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SUAV WARFARE IN THE NEXT DECADE

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Abstract*: In this document we have focused on researching the so-called "Small Unmanned Aerial Vehicles" in order to find out what their main characteristics are and how they may affect the way we fight in the future. To achieve our goal, we have established several subjects relevant to any fighting system: design, manufacturing, tactical capabilities, logistics, recent experiences. After analyzing them we have come to a series of conclusions.*

Keywords*: SUAV; future; characteristics; experience; logistics; trends.*

Introduction

In the present paper we will examine the role that the development of the S.U.A.V., that is, the "Small Unmanned Aerial Vehicles", could have in the conflicts of the future taking into account their nature in the sense of tactical capabilities, logistics, research and development, and production.

To reach our objective we will use the deductive method. First, we will contextualize the appearance of small-sized drones, then we will analyze the technical specifications that determine their characteristics within the framework of logistics, industry and tactics. Finally, the previous process will be filtered to generate a series of conclusions.

Context

As far as we are concerned, we will consider as SUAVs those aircraft with a maximum take-off weight (MTOW) under 150 kg, corresponding to Class I drones, which comprehends Mini category (under 15 kg) and Small category (15-150 kg) according to Spaniard Operational Air Traffic Regulations[1]. Nano category, with a mass of just a few grams[2] will be excluded from this study, mainly due to their minor importance.

The use of Unmanned Aerial Vehicles (UAV) dates back to the two World Wars. We can mention the TDR-1 that in 1944 could launch one 1,000-pound bomb or a single torpedo. The main trend regarding UAV development since the Second World War is that drones have been thought as a cheap replacement for their manned counterparts.

The trend has been for manned reconnaissance or attack aircraft to be replaced by UAVs. In the foreseeable future, drones are already being planned for refueling, air supremacy and many other missions[3]. The best representative of this philosophy, that seeks to do the same as the old tactical bombers but with new means, is the popular Predator which was introduced as a surveillance aircraft and now it is also used for strike missions.

On the other hand, in the last thirty years, the Mini and Small drones have come into play, as they bring a new difference: instead of replacing manned aviation and previous platforms, they constitute a new unexplored world of "war machines". Exploring it is just what we are going to do next.

[1] Annex 1 of the "Real Decreto 601/2016 del Reglamento de Circulación Aérea Operativa", according to https://www.boe.es/buscar/act.php?id=BOE-A-2016-11481, accessed on 1 January 2020.
[2] *Ibidem*.
[3] For an overview of future unmanned platform trends in U.S. Air Force: Mark Gunzinger&Lukas Autenried *Understanding the Promise of Skyborg and Low-Cost Attritable Unmanned Aerial Vehicles,* Mitchell Institute Policy Paper, Volume 24, September 2020.

Analysis of characteristics

Technical Specifications and Popularization

In 2003, the United States saw the beginning of the Low Rate Initial Production of the SUAV RQ-11 Raven Block I, a hand-launched high-winged SUAV which did its first flight on 2001[4].

In 2007, after winning the U.S. Army SUAV program, the RQ-11B began its Full Rate Production[5]. At present, thousands of frames have been manufactured and exported to more than 30 countries. The case of the Raven is paradigmatic because it clearly shows some of the main advantages and characteristics of modern SUAVs: Since the beginning of the program, the development and manufacturing times were extremely low.

The RQ-11B of the year 2006 had the following specifications according to the manufacturer Aerovironment:

Table 1 - RQ-11B specifications

Speed	32-81 km/h
Autonomy	60-90 minutes
Radius	10 km
Weight	1,9 kg

20 years after the Raven, a country such as Turkey, which is the 19th world economy[6], has been able to develop SUAVs like the quadcopter Kargu[7], the Togan or the loitering ammunition Alpagu[8].

Also, 20 years after the Raven, the aeromodelling industry has been largely surpassed by the commercial drone industry for recreational and business purposes: from roof inspection to agricultural monitoring using thermal imagery, or search and rescue, among others.

