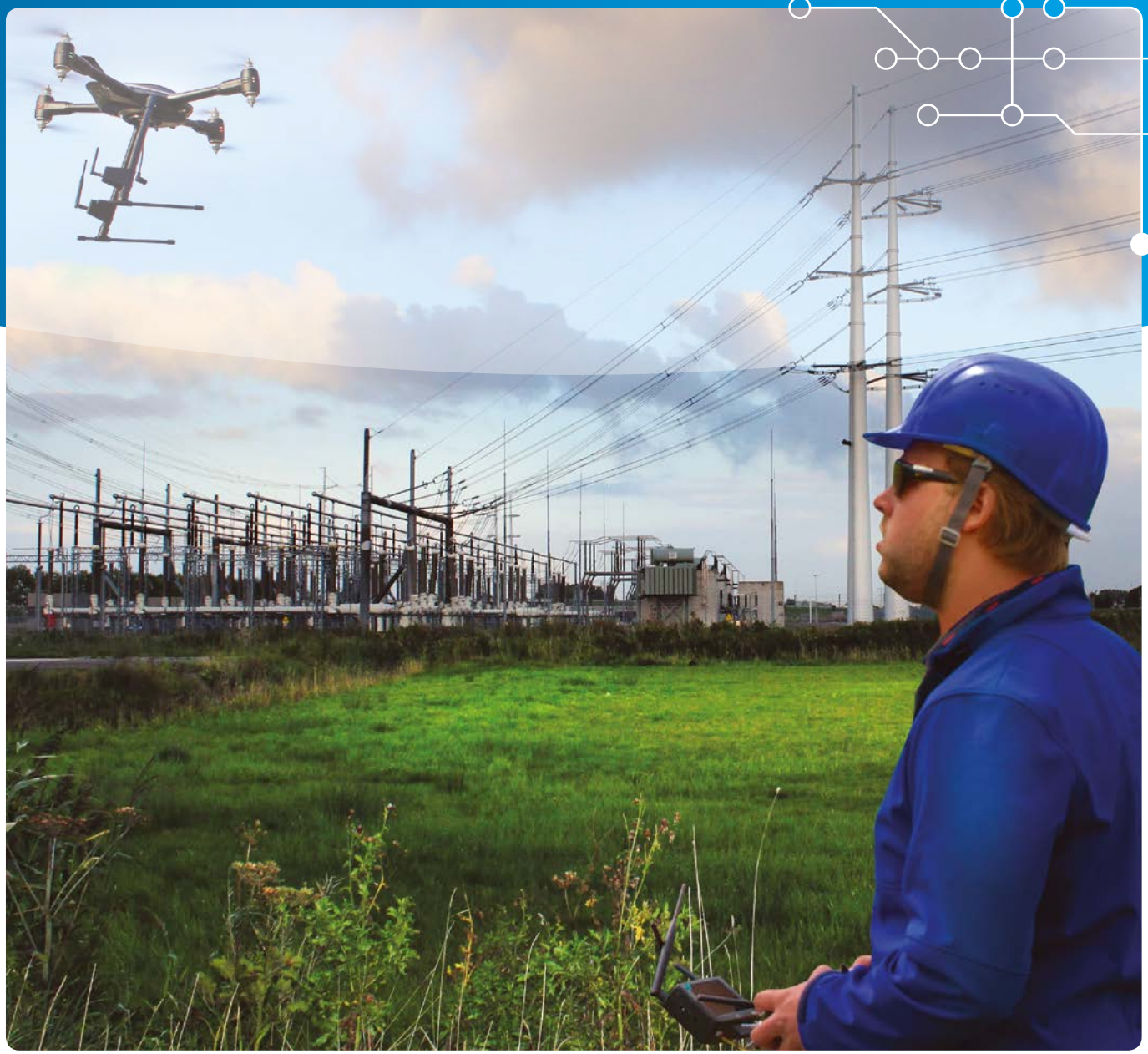
A Blessing in the Skies?

