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THE FIRE FLY ("LICURICIUL") – A VERSATILE TARGET FOR ANTI-AIRCRAFT DEFENCE

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Abstract: *The aviation employment, as way of determent and enemy's combat ability weakening, by defeating the infrastructure and the means of communication, implies an adequate training of the operators within the anti-aircraft defense system. This training could be performed either on simulators, which virtually recreate the space where the hostilities are developing, or by employing a type of target that precisely pattern after the enemy aircrafts configuration. This paper presents an aerial target that could be used for training the operators (crew) performing the troops close defense, using IR anti-aircraft guided missiles, radio-controlled anti-aircraft missiles, up to ranges of 6-7 km, and a.a. guns and machine-guns. The target named "Licuriciul" is able to travel with speeds up to 120 km/h, being fitted with two smoke candles that generate smoke for maximum 3 minutes, and four infrared emission tracers, operating on three wavelengths of: 2-2.7μ, 3-5μ and 8-14μ. Moreover, by coating the wings with metallized plastic film, the target may also be detected by the anti-aircraft defense systems radars, KUB or OSA type. The drone may be programmed to fly, on ranges up to 6 km, and it could also perform reconnaissance missions.*

Keywords: *Licuriciul, aerial target, anti-aircraft defense system, operators training, autopilot*

1. INTRODUCTION

The aerial targets are a few hundred years old and they have first been used for the hunters' practice, being known as plates or clay doves. Together with the manufacturing and development of aircrafts as air combat means, the need of training the operators within the ground and in-flight anti-aircraft defense system has also occurred, as the targets realistically simulate the characteristics of the enemy aircrafts. In the same time, the testing of some anti-aircraft defense means, like the fighters, the missiles, laser guns or the artillery ammunition was developed by using full-sized or to scale aerial targets, by simulating the main features, like: the radar reflection surface or the radiant energy of the power plants [2].

2. INTERNATIONAL SITUATION

The rapid development of the military aviation in the 20th century accords with an increasing of the requirements complexity for anti-aircraft defense systems, especially for the anti-aircraft artillery. The development of a modern aviation and anti-aircraft defense network led to the improvement of the requirements for the aerial targets, which had

to simulate the hostile threats within the anti-aircraft defense and the pilots training programs [3].

One of the first aerial targets was developed in the middle 30s by CALIFORNIA RADIOPLANE COMPANY, a division of NORTHROP AIRCRAFT COMPANY. They built a radio-controlled model airplane, which formed the basis for the subsequent development for the aerial targets designed for the anti-aircraft artillery troops training. Between 1940 – 1951 there have been designed and built about 15 types of aerial targets, manufactured in over 5500 copies.

At the end of the 20th century, the targets were not more complex than the radio-controlled model airplanes. They used the towed target sleeve as payload [4]. In time, the targets became more sophisticated, being fitted with countermeasures means, devices for the shooting estimation, active or passive radar equipments, towed targets and much more complex programming systems.

The modern targets are usually launched by aircraft, or from the ground, by using rocket assisted take-off boosters, hydraulic, pneumatic or electromagnetic catapult. Very small target drones can be launched by an elastic bungee catapult [4]. Some of the known targets are fitted with landing gears, and parachute recovery, or skid landing.

Below there are a few of the currently employed targets, having characteristics similar to the *FIRE FLY* ("*LICURICIUL*") aerial target.

The US Army:

- *FQM-117*, a relatively complex target, designed for the training of troops operating the anti-aircraft artillery, having the dimensions a little larger than those of a RC model. The first piece was built in 1979, and about 30.000 copies of this model were manufactured. Since then, the target has been slightly improved, and received the FQM A, B or C codes, by approaching some different nose models and tail configurations, to better simulate the Soviet aircrafts *MIG-27* or *Sukhoi Su-25*. Overall there have been manufactured over 100.000 pieces [4].

In the table below there are presented the characteristics of two of the *FQM-117* target variants, and in Figure 1 there is a photo of the target.