The new civilian-based SUAV industry has been able to grow thanks to two different factors:

- The world markets and the digital trade;
- The miniaturization of electronic components and devices.

Electronic miniaturization is an old phenomenon that has accompanied us since the appearance of the first computers; however, the degree of miniaturization achieved in recent years has allowed a key improvement in sensors, links and navigation. Yet, if it had not been for the existence of a solid digital trade combined with the existence of global networks of manufacture and distribution, the miniaturization would have been less relevant.

If miniaturization has been the fundamental technical advance, global digital commerce has been the economic boost that civilian drones needed to give rise to an extraordinary improvement curve whose increase we can observe each year. For example, an Inspire 2X7[9], which is a quadcopter that DJI offers for 9,800 euros per system has the next characteristics: 7 km radius, 90 km/h top speed and a 6k camera. In websites like Amazon or Alibaba there is a huge market of spare parts and components that allow any individual to customize the design of the drone for very little money.

We need to be aware of the impressive change evolution. In 1982 during the Falklands War, GPSs were luxury products. In order to perform precise and efficient flights, the

[4] Van Bourgondien, Jeffery, *Analysis of the Sustainment Organization and Process for the Marine Corps RQ-11B Raven Small Unmanned Aircraft System (SUAS)*, Naval Postgraduate School, Monterey, March 2012, p. 11.
[5] *Ibidem*, p. 29.
[6] https://data.worldbank.org/indicator/NY.GDP. MKTP. CD?most_recent_value_desc=true
[7] *To overview Kargu official technical specifications*; https://www.stm.com.tr/en/kargu-autonomous-tactical-multi-rotary-attack-uav, accessed on 1 January 2020.
[8] *To overview Alpagu official technical specifications*; https://www.stm.com.tr/en/alpagu, accessed on 1 January 2020.
[9] *To overview Inspire 2X7 official technical specifications*; https://store.dji.com/es/product/inspire-2?vid=96981, accessed on 1 January 2020.

Argentinians had to use their reconnaissance Learjet planes to help guiding the Skyhawk and Mirage attack formations. In 2014 anyone could purchase a 30 gram GPS for 30 euros[10], and use the Arduino software to allow a homemade drone to make a tremendously accurate Waypoint Navigation. An impossible deed for a whole country in 1982 can be done for 30 euros on a modern homemade platform.

The previous ideas allow us to confirm that one of the most relevant characteristics of the SUAVs is that most of their components are available in the civilian market, and therefore the probabilities of reverse engineering and illegal transfers for military purposes are much greater, as it is their potential use by non-state actors, such as guerrillas or terrorist groups.

In conclusion, the technology of the SUAV is extremely accessible, cheap, and at the same time it offers great possibilities of use due to its quality.

Manufacturing

The quality of the homemade drone, when built by experienced personnel is close to that of an industrial UAV. After all, a user has at his disposal a market that allows him to buy the best parts form all of the competing companies, hence allowing to choose the best pieces from each designer.

The construction of the SUAV is very simple: you only need a tin soldering iron and a screwdriver; in addition, both the software and the learning to manufacture and program can be found in the Internet thanks to online tutorials and guides. What this means is that any individual or small organization, such as a terrorist group, can learn to design and manufacture drones at a very high rate. No industry is needed, you just need access to the world trade and a lot of workers to do the job with quite simple tools.

It should be noted that since there is no strict need to build factories, in case of war and air raids SUAV production can be decentralized, as only a small room and electricity are needed to resume production. This characteristic represents a great advantage for certain actors, since it reduces the effectiveness of strategic bombing campaigns against the enemy's industrial base.

In conclusion, another key characteristic is the simple and easy way of buying and manufacturing SUAVs for any actor, and at the same time the ability to decentralize production to avoid strategic bombing campaigns.

Tactical Relevance

Now let us analyze the tactical capabilities of SUAVs, because if they are not effective in the realm of the battlefield, why should we trust them?

Generally speaking, SUAVs can be divided among three different types: rotary-wing, fixed-wing and Vertical Take Off and Landing (VTOL).