Challenges and Opportunities in Creating Space for UAVs in the Netherlands



The Hague Security Delta

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Executive Summary

Recent developments in Unmanned Aerial Vehicles (UAVs), or 'drones'[1], have truly added a new dimension to enabling human activity. While only 10 years ago few had heard of drones at all, today thousands of UAVs roam the skies worldwide. This rapid development has created a lot of anxiety in some quarters, but also much anticipation in others. On the one hand, there is a lot of excitement among those parties that wish to use UAVs, such as public authorities and businesses, as well as among companies that engage in the development of UAV technology. On the other hand, there are serious concerns among authorities and the general public about safety and security in regards to operating UAVs. Most of the public concerns focus on privacy, given that UAVs create a host of possibilities that can lead to the violation of privacy rights. In the Netherlands, as in many other countries where UAVs are an emerging phenomenon, there is a lack of adequate regulations and laws to ensure the safe and commercially profitable use of UAVs. This report lays out which obstacles stand in the way of the successful implementation of such rules, that should to ensure that UAVs can be safely operated in Dutch skies, while creating opportunities for business.

Market Developments

As with many advanced technologies, the evolution of UAVs was initially greatly boosted by military developments. Today, the military is still important in terms of demand for UAV technology, but developers are increasingly starting to cater to private sector needs. The private sector is almost exclusively interested in smaller UAVs, which are most promising in terms of commercial applications. Other stakeholders, such as police and firefighters, are also interested in larger UAVs, in particular quadcopters. Reassuringly, at present, the smallest UAVs cannot be equipped with weapons of any kind.

Markets worldwide find themselves in different stages of development, although the most promising ones among them, including the American, French and British, are still awaiting a veritable take-off; the key factor being a lack of proper regulations. Some countries, such as Japan and Australia, already have a significant head start and have allowed the commercial operation of UAVs for over a decade. Others, such as Canada and France, opened up their commercial UAV market only recently. The Dutch market has clear economic potential, but is awaiting the implementation of a regulatory framework.

Opportunities

UAVs made headlines over the past decade because of their military deployment over countries such as Pakistan, Yemen and elsewhere. But lately, public and political attention has been shifting towards their civilian use. While UAVs still need to meet basic safety standards, it is evident that they have great potential to be used in agriculture, firefighting, city planning, package delivery, etc. In terms of enhancing safety and security, they can also aid police forces with arrest operations, traffic controls, or monitoring suspects.

While Dutch stakeholders seek to learn from these developments, they can also use them as a benchmark for strategically developing a particular niche for UAV technology. Developing specialised drones for security purposes could be one approach. Another could be to focus on agriculture, such as crop dusting, fertilising, assessing the condition of soils etc., and to seek synergies with existing technologies in that field. While developing a UAV industry at home could provide a major economic impetus to the Dutch economy, Dutch businesses could also benefit from synergies, in particular when European airspace would open up as a whole.

Concerns and Obstacles

Uncertainty about how UAV technologies will develop and the increasing number of purposes for which they can be used raises a number of concerns, in particular regarding security, flight safety and privacy. Security-wise, the key issues are the risk of UAVs being used by criminal groups, as well as the potential for weaponising such vehicles in the future. Safety-wise, there are concerns whether UAVs will be properly operated by pilots on the ground, and if accidents and collisions with objects—even mid-air between UAVs—can be prevented. Most prominent are the concerns about violations of privacy. Such worries can arise when police forces operate UAVs, enabling them to monitor suspected individuals for long periods of time, or if this is done by private individuals. The possibility of UAVs facilitating industrial espionage is another worry in that regard.

The principal obstacle to creating a UAV market as well as a safe airspace for UAVs to be flown in the Netherlands is a lack of adequate regulation and legislation. As a result, the commercial use of UAVs is currently prohibited altogether, unless an exemption has been obtained. Such rules also apply to the use of UAVs by the police and other public authorities. This absence of adequate regulations is partly the result of the fact that there has been a lack of clear stewardship of the issue within and between government departments.

Solutions

This report offers the following recommendations:

- Conduct an inter-agency investigation into security and safety risks of UAV proliferation;
- Formulate a whole-of-government policy on UAVs to better respond to issues concerning UAVs;
- Adopt proper legislation to ensure that safety and security standards are respected, but also that they facilitate—or at least not unduly hinder—the development of a market for UAV technology in the Netherlands. The relevant authorities have announced that new regulations are being drafted and will be enacted in 2015;
- Share UAV capacity across government services to ensure the effective and efficient use of UAVs;
- Formulate specific rules for police and fire brigades to enable them to fly UAVs over crime scenes and fires, and to bring UAVs used by law enforcement and emergency services units under the same regime as UAVs used by the armed forces;
- Allocate more flying zones, for instance the areas connected to former military airfields, for conducting experimental, test and training flights to help spur technological development;
- Establish a veritable ‘triple helix’ for UAV development, involving government, knowledge institutes and industry.