Table 1. *FQM-117* Characteristics [7]

	FQM-117A	*FQM-117B*
Length	0.91 m	1.83 m
Wingspan	1.6 m	1.68 m
Weight	3.9 kg	3.6 kg
Speed	148 km	120 km
Altitude	3000 m	
Endurance	12 minutes	
Propulsion	1.2 HP *K&B* two-stroke heat engine	2 HP two-stroke heat engine

Figure 1. *FQM-117* Target [4]

- *MQM-170* "Outlaw" designed as a multi-function, not too expensive, target, which can also have the role of unmanned air vehicle. It is fitted with an autopilot and GPS that provides the waypoint autonomous navigation. It is really adaptable, it can accomplish different missions and it can bear many sensors and load types. It is currently used by US Army as aerial target, for the training of anti-aircraft forces [6].

The main characteristics are those in Table 2. The target is presented in Figure 2.

The target is powered by a two-stroke engine and a "pusher" type propeller [4]. It is launched from a pneumatic launcher and recovered by "belly" landing. On request, it may be fitted with a landing gear for the conventional wheel landing. The plane may be manually controlled, within eyeshot, with a platform that also allows the simultaneous control of more targets. There is also the

possibility of the waypoint autonomous navigation, on a pre-programmed flight path. The plane is figured so as to cover some automated recovery procedures on the occurrence of nonconformities like losing the satellite connection, or the radio communications. It may be recovered either by wheel landing, or by "belly" landing, or by parachute opening. The maximum effective load is of 18 kg. This may be: an IR amplifier or a laser multi-integrated system, a night operations illuminator, a smoke generator or a Doppler radar system for the shooting estimation.

Figure 2. *MQM-170 "Outlaw"* [6]

Table 2. *MQM-170* Characteristics [6]

Length	2.7 m
Wingspan	4.15 m
Weight	54 kg
Speed	max: 193 km/h; cruise: 95 km/h
Altitude	4900 m
Endurance	standard: 1 h; max: 3-4 h
Propulsion	17 HP *3W Model 150i* two-stroke heat engine

The European armies:

- *ULTIMA* has been developed for the homologation of *MISTRAL* anti-aircraft missile, currently owned by the Belgian army, also used as UAV, which is able to be deployed on a 12 km range. The first launching took place in 1994, and in 1997 it was improved for the automated anti-aircraft armament firing, by using a shooting estimation system. It is made of composite materials, with the fuselage wooden reinforcement. It is also fitted with a specially designed autopilot, with smoke and IR radiations generators.

The most important characteristics are presented in Table 3, and Figure 3 shows a target image.

Table 3. *ULTIMA* Characteristics [1]

Length	1.92 m
Wingspan	2.0 m
Weight	9.0 kg
Altitude	3000 m
Endurance	20 min
Propulsion	4.1 HP two-stroke heat engine

Figure 3. *ULTIMA* target

- *X-SIGHT Airframe* Germany is an aerial target designed for the training of the operators and crew within the close anti-aircraft defense systems. It is fitted with reflector prisms, or Luneberg lens, IR tracers and smoke generators. It disposes of a parachute recovery

system, and for higher payloads, the take-off is initiated by a launcher.

The main features are those in Table 4. In Figure 4 you can see the target.

Table 4. *X-SIGHT Airframe* Characteristics

Length	1.96 m
Wingspan	2.65 m
Weight	16.0 kg
Altitude	3000 m
Endurance	1- 3 h
Propulsion	3,5 HP two-stroke heat engine

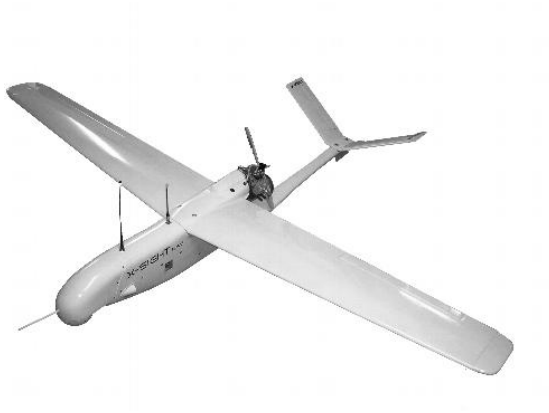

Figure 4. *X-SIGHT Airframe*

3. LICURICIUL – THE TARGET AIRPLANE

It is conceived as a low-priced aerial target, for the training firing and skill improving of the operators and crew within the close anti-aircraft defense troops.

