UNMANNED AIRCRAFT VEHICLE (UAV) IN THE ROMANIAN AIRSPACE. AN OVERVIEW

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For the last decade the unmanned aircraft vehicle (UAV) field has evolved in terms of the sub-branches established in the aerospace industry. At national level the UAV market is still in its infancy but acknowledges an upward trend in the implementation and use of UAVs in civilian and military missions. The achievements of the past decade confirms that Romanian specialists are able to conceive, design and build UAVs at a technological and operational level comparable to the one achieved by large international producers creating the prerequisites of developing a sub-sector for the national aeronautic industry. The current article aims at providing an overview of all activities related to the conception, manufacturing, testing, improving, operating UAVs as these activities evolved within the national airspace filed with brief references to the missions and legislation in this area.

Key words: *unmanned aerial vehicles, air missions, UAV legislation.*

1.INTRODUCTION

1.1. Definitions

The Defence Department of the U.S.A. defines UAV as a self-propelled aerial vehicle that does not have a pilot on board and uses aerodynamic forces to fly autonomously or remotely piloted and is capable of carrying payloads on board [1].

The abbreviation UAV has been extended in some cases to UAVS (unmanned-aircraft vehicle system). The U.S. Federal Aviation Administration has adopted the name unmanned Aircraft System (UAS), to reflect the fact that these complex systems include, in addition to the vehicle itself ground control stations, plus other auxiliary support elements. Also, the term is also used unmanned aircraft (UA) when making direct reference to the air component of UAS [2].

1.2. Historical references regarding UAVs in Romania

In 1981 the first flight of the target aircraft ATM-1(M) manufactured in IPL "23 August" Tg. Mures took place (see Figure 1, table 1), and the first drawings of the aircraft ATM-1 at the shooting range Capu Midia, Constanta date back 1983. The vector was made of composite materials (fuselage) and polyurethane foam (wings) and the propulsion system consisted of a two-stroke combustion engine that involves a bipal propeller, [3, 4, 29]. IPL "23 August" has made flying wing ATM-001 (wingspan 1.54 m), see Figure 2 and ATM-3 (Figure 3).

Fig. 1 ATM 1M

Fig. 2 ATM-001 (flying wing)

Fig.3 ATM-3

Table no. 1. ATM Features 1M [3, 29]

Span/ Length/ Height	2.63 /1.75 0.58 m	Range	2 km
Speed max / cruise / min	190/160/ 35 km/h	Propulsion	24cm^3 / 1.7 CP
Weight max / payload	8/5 kg	Systems	RPV / remote control
Max. ceiling	2800 m	Missions	Aerial target

Between 1986-1997, research UAV are used, type VR-3 Reis, Soviet production on Kogalniceanu airfield, Constanta. The air vector was a modified version of target-17 MM. VR-3 Reis and was equipped with a jet engine R9A-300/KR-17 (RU-19 A-300) and the aerodynamics was kind canard delta wing structure made of Al alloys and composites (Figure 2 and table 2). Payload consisted of camera sensors. The system was auto-managed by BAZ -135 transporters TZM, which could carry two planes, and the launch was in a cylindrical container mounted on the vehicle BAZ -135 SPU, see Figure 4, [17, 26].

The VR-3 squadron was a completely autonomous and deployable system, completed with technical and technological capabilities necessary for the preparation and the maintenance of systems, ground equipment and embarked equipment, to prepare for launch, launch, recovery, transport, and for the procurement, processing, interpretation of the information obtained during missions in areas of interest.

In 1991 it achieved the target plane and introduced the ATM-03 shooting in the shooting range Capu Midia, Constanta (see figure 3) and in 1997 introduced the radio directed system of targets, EADS & SDE FOX-TS1, (see figure 5, table 3) French production in the shooting range Capu Midia, Constanta [4].

Table no. 2. Features VR-3 Reis [26]

Span/ Length/ Height	2.24 / 8.06 / 1.54 m	Range	200 km
Speed max / cruise / min	950 km/h	Propulsion TRZ 117	590 kgf
Weight max / payload	1230 kg	Systems	Autonomous guided
Max. ceiling	5000 m	Missions	Data acquisitions

Table no. 3. Features Fox-TS 1 (TX) [28]

Span / Length	4 / 2.75 m	Endurance	1÷5 h
Speed max	180 km/h	Propulsion	Limbach / 22 HP
Weight max	135 kg	Systems	RPV / remote control
Max. ceiling	3000 m	Missions	Aerial target

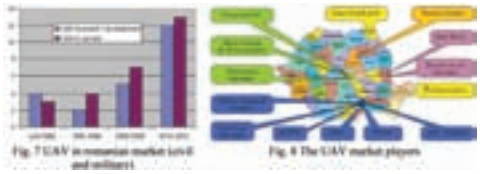
Shadow 600 (see Figure 6, table 4) is first used in 1998 at Timisoara airport and in 2000 the first application of UAVS occurs on Sibiu airfield. In 2003 SHADOW-600 system is deployed in the Iraq theater of operations between 2003 to 2009 and executed over 800 missions in Iraq (over 2000 flight hours). The system was delivered in 2001 and entered service with the 143rd Squadron at Mihail Kogalniceanu, with a value of .5 million dollars replacing the VR-3. [5, 27].