Given the speed with which UAV technology develops, and the long history of aviation technology in the Netherlands, the time is now for Dutch businesses to capitalise on the opportunities that UAVs offer.

Table of Contents

Introduction

In recent years, the development of Unmanned Aerial Vehicles (UAVs), or 'drones', has really taken off. Just 10 years ago, few had heard of drones at all. Yet, today, thousands of UAVs already ply the skies the world over. This rapid development has created a lot of anxiety in some quarters, but also lots of anticipation in others.

To examine some of the key questions regarding UAVs and security, The Hague Security Delta (HSD) was mandated by the Dutch Ministry of Security and Justice to provide an assessment of the challenges and opportunities associated with growing use of UAVs. The goal is to contribute to an informed debate about the possibilities for which drones can be used to the benefit of national security and commercial ends, as well as the potential dangers that are associated with their use in society. This report offers a range of practical solutions that aim to improve existing government regulations on UAVs, allowing the development of a nascent UAV industry in the Netherlands, whilst upholding public safety.

Due to their use in military conflicts around the world, UAVs acquired a negative connotation as a result of which there has been wariness about their potential applications. Today however, the discourse about UAVs is rapidly evolving, and they are increasingly being seen in a different light. As novelty among aerial vehicles, it is understandable that in this day and age, in which digital and cyber-based applications increasingly dominate our lives, concerns are raised about the potential downsides to the use of UAVs. However, the myriad purposes to which they can be used, as well as the ever-greater access to UAV technology that people everywhere come to enjoy, make that drones also constitute an opportunity in many respects. The European Commission believes for instance that "[i]n the future UAVs could make it possible to bring giant wind turbines into the air and produce "green" electricity. On the other end of the scale, engineers are working on micro UAVs which could be used to tackle gas or chemical leaks, or which could be programmed to act like bees to pollinate plants."[2]

UAVs were first developed in the defence domain, with the principal aim to reduce the number of military personnel being put in harm's way, as well as to improve the accuracy of strikes against particular targets. This is to underline that drones are particularly well equipped for work that is dull, dirty or dangerous: they can remain airborne for hours on end, and are well suited to access remote and/or inhospitable areas. These qualities have triggered many ideas for developing UAV technology and applications in the commercial realm. But the easier access to such technologies also prompts public agents such as law enforcement authorities to want to acquire such devices.

Today, private and commercial applications have come online in the public domain, featuring the marketing of small-sized UAVs being fitted for doing package deliveries to surveying agricultural plots and beyond. The fact that development and procurement costs have substantially decreased over the years, bringing drones within the reach of private individuals as well, has been a major factor in spurring the proliferation of UAVs.

However, as with other kinds of breakneck developments, there remain concerns about the rapid emergence of UAVs relating to security, safety, as well as privacy. For instance, there have been worries about the potential use of unmanned aerial vehicles by criminal organisations; about the proliferation of drones in the skies as such, and about the potential for domestic spying by private individuals. In the Netherlands, a proper regulatory and institutional framework on UAVs is lacking, but could make a big difference in allaying some of the aforementioned concerns. Additional solutions include the creation of a system for sharing drone capacity; the formation of a single body to coordinate UAV policy at the national level, and

the construction of infrastructure that would enable a network-centric approach for the operation of UAVs, with sufficient data-processing capacity.

The study takes a broad look at the development of UAV technology, markets and regulations, and focuses in particular on the use of such vehicles by civilian parties. The report is structured as follows: sections 1 and 2 look at how UAVs emerged and the criteria by which they can be identified. Section 3 looks at how UAV markets worldwide and in the Netherlands have developed in recent years. In section 4, we look at the opportunities that can be exploited with respect to the technology development and the use of UAVs. Sections 5 and 6 focus on some principal concerns and practical obstacles to achieving a conducive and safe environment for UAVs and their development. Finally, section 7 makes several concrete suggestions as to how to assuage the concerns, overcome the obstacles and capitalise on the opportunities.

'This tremendous growth potential for small-sized UAVs brings numerous opportunities. In addition to performing observation tasks inside buildings, small-sized UAVs can perform a wide array of other useful functions, ranging from package deliveries, through surveying agricultural land and aerial news coverage, to supporting law enforcement in neighbourhood watch activities.'

1 – What are UAVs?