Usually, rotary-wing SUAVs are characterized by higher payload capacity and the possibility to stationary flight. They can be both very fast or very slow depending on the design. Some of the so-called “racers” can reach well over 200 km/h. Their disadvantages are high consumption rates that usually limit endurance to 15-60 minutes depending on the model. Essentially, rotary-winged SUAVs are good for carrying small payloads: from a few hundreds of grams to a few kilos of explosives, but they are also suited to transport relays, electronic warfare devices, accomplish recovery operations of downed drones or transport light logistic packages. Also, their mobility allows them to be appropriate for inspecting or reconnaissance missions, to do faints, and to maneuver in order to take advantage of unexpected approach thanks to the terrain features. Finally, they are able to fight inside urban environment, such as

[10] *To overview a COTS GPS available in Amazon*; https://www.amazon.es/KEYESTUDIO-Module-Compatible-Arduino-Raspberry/dp/B07FTFMTBK/ref=sr_1_29?__mk_es_ES=%C3%85M%C3%85%C5%BD%C3%95%C3%91&crid=21ZWR1CV1IQHT&dchild=1&keywords=gps+drone+modulo&qid=1610431134&sprefix=gps+drone%2Caps%2C656&sr=8-29, accessed on 1 January 2020.

streets, the interior of buildings or in underground structures. On the other hand, they are not suited for surveillance, electronic warfare missions or long range actions as they consume most of the energy to move.

Fixed-wing SUAVs on the other hand are good at long range missions, traveling to distances up to 10 km or more. They are always fast, and some of them can be very fast when needed. We should bear in mind that an Orbiter-1k can carry up to 3 kg warhead with a mission range of 100 km, 150 minutes endurance while staying in the 13 kg MTOW[11] limit.

The point on presenting this data is to compare it with other weapons and systems in existence. For example, an AH-64A Apache is capable of reaching 297 Km/h as a cruise air speed[12], a velocity that can be reached by some specifically designed rotary and fixed wing SUAVs. What it means is that slow flying manned and unmanned platforms can be very vulnerable to SUAVs when flying close to the ground or when approaching or leaving airfields.

On one hand, a heavy 120 mm mortar is able to hit targets at 10 km, but it requires a few rounds, and a support team while guided rounds tend to be expensive. On the other hand, SUAVs can provide target surveillance and reconnaissance, precision strikes, they can maneuver against the enemy or act as a mere round, and finally they can work along other assets and platforms.

Rotary wing commercial SUAVs where intensely used during the Marawi Battle[13] between the Filipino Army and Islamic State and even in Syria[14], Iraq[15] or Ukraine, while fixed wing SUAVs have seen action in almost any conflict since 2000: from Operation Iraqi Freedom to the 4-Day War (2016), Nagorno-Karabakh War (2020), or the offensive of Ethiopia against Tigray in October 2020.

Donbas War, 4-Day War (2016) and Nagorno-Karabakh War (2020) have shown the tactical advantages of SUAVs as they have become a force multiplier and, arguably, a Military Technical Revolution themselves. Since Donbas War, both Ukraine and Russia have boosted efforts regarding SUAV design, production, acquisition, deployment, tactics…

Regarding tactical capabilities my conclusion is that SUAVs can be just a force multiplier when they help to manage artillery fire, targeting processes, reconnaissance, however, when employed systematically in a new structure that allows greater inter-arms cooperation and dedicated SUAV units they might have the potential to become a Military Technical Revolution themselves.

Battle Experience

If we analyze the 4-Day War between Armenia and Azerbaijan in which machines such as Orbiter or Skystriker played a significant role on Azerbaijan's victory, we can even argue that they represented the main innovation and the key asset of Baku. 4-Day War was short, but it provided the self-confidence that Azerbaijan needed to launch their victorious war in September 2020.

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[11] *To overview Orbiter 1k official technical specifications*; https://aeronautics-sys.com/wp-content/themes/aeronautics/pdf/orbiter_1k_v2.pdf, accessed on 1 January 2020.

