enough.

A lot of the workload on officials can be reduced by using a computer program to do all the paperwork and the draws for the rounds.

Alex Prokofiev is working on such a program and it has already been used at some competitions in USA.

### **Flying field:**

For a start it would be simple just to use the F2D circles for eCombat.  
If eCombat is done without mechanics and with models taking off from a stooge there will be no need for the 22 m pitting circle. The 20 m flight circle will still be relevant for security reasons.

### **Streamers:**

A simple way to improve combat (more dogfights) is to use a streamer design that will give more cuts than the streamers used for F2D.  
An experimental streamer has been tested in F2D competitions with good results. At the meeting in Munich it will be possible to see and test this streamer  
More info: <http://www.f2d.dk/equipment/streamer/streamer-10.htm>

### **More info online:**

eCombat on F2D.dk



<http://www.f2d.dk/electro/ecombat.htm>



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