The aerial target can be used for training and skill improvement firing with close-range anti-aircraft missiles, *STINGER*, *MISTRAL*, *STRELA 2, A94* type, as well as for anti-aircraft artillery firing, with calibers between 20 and 130 mm. An aerial target system is made of three fully-equipped platforms, enclosed in containers, a radio-control station and a computer, necessary for the flight programming.

LICURICIUL is able to simulate an aerial target, flying with a speed of max. 30 m/s, for 15 min, at an altitude between 100 and 1500 m. The target may be hand-launched by two operators or by using a light launcher, and it may be recovered by direct landing. For payloads larger than 3 kg, the target is fitted with a rolling gear.

The radiolocation reflection surface may be increased by covering the wing with a metallized thermo contractile material.

Figure 5 presents the target, and in Table 5 its main features are specified.

Figure 5. *LICURICIUL*

Table 5. *LICURICIUL* Characteristics

Length	2.15 m
Wingspan	2.0 m
Weight	15.0 kg
Altitude	1500 m
Endurance	15 min
Propulsion	*OS MAX* 4.1 HP two-stroke heat engine

For the point-to-point autonomous navigation, the Ardu Pilot Mega auto-pilot, Ardu IMU Shield inertial measurement unit and Mediatek GPS were enclosed within the target, and they are showed in Figure 6.

The flight path programming is made by a USB serial interface, on a Google map, displayed on the computer screen.

The auto-pilot has programming facilities for automated take-off and landing, or for reset to the start point coordinates and for making a circular flight, until the taking-over of the manual control.

Figure 6. Ardu Pilot Mega, Ardu IMU Shield and Mediatek GPS

The target fuselage is made of composite materials, based on epoxy resin, glass fabric reinforced and carbon tape hardened. The wings and empennage are cut from polystyrene, covered with 1 mm thick balsa wood and a layer of glass fiber, vacuum formed. Figure 7 presents the 3D general assembly.

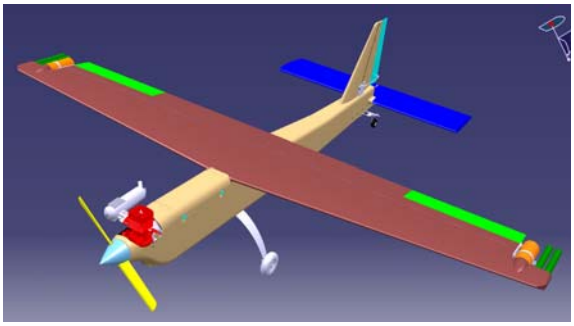

Figure 7. 3D general assembly

One piece of the target airplane "Licuriciul" was built, and it already passed through the first flight stage. In the next period of time, it will be subjected to the tasks of the test-evaluation program.

4. CONCLUSIONS AND PERSPECTIVES

1. The target airplane "*LICURICIUL*" is a training opportunity for the anti-aircraft defense troops.

2. The plane can develop a programmed autonomous flight, thus it could also be used as a reconnaissance airplane, its autonomy currently being of approximately 6 km.

3. The plane may be fitted with different payloads, like smoke candles, IR tracers, video or photo cameras.

4. The maximum effective load is 3 kg, with the possibility of increasing it to 5 kg.

5. The low cost price, compared to other similar targets, makes *LICURICIUL* an optimum alternative, under the current circumstances.

6. In so far as the potential beneficiary purchases more systems for internal use, the target modernization and even the export is possible.

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