[12] *To overview AH-64A Apache technical specifications*; https://cdn.rochesteravionicarchives.co.uk/img/catalog/ZZ_1395656824_DDBR0244+%28O%26A-1b%29.pdf, accessed on 1 January 2020.

[13] *To have deeper knowledge about Marawi Battle*: Rafael López Mercado&Yago Rodríguez Rodríguez, *Marawi 2017: Story and End*, Ejércitos Review, https://www.revistaejercitos.com/2020/02/29/marawi-2017-desarrollo-y-desenlace/, accessed on 9 January 2020.

[14] To have deeper knowledge about SUAV usage in Syria Rodríguez, Yago, *Tactical innovations of Syrian War*, Ejércitos Review, https://www.revistaejercitos.com/2020/03/02/novedades-tacticas-de-la-guerra-de-siria/, accessed on 1 January 2020.

[15] José Alberto Marín Delgado, *Commercial drones usage as terrorist vectors,* Instituto Español de Estudios Estratégicos, 29 January 2018.

The story repeated itself in Nagorno-Karabakh War, when SUAVs combined with other UAVs were able to dislodge the Armenian Army to the point of surrender after one month of heavy losses.

On the other hand, Donbas War[16] in 2014 saw the popularization of both military and civilian SUAVs as they allowed small units to get integral long range aerial reconnaissance, even if their main role was to support artillery and mortar batteries in order to find targets, correct fire and evaluate the effects of each bombing.

SUAVs were so important that the seed of a SUAV industry practically appeared in Ukraine due to the conflict. Nowadays the country has a number of small companies with national designs based on Commercial Off the Shelf (COTS) parts.

The presence of this kind of platforms along other UAVs is already affecting the unit organization and the Tactics, Technics and Procedures (TTP) of countries such as Russia, China or the United States.

The Russians have been trying to introduce drones into their armed forces at least since the 2008 Georgia War, yet it was the war experience of the last 6 years that lit the fuse for greater reforms.

The most influential experience was the Ukrainian shock, where the Battalion Tactical Groups had to deal with the Ukrainian Armed Forces. Also, Armenian and Russian forces have very deep ties so it is likely that the 4-Day War experiences were shared. Finally, between 2019 and 2020 Russia had to deal with Turkish UAVs both in Libya[17] and Syria, therefore having the opportunity to learn new lessons.

Currently, all Russian brigades are receiving a drone company, while the Interbranch Center for Unmanned Aviation in Kolomna[18] is certifying the first promotions of specialized officers in the new companies. Russian military exercises also reflect a new mentality. Massive exercises in which the bulk of the action revolves around UAVs are carried out, TTPs have been modified and in fact during the "Khavkaz 2020" exercises we could observe how the all-arms-air-defense concept was put in to practice, so that all the members of a platoon or a squad combined their fires to shoot down the flying machines.

Most of the battle experience both in high intensity and hybrid wars between 2010 and 2020 has shown that SUAVs have an increasingly important role to play in the tactical realm. Thus, if in 2014-Donbas War SUAVs were used for targeting and observation missions, in the 4-Day War they carried out a big part of the key missions in the Azerbaijani plan along other UAVs, while in Nagorno-Karabakh 2020 they did the same but this time their shared their success along larger Hermes 400 and Bayraktar TB2 platforms.

In conclusion, SUAVs are highly capable tactical[19] assets, especially when there is a gap in their usage between two adversaries. They represent a relevant threat to any ground-based platform and they can increase their success when combined arms principles are applied, especially when SUAVs and other UAVs cooperate. SUAVs are already provoking changes in force organization in a number of countries and that trend should be expected to grow in the incoming years.

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[16] Francisco José Matías Bueno, Donbass, *Trench Warfare, Ejércitos Review*, https://www.revistaejercitos.com/2020/02/29/donbass/, accessed on 2 January 2020.

[17] Jesús Manuel Pérez Triana, Spring Shield: Turkish Innovations during Idlib Offensive, Spaniard Army Review, pp. 30-35.