Table no. 4. Features Shadow 600 [16, 27]

Span / Length / Height	6.83 / 4.62 / 1.15 m	Endurance/ range	12-14 h / 200 km
Speed max	190 km/h	Propulsion	52 HP
Weight max	585 kg	Systems	Autonomous guided
Max. ceiling	5100 m	Missions	Data acquisitions

1.3. UAV evolution in Romania

Due to increasing funding for projects and to the increasing demand for systems market profile drones used for data acquisition in areas of interest, see Figure 7, [6, 7], UAV development in Romania has been evolving. In this respect, partnerships between research institutions and industrial entities are worth mentioning (INCAS Bucharest, Politehnica University of Bucharest, Dunărea de Jos University of Galati, Transilvania University of Brasov, Military Technical Academy Bucharest, ACTTM Bucharest, INAV Bucharest). UAV market players (research, manufacturing, use) are shown in Figure 8.



Projects and domestic firms like TeamNet & AFT Hirrus flying wing (Figure 9), AFT (Autonomous Flight Technologies) with Falcon I, Falcon II (see Table 5 and Figure 10), Electromecanica Ploiesti with ATT-01 [8, 9] have become visible and there have been purchases of airline models FPV (ARF / RTF – almost ready to fly) and FPV components of renowned manufacturers: Graupner, Robbe and E-flite, Hobby King [10, 11, 12], and national distributors Sierra Modelsport Ltd. and Phoenixmodels Ltd., see Figure 8, [13, 14].

Table no.5. Falcon I and Falcon II features [8]

Features/ UAVs	Falcon I	Falcon II
Wingspan/ length	3.2 / 2.6 m	5.3 / - m
Speed max/ cruise	230/120 km/h	280/130 km/h
Total mass (MTOW/ payload	25/5 kg	140/50 kg
Operating range/ Endurance	32 km/1 h	100 km / 6 h
Service ceiling	3000 m	
Propulsion	12 HP	32 HP
Mission	aerial target	

2. NATIONAL RESEARCH IN THE UAV FIELD

National concerns for the UAV are found both in the private and research and development institutions. A number of research institutions have initiated and completed projects aimed at developing vectors and human unmanned systems on board that can be used in military and / or civilian missions. Efforts in the concept, design manufacture, testing, operation and management of UAV systems are currently being conducted as part of a series of research/development endeavors undertaken in institutions and in higher education such as:

a. INAV Bucharest (Argus XL, XS, S), see Figure 11 and Table 6 [18];

Table no. 6. Argus XL, Argus XS [7]

Features/ UAVs	Argus XL	Argus S
Wingspan/ length	5/4.1/1.72 m	2.4/0,84/1.94 m
Speed max/ cruise	230/63 km/h	150/40 km/h
Total mass (MTOW/ payload	140/40 kg	24 / 5 kg
Operating range/ Endurance	300 km / -	220 km/ 4 h
Propulsion	20 HP	-
Mission	Data acquisitions	

b. Military Equipment and Technologies Research Agency, Bucharest - ACTTM (SACT 5 Boreal) (see figure 12a, table 7) [19] and ATM-01 aerial target upgrade (figure 12b) [40];

Table no.7. SACT 5 Boreal features [19, 33]

Span I/ II	1.8 / 2.8 m	Autonomy/ Range	1.2 h/ 6 km
Cruise speed	60 km/h	Propulsion	electric
Weight max	5 kg	Systems	Autonomous guided
Ceiling	250 ÷800 m	Missions	Data acquisitions

c. National Institute for Aerospace Research "Elie Carafoli", INCAS Bucharest (IAR-T and Automatic aerial platform strategic battle mode – PAMLUS project), see Figure 13 and Table 8 [20];

Table no.8. IAR-T features

Span	-	Range / Autonomy	10 km / 0,5 h
Max. speed	180 km/h	Propulsion	4.1 HP
Weight max/ payload	20/ 5 kg	Systems	Autonomous guided
Ceiling	300 m	Missions	Data acquisitions

d. Henry Coandă Air Force Academy of Braşov, with research on improving flight performance of ATM 1M [29];

e. Dunărea de Jos University of Galați (see Figure 14) [30].