While at first glance it may be obvious, in practice it is not always easy to ascertain what constitutes a UAV and when. According to a simple definition, a UAV is an airborne vehicle without an on-board pilot.[3] However, there are several issues with using such a non-specific classification. For example, should an unmanned aircraft be in the line of sight at all times in order to qualify as a UAV? Another issue is the extent of human control over the aircraft. Depending on whether the vehicle flies on autopilot or not, it may or may not be deemed a UAV. These questions are important as they create numerous problems, not least from a legal point of view. For example, when it comes to defining UAVs in legal terms, which vehicles fall under which category under what circumstances?

1.1 UAVs in all Shapes and Sizes

UAVs come in many forms, shapes and sizes. The broader category of UAVs also includes aircraft that can be programmed to fly autonomously without the involvement of a pilot. A common categorization of UAVs is made by the European Commission, which, incidentally, speaks of Remotely Piloted Aircraft Systems (RPAS) and Unmanned Aerial Systems (UAS). In the EC's definition, RPAS, as the name suggests, are controlled by a pilot from a distance.[4] In the remainder of this study, we will use the term UAVs as synonymous with RPAS. Military as well as civilian UAVs are in operation in almost every country worldwide, while at least 76 countries possess UAV capabilities.[5]

By way of classification, one can distinguish between three broad categories of UAVs: Class I (up to 150 kg), Class II (between 150 and 600 kg) and Class III (over 600 kg). Some of the sub-categories that can be differentiated are Micro UAVs (MAVs), Miniature UAVs (MUAVs), Tactical UAVs (TUAVs), Medium-Altitude Long Endurance UAVs (MALE UAVs), Unmanned Combat Aerial Vehicles (UCAVs), and High-Altitude Long Endurance UAVs (HALE UAVs) (see Table 1).[6]

Broadly speaking, and notwithstanding differences in range, endurance, and capabilities between these types of UAVs, one can further distinguish two major categories[7] of drones: those used for surveillance and reconnaissance purposes, and those that are fitted with weapons to be used in a combat role.[8] But more roles can be identified.[9] Drones designed for combat operations are sometimes referred to as Unmanned Combat Aerial Vehicles, or UCAVs. UCAVs generally refer to high-performance vehicles, capable of high speed, long range and of carrying a heavy weapon load—more or less the equivalent of a manned fighter-bomber aircraft.[10] An example of a UCAV is the experimental Northrop Grumman X-47B, which is being tested by the US Military. Most armed or weaponised drones currently in use are in fact surveillance platforms with provisions for weaponisation, such as the MQ-9 Reaper (see Table 1). Incidentally, this latter one is a type of drone that the Dutch Defence Ministry is planning to acquire.[11] Although an increasing variety of UAVs, both large and small, is becoming available for military and civilian use alike, one can still generally distinguish between drones for military and non-military purposes based on this table. The former comprise Class II and III UAVs, while all others fall into Class I. Larger (cargo) UAVs are being developed for civilian use, but the cost of these systems together with their conventional aircraft-like technical features and flying characteristics, will most likely restrict their use to larger professional (civilian and military) operators. In this study, we will focus exclusively on Class I UAVs, since the vast majority of drones used for commercial, civilian and recreational purposes fall within this category.

1.2 Small-sized UAVs

Small-sized UAVs (Class I), as indicated in Table 1, range from drones smaller than 2 kg up to 150kg. They can be classified according to three categories: small (> 15 and 150kg), mini (<15kg) and micro (<2kg). Within the micro-category, some drones can be so small they fit in the palm of one's hand (see Figures 1 and 3).

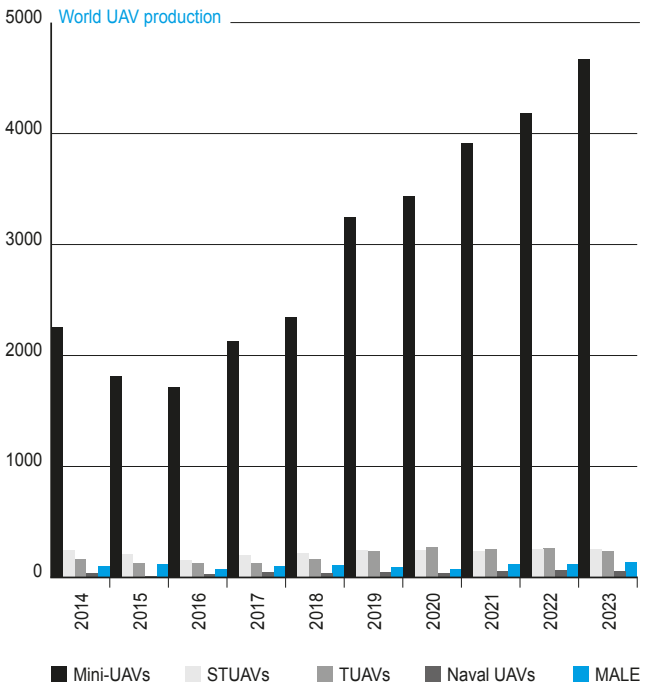
Figure 1 **MeCam Micro UAV.** Source: Gizmag[13]

