Noise reduction in F2D combat

Some thought on how combat noise can be reduced in the future

By Henning Forbech

Version: Beta 1
20/7 2010

The intension with this paper is to find a way to develop a set of rules that reduce the noise to an acceptable level with as little side effect on the way combat is flown as possible.
It is also important that existing engines can be used under the new rules with minor modifications.
When new engines and propeller are developing in the future they will probably replace these old engines but it is also important the noise level will not go up in this process.

Homologation:

The basic idea is to make simple and effective noise rules by using a standard procedure to test and certify the equipment. Equipment that has passed the test will get a certificate and can be used without any further test at competitions. This is called a homologation procedure and a similar system has been used for mufflers in F3D Pylon Race.

The homologation procedure for Combat will have to be designed for the special needs in the F2D class.
A good description of the method used for mufflers in Pylon Race can be found here:
http://www.fai.org/aeromodelling/system/files/F3D+Silencer+Implementation+Nov+09.pdf

The rules for Pylon Race have a special section on noise. See the Annex 5P on page 17-19 in this document: http://www.fai.org/aeromodelling/system/files/SC4_Vol_F3_Pylon_10.pdf

Sorry, but you will probably have to reed these two documents to understand how F2D Combat can benefit from this system.

Combat noise:

From 2011 we will have a 6 mm muffler outlet and from then we will have two dominant sources for noise: Engine exhaust and propeller. To reduce the total noise we will have to reduce both these sources. There will also be some mechanical noise from the engine and some noise from the intake. The vibrations in the model will also contribute to the total noise but all these secondary noise sources will be minor to the noise from the exhaust and the propellers.

Engines exhaust noise:

With a homologation procedure muffler manufactures can have there muffler certified and these mufflers can then be used by pilots as long as they do not change the muffler.

Mufflers can be tested on a loudspeaker system as described for the similar test in Pylon Race. A combat muffler should probably be able to reduce the noise by 30 dB (from 120 dB to 90 dB). The actual noise reduction must be based on some experiments before the exact value can be set.

By testing and certifying mufflers on the noise reduction we will have the noise level as one of the key parameter for muffler development. The internal design and the size or shape of the outlet can be up to the designer as long as the muffler can demonstrate its capability to reduce noise.
With the old rules mufflers was designed for highest engine performance with the given length, volume and outlet diameter. Noise reduction was just a side effect and nobody have ever trayed to design a muffler that was good at reducing noise.

To prevent the muffler form being used as a tune pipe we might still need some simple rules for maximum length and minimum volume like we have today.

Propeller noise:

Propeller noise is a new issue for combat. The key factor in propeller noise is the tip speed. The shape of the tips does probably also plays a big role on the noise level.

Maybe propellers can also be tested and certified under some kind of homologations process.

The propeller can be mounted on an electro engine in a test bench. The power to the electro engine can be regulated too e.g. 500 W and the noise can be measure in different directions. In the test the noise from the propeller must be under a certain level (e.g. 90 db @ 3 m) in all directions.

A certified propeller must be clearly marked with the homologation number.
A list with all certified propellers must be published. Some critical parameters for each propeller should be published together with the homologation number. This could be the diameter, shape of the blade, blade cord and thickness at certain positions, weight and volume of the propeller etc. These parameters would make it easy for officials at a competition to verify if a propeller is identical with the tested propeller.

Gear reduction:

Another way to solve the problem with the engines developed for high revolutions and the noise from the high propeller tip speed could be to put a mechanical gear between the crankshaft and the propeller.
With a noise rule that stated that the propeller should be more than 200 mm in diameter the existing engines will probably be forced to run at 20,000 rpm or so. Engines are optimized for 30,000 rpm so a 3:2 gear between the crankshaft and the propeller shaft could solve the problem. This kind of gear is known from big RC models.

If this gear solution will give an advance some pilots will use it. A gear will make engines even more complicated and expensive than what we see today. I don’t think anyone want this development and to save pilots from loosing time and resources on a technique that we do not want I think we should prohibit any kind of gearing right from the start. The rule could be some thing like: “Propellers must rotate at the speed of the crankshaft”.

/Henning Forbech