[18] Lester Grau & Charles Bartes, *The Russian Way of War*, Foreign Military Studies Office, 2016, p. 372.

[19] *To know the U.S. Defense Department Counter Small Unmanned Aircraft Systems Strategy*; https://media.defense.gov/2021/Jan/07/2002561080/-1/-1/0/DEPARTMENT-OF-DEFENSE-COUNTER-SMALL-UNMANNED-AIRCRAFT-SYSTEMS-STRATEGY.pdf., accessed on 17 January 2020.

Logistics

But what about logistics? Once Napoleon said: "Armies walk on their stomachs" to reflect the weight of supplies in warfare, a question often overlooked when the procurement of new systems comes to the public debate.

Let's choose the Turkish Kargu drone as an example: its dimensions are: = (600 mm) * (600 mm) * (430 mm) = 0.155 m^3 volume. Taking the result into account, how many Kargu drones can we carry in a standardized 20 feet container? The 20 feet container dimensions are: (5.9 m) x (2.35 m) x (2.4 m) = 33.27 m^3 approximately. The calculations allow us to estimate that an average 20 feet container volume carrying capacity for the Kargu is: 33.27/0.155 = 214 Kargu SUAVs per container.

The packaged Kargu is smaller than when it gets ready for action, so it is very likely that in reality the figure of 214 is higher, even if we take into account the thickness of the container walls and the package of each Kargu. Each Kargu weights 7 kg, which means 1.5 tones for a total of 214 Kargus, well under the 28 tones limit of a 20 feet container.

If we compare the previous results with the 40 120 mm rounds that an M1 Abrams tank carries, assuming that all those rounds are M830A1 HEAT Multipurpose projectiles that weight 24.6 kg we will find out that a whole ammunition load for an Abrams weights 1 tone.

Each Kargu can be used to inspect a suspicious house, to accomplish reconnaissance missions over a wide area, to execute swarming attacks through various groups of SUAVs… Each Kargu can be reutilized and their fighting range is even longer than that of a 120 mm tank gun, because a single Kargu enjoys a 5 km radius, well over the 2-3 km Line of Sight range where MBTs used to be effective.

Finally, in order to use their main gun, tanks have to expose themselves and stay in Line of Sight with the enemy, not to speak about the risk for the crew of an armored vehicle.

Regarding strategic and tactical projection, on one hand, to transport an armored fighting vehicle you need air transport, which can be considered a costly and scarce resource. Platforms such as the A-400M can transport a Piranha IIIC while strategic transport planes can carry a modern MBT. On the other hand, a tactical transport plane such as the C-130 can move a fairly large fleet of Kargu drones along their systems, support needs and pilots, everything in just one flight.

We could choose other models than the Kargu as an example, but generally speaking the conclusion is that SUAVs offer really good cost/effectiveness ratios while the possibility to move large fleets of relatively light and compact drones is highly beneficial for the logistic footprint and for the last mile logistics.

Industry

It does not surprise anyone that the SUAV defense industry is growing rapidly around the world; as we have already explained that these kinds of drones are easy to design and manufacture, and that there are civilian components for sale all over the world.

One important difference, however, is that while the civilian SUAV industry is dominant and often provides many of the basic technologies for military drones, the military SUAV industry remains important and necessary in light of the special requirements that this kind of machine needs to be useful in actual combat. The main technical difference between the military SUAV and the civilian SUAV can be found in three main aspects: sensors, Artificial Intelligence and above all, in the radio link and datalink.

Military affairs are competitive in their nature, so in order to reach a competitive edge all kinds of actors seek technological excellence as a tool to compete. That is why sensors such as cameras and radars, or the AI of civilian and military drones differ, and are generally more capable in the military environment.

However, the major differences between both kinds of designs exist in the datalink and the radio link. As military affairs are competitive by nature, time is a much more compellent issue in military products than in civilian ones. Remember that it is time that shapes the result of wars as it

can be explained by the OODA loop theory. In turn, time depends on the ability of the drones to receive and share data and information as quickly and safely as possible, a problem that civilian SUAVs do not suffer usually: after all, for a worker inspecting a roof, it is enough to record the roof on a delayed basis and render it a few hours later while seated in his office.