In terms of production figures, small-sized UAVs, and in particular the mini-UAV category, are expected to dominate the drone landscape in the near future (see Figure 2).

	Category	Normal Military Employment	Normal Civilian Employment	Normal Operating Altitude AGL	Normal Mission Radius	Sensor Suite	Civil Mission	Vehicle
Class III **> 600 kg**	**UCAV**	Dedicated Strike/Combat	NA	Up to 65.000 ft. (20 km)	Unlimited Beyond Line of Sight (BLOS)	Target Acquisition and Designation	NA	Pegasus Phantom Ray nEUROn Skat AURA
	HALE	Strategic/ National Observation	Nationwide Observation	Up to 65.000 ft. (20 km)	Unlimited BLOS	SAR/MTI EO IR	High-Res, Near Real-Time Imagery of Large Geographic Areas	Global Hawk Euro Hawk
	MALE	National/ Theatre Observation and/or Strike	Nationwide/ Regional Observation	Up to 65.000 ft. (20 km)	Unlimited	SAR/MTI	High-Res,	Predator
					BLOS	Ground Search Radar EO & IR Laser Range Finder/ Designator	(Near) Real-Time Precision Imagery Target Identification/ Tracking Facial/ Licence plate Recognition	Reaper Heron Hermes 900 Sentinel
Class II **150-600 kg**	**Tactical**	Tactical Observation and/or Strike	Regional Observation	Up to 10.000 ft. (3 km)	200 km Line of Sight (LOS)	SAR/MTI or EO & IR Laser Designator	High-Res, Real Time Precision Imagery Target Identification/ Tracking/ Designation	Sperwer Aerostar Ranger Hermes 450 Hunter Fire Scout
Class I **< 150 kg**	**Small** 15-150 kg	Tactical Unit Observation Launch System On Site	Regional/ Local Observation	Up to 5.000 ft. (1,5 km)	50 km LOS	EO & IR	High-Res Real Time Imagery Detection/ Vehicle Identification/ Neighbourhood Over Watch	Scan Eagle Phoenix
	Mini < 15 kg	Tactical Unit Observation Hand Launched	Local Observation	Up to 3.000 ft. (900 m)	Up to 25 km LOS	EO or IR	Low-Res Real Time Imagery Detection/ Vehicle Identification	Raven Aladin Altura Zenith Parrot
	Micro < 2 kg	Individual Observation Hand Launched	Local/On site/ Indoor Observation	Up to 200 ft. (60 m)	Up to 5 km LOS	Daylight Color (Video) Streaming	Personal Reconnaissance/ House/ Room Search	Black Widow Black Hornet

Table 1 **UAV Classification**[12]

Figure 2 **World production forecast by UAV type**
Source: World Unmanned Aerial Vehicle Systems, 2014. Teal Group



This tremendous growth potential for small-sized UAVs brings numerous opportunities. In addition to performing observation tasks inside buildings, small-sized UAVs can perform a wide array of other useful functions, ranging from package deliveries, through surveying agricultural land and aerial news coverage, to supporting law enforcement in neighbourhood watch activities. However, it should be pointed out that there are also concerns about the spread of small-sized UAVs. Whilst equipping them with arms is rare but not impossible, they can also be used for espionage, criminal purposes or simply pose a physical danger if they are not piloted properly. Given the rapid growth of the UAV market, this latter point is not a moot one.

Figure 3 **Delfly Explorer** Source: Delfly.nl
An example of an innovative new type of micro UAV is the 'Delfly Explorer' which is currently being developed by Delft University of Technology in the Netherlands. It can be used for exploring buildings, or otherwise cramped and hard-to-reach areas.[16]

'At present, the field of micro UAVs is the most dynamic area of aeronautical development. What was only ten years ago regarded as 'a good idea', but considered out of reach because of practical limitations of available technology, has now become commonplace. It can therefore be expected that once markets open up in the key countries, private sector demand will provide an ever greater boost to UAV markets worldwide.'