In the private sector a number of businesses are engaged in designing, manufacturing, testing and marketing unmanned aerial systems such as:

a. AFT (Autonomous Flight Technologies) /TeamNet (București) with Hirrus, Soim I, II, (see Figure 15 and Table 9) [21, 36];

b. Sierra Modellsport Ltd. (Botosani), sells UAV systems (flying wing) ready to fly or components (Lehmann systems, see Figure 16) [22];

c.Compozite Ltd. (Braşov) company initiated a research project on miniUAV (aerial target) catapult-launched with a canard design, see Figure 17, [35].

d. Reev River Ltd. (Galați) with Phoenix-1 portable miniUAV, Phoenix-2 medium portable UAV and Phoenix-3 portable UAV (see Figure 18, and Table 10), [37].

e. Electromecanica Ltd. Ploiesti, developed product ATT-01 (aerial target) with characteristic of table 11 (see figure 19), [38].

Table no. 9. Hirrus flying wing features [21]

Span/ Length	2.35/ 1.1 m	Endurance/ range	3 h/15 km
Speed max/ cruise	130/ 90 km/h	Propulsion	electric
Weight max / payload	7 / 0.9 kg	Systems	Autonomous guided
Missions	law enforcement, reconnaissance, search and rescue, data acquisitions		

Table no. 10. Phoenix1, Phoenix 2, Phoenix 3 features

Features / UAVs	Phoenix1	Phoenix 2	Phoenix 3
Wingspan	1.2 m	1.7 m	2 m
Speed max.	100 km/h	220 km/h	80 km/h
Payload	0.7 kg	2 kg	2.5 kg
Ceiling	3500 m	4500 m	4500 m
Endurance	0.75 h	1 – 2 h	0.8 h
Propulsion	electric	combustion	electric
Mission	Data acquisitions		

Table no.11. ATT-01 features

Span	-	Range / Autonomy	10 km / 0.5 h
Max. speed	180 km/h	Propulsion	4.1 HP
Weight max / payload	20/5 kg	Systems	Autonomous guided
Ceiling	300 m	Missions	Data acquisitions

3. UAV STANDINGS, MISSIONS AND LEGISLATION

3.1. UAV standing

The literature in the UAV field [15, 16] reveals classifications in military terms, as follows:

First Grade: portable, hand launched and operated individually, with a range of 30 km and under 2 hours. The simple launch and recovery features allow operators to quickly engage.

Second Grade: are limited in terms of range and capacity to support large areas of operations, requiring previously controlled launching and recovery areas.

Third Grade. Most fixed-wing UAVs in this class require landing runways, although some are supported by the launch and recovery systems. They require information on airspace much larger than systems in other classes of airspace management alongside manned aircraft. Depending on the geometry and mass restrictions systems, this class can be tracked by a monitoring system.

3.2. UAV missions

UAV use is determined by capacity and quality of the payload. Unmanned aerial systems on board can perform a series of missions in areas of interest, according to the user, as follows: surveillance missions, security and prevention (security, control and security objectives); search and rescue missions (MEDEVAC), military and special missions (ISTAR, combat mission) scientific missions and experimental (experimental models, demonstrators).

Depending on the difficulty of the mission, UAVs can execute D3 missions: Dull (missions wear), Dirty (missions "dirty") and Dangerous (dangerous missions). Using UAV platforms in hostile environments reduces the risk of human losses and allows launching precision-guided munitions out of enemy forces range.

UAV operating in national airspace have a number of distinct missions: air targets, data acquisition (in various areas of interest), scientific and experimental ones [15, 16].

3.3 UAV related Romanian legislation

Exploitation of ground and flight of unmanned aircraft vehicles in national airspace is regulated by a series of laws and regulations to date [23, 24, 25] delineating both categories and concepts (aerodyne, balloon) and flight documents admissibility: "Unmanned aerial vehicle (UAV) – a vehicle that meets the conditions specified in RCAR-AZAC.100 section (1). E – unmanned aerial vehicle, operating with a mass less than 150 kg."

A recent regulation [24] defines and maintains the use of UAV airspace in accordance with modern technological developments of the years 2013 to 2014, especially for unmanned airborne vector systems for recording and transmitting data. The document defines terms used in the current UAV and operating conditions in the national airspace (see Figure 20).

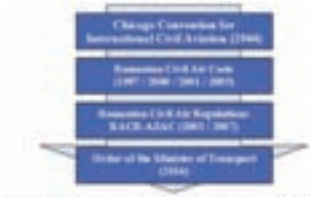


Fig.20 Evolution of civil aviation legislation (including UAV)

4. CONCLUSIONS & PERSPECTIVES

Review of unmanned aircraft by classifying them and their wishes with the laws and regulations in the field clarification of this relatively new field of aeronautics. The difference in equipment, implement and development lead implicitly to cost differences and capabilities of these aircraft that have already their own history and development along with other types of aircraft known.

The achievements of the past decade confirms that Romanian specialists are able to conceive, design and build UAV at a technological and operational level comparable to the one achieved by large international producers creating the prerequisites of developing a sub-sector for the national aeronautic industry.

Research studies state that surveillance missions, reconnaissance and electronic warfare, manned

performed onboard will be taken completely by UAS. Moreover, these missions will extend regarding direct air support and air defense in neutralizing enemy ground-based.

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