Currently, military drones cannot operate in this way. They need to transmit and receive data fast, hence military links are much more powerful than those on the civilian market. In addition, there is an emergence of Electronic Warfare as an important and widespread means of combat, so it is important to develop advanced military link equipment that cannot be found on the civilian market.

Chinese industry is offering an increasing number of SUAVs to its armed forces, including some capable of performing logistic missions in the highlands of Tibet and near the https://www.globaltimes.cn/content/1200583.shtmln border[20], loitering ammunition carriers or even reconnaissance drones included in an armored vehicles.

Even the Russian military-industrial complex is being affected by the SUAVs. On 2016 the Ministry of Defense ordered setting up various companies dedicated to producing new kinds of drones, including UCAVs and loitering ammunitions.

The national production and design of SUAVs permits equipping armies with small drones that multiply the capability of small infantry units, armored vehicles and other formations. We could spend several paragraphs explaining the industry developed in Turkey, Israel, Spain, Poland, Vietnam, Ukraine, but suffice it to say that Shephard's April 2019 book[21] "Military Unmanned Systems" includes about 530 different UAV designs from multiple nations.

The conclusion is clear, the military SUAV industry is largely based on its civilian equivalent; however, there are some fundamental differences, especially in the links. Likewise, many companies around the world have bet on SUAVs, including rich countries like Spain or the United States, average-income countries like Poland or China, and poor countries like Vietnam. We are living an industrial race for this type of equipment.

Conclusions

When we look at the set of characteristics analyzed: logistics, design, research, manufacturing or technical specifications, we will note that SUAVs offer outstanding characteristics in all areas. They are fast, cheap and easy to design, manufacture, acquire and use, and also have remarkable combat capabilities. Until a few years ago, if you wanted to hit targets at 10 km away you had to develop a howitzer, a heavy mortar, or an expensive and complex anti-tank missile like the Javelin or the Spike. Today this work can be done by a SUAV weighing only a few kilos, costing a few thousand euros and even being able to be used for missions other than suicide attacks.

The SUAV screams one term: economy of the forces. We are facing an extremely efficient weapon in all senses, and it is also very accessible, unlike other weapons such as MANPADs, which, although cheap and effective, are not easy to obtain.

Recent experiences corroborate that the SUAV can become a force multiplier through a fast acquisition cycle. Just think about the short time it took Ukraine to acquire drones *en masse* in order to fight in the Donbass; however, when combined with other organizational enhancements and combined arms, such as artillery, electronic warfare or other UAVs, the SUAV can be one of the fundamental pieces of a true RMA. The experiences of the last years and the intrinsic characteristics of the drones and the continuous technological improvement predict that the tendency to use the SUAV is going to increase vertiginously during the next decade for all the missions, for all the actors and for all the types of conflicts.

[20] The height of Tibet means that air is lighter and so flights are less efficient and even quite difficult for heavy manned platforms. Zhang Hui, "PLA Tibet military command adopts drones for logistics support in drills amid China-India border clash", https://www.globaltimes.cn/content/1200583.shtml, accessed on 1 January 2020.
[21] Matthew Smith, *Military Unmanned Systems*, Shepherd Press, pp. 13-189, April 2019.

Likewise, those who learn to integrate the SUAVs doctrinally and organizationally, those who acquire them earlier and those who develop their own industries will have a key edge over their adversaries.

Finally, we must remember that the "S" in the term SUAV means "small". When something is small, it undoubtedly has some disadvantages: worse sensors, less powerful weapons, worse Artificial Intelligence, less range... In that sense we have to understand that the SUAV will always need other assets to complement itself and get the most out of it.

In conclusion, the SUAV will be at least a force multiplier, and at most one of the key innovations that can open the door to a true RMA if coupled with organizational, doctrinal and combined arms improvements.

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