2 – A Short History of UAVs

In order to understand where drone technology is heading, and what drives its development, it is instructive to consider how it came about, and how past developments, perceptions and the use of drones help shape their future. The massive attention paid to drones in the media at times seems to suggest that UAVs entered into the public domain only yesterday. However, the opposite is true. Drones have been with us in differing roles for almost a century. This section takes a closer look at the development of UAVs and how they came to play an increasingly prominent role in the public domain.

2.1 From World War I to 1990

Unmanned aerial vehicles are nearly as old as manned flight. Military purposes provided the first impulse for developing UAVs. During World War I several aircraft designers tried their hand at developing and building unmanned aeroplanes. As early as 1915, the US Navy invested in developing and building the Sperry Automatic Aeroplane, or Sperry Flying Bomb. In 1918 the Kettering Bug (see Figure 4) was designed and built for the US Army to attack targets behind enemy lines. Despite their promising potential, they were never used operationally.[17]

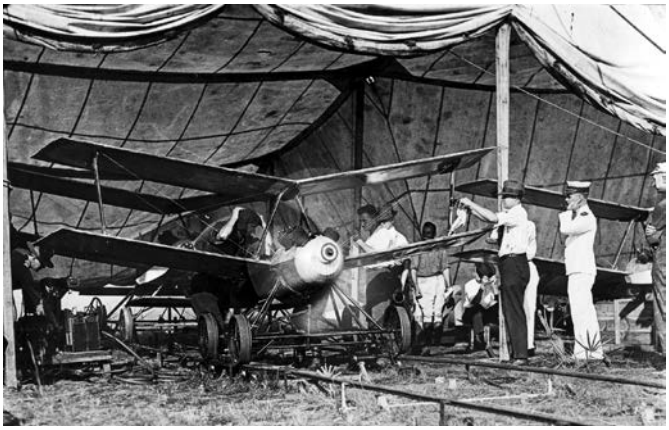


Figure 4 **Kettering Bug** Photo: US Air Force Museum

Nevertheless, the idea was born and would not go away. In the 1930s, the California based Radioplane Company built the Radioplane OQ-2, the first mass-produced UAV. A total of 15.000 aircraft were built for the US Army and US Navy. Based on this success, Radioplane developed and built the OQ-19 (Navy designator 'KD2R') of which a total of 73,000 aircraft were built for customers in 18 countries, including The Netherlands. (See Figure 6).[18] Their primary function was to serve as 'target drones' for anti-aircraft artillery. In Europe the British RAF developed a target drone based on the famous flight-training aircraft, De Havilland Tiger Moth. Known as the DH-82B Queen Bee, it was the first fully produced, full-sized, reusable, pilotless aircraft. The Queen Bee was certainly the first truly successful pilotless aircraft in Europe with nearly 400 being manufactured over several years after 1935.[19]

The great breakthrough for reconnaissance UAVs came with the war in Vietnam. Although the USAF had already shown interest in a reconnaissance version of the O-2 Firebee II, now re-designated A/BQM-34 (see Figure 5), it was not until the mid-1960s that the USAF began using this version extensively in South-East Asia. In the late 1960s and early 1970s, both the US Navy and US Air Force expressed interest in weaponised versions of the A/BQM-34. However, some high-ranking USAF officers saw the UAV as 'competition' to manned aircraft. As a consequence, no funds were approved for further development of UAV technology.[20]

Figure 5 **BQM-34 target drone** Photo: US Navy

2.2 1990s-Present

It was not until 1991 that a truly integrated UAV programme, centred on the MQ-1 Predator, was launched, inaugurating the age of unmanned systems. Until that time, much use was made of space-based systems, but these generally lack the real-time flexibility and imagery precision that UAVs have.[21] Only since the Balkan wars, and especially during Operation Allied Force in 1999, have UAVs really started to catch the limelight—both in terms of their military effectiveness as well as their questioned status under international law when used in targeted killings. In contrast to earlier conflicts, modern high-flying UAVs are largely impervious to surface-to-air attacks. The use of the Predator and Reaper in particular has become so critical to the war effort "that they fundamentally changed the nature of air combat in peace-keeping operations against insurgent forces."[22]

Since the use of UAVs enables the deployment of lethal weapons without consequences for the party that uses them, they also raise moral and legal questions. In some respects, this debate has also spilled over into the realm of private and commercial use, albeit that it becomes ever clearer to all stakeholders that both in terms of nature and use, UAVs used for civilian purposes present a qualitatively different proposition, and thus require a different approach in terms of thinking about safety and security.

While until the beginning of the 21st century almost all UAVs looked more or less like small-sized fixed-wing aeroplanes, new technological developments would make them look more like 'brainy birds'.[23] The commercial sector discovered the huge potential of this development, given the capability of UAVs for search-and-rescue, firefighting, law enforcement, journalism, disaster response, agriculture, wild life control, real estate business, and other kinds of operations.[24] Due to the miniaturisation of technological devices such as the smartphone, UAV technology and model airplane technology have become increasingly merged. Mass production of miniaturised computers, sensors and GPS equipment led to the present generation of multi-copter UAVs.[25]

At the same time, technological developments in the military realm continued to be important drivers for private sector applications. For instance, the use of micro UAVs such as quadcopters — which have great potential in the private sector — were first pioneered in the US Army.[26] At present, the field of micro UAVs is the most dynamic area of aeronautical development. What was only ten years ago regarded as 'a good idea', but considered out of reach because of practical limitations of available technology, has now become commonplace. It can therefore be expected that once markets open up in the key countries, private sector demand will provide an ever greater boost to UAV markets worldwide. It is expected that civilian use of UAVs will outgrow military use in the near future. Growth will be defined by the pace of development of UAV technology and the adjustment of aviation laws and regulations, and it will be driven by demand for small UAVs from across a range of lucrative sector applications.[27]

Figure 6 **Northrop (Radioplane) OQ-19** Unmanned aerial target-towing aircraft for anti-aircraft artillery, used around the 1960s.
Source: Historische Collectie Grondgebonden Luchtverdediging (HCGLVD), Venray, Netherlands

'Full integration of UAVs into European airspace would not only be a boon for companies, but it could also provide an additional boost to employment figures. The EU projects that this could lead to adding up to 150,000 jobs to the European economy in 2050. What is more, Europe is already in an advantageous position given that out of an estimated 471 UAV manufacturers worldwide, some 176 are European.'

3 – The Emerging Global UAV Market

A wide variety of different factors have contributed to the rapid growth of UAV markets worldwide, and account for the even greater potential that can be exploited once airspace in national jurisdictions will open up in the years to come. Out of all the factors that play a role, there are two that stand out: developments in UAV technology itself, and the prospect for efficiency gains in business procedures. This chapter analyses both relevant developments on a global level, as well as in several important national markets.

3.1 Global Developments

Technological improvements have made a big contribution to bringing UAVs within reach of private and commercial partners. First, exponential growth in the power of silicon chips, digital sensors and high-bandwidth communications has led to significant improvements in the capabilities of UAVs. Of particular importance has been the miniaturisation of technology in general, combined with the increase in computing power and sensor technology that can be bought at a given price.[28] Secondly, the cost of production of UAVs has come down significantly, in particular in the small and micro segments, which are of specific interest to the private sector. As a result of these factors, small-sized UAVs are increasingly viewed as an effective and low-cost alternative to manned aircraft.[29] The use of UAVs can help reduce production and operating costs, for instance for companies with large open-mining operations. UAVs are also instrumental in reducing work-related safety hazards, and can contribute to increasing production and competitiveness of businesses.[30] As a result, many countries are acquiring UAV capabilities.

Whereas by 2004, approximately 41 countries had acquired UAVs, Figure 7 demonstrates that the number of countries with UAV capabilities (including both civilian and military capabilities) has roughly doubled within the seven years that followed.[31] By 2012, virtually all economically important countries possessed UAVs.[32] Although the majority share of these investments is still directed at the defence industry, the share of investments aimed at the civilian market is growing steadily (see Figure 8), and promises to be one of the fastest growing segments in the next decade as access to national airspace becomes more available.[33] At a global level, some estimates place the value of the market for civilian unmanned systems between €43 billion and €48 billion per year by 2020.[34]

Looking specifically at the market for civilian applications, the 2013 edition of the *Aerospace America Global UAV Roundup* lists a total of 57 countries and 270 companies, which are collectively responsible for the production of more than 960 different types of UAVs. In 2011, these numbers were significantly lower: 44 countries, 226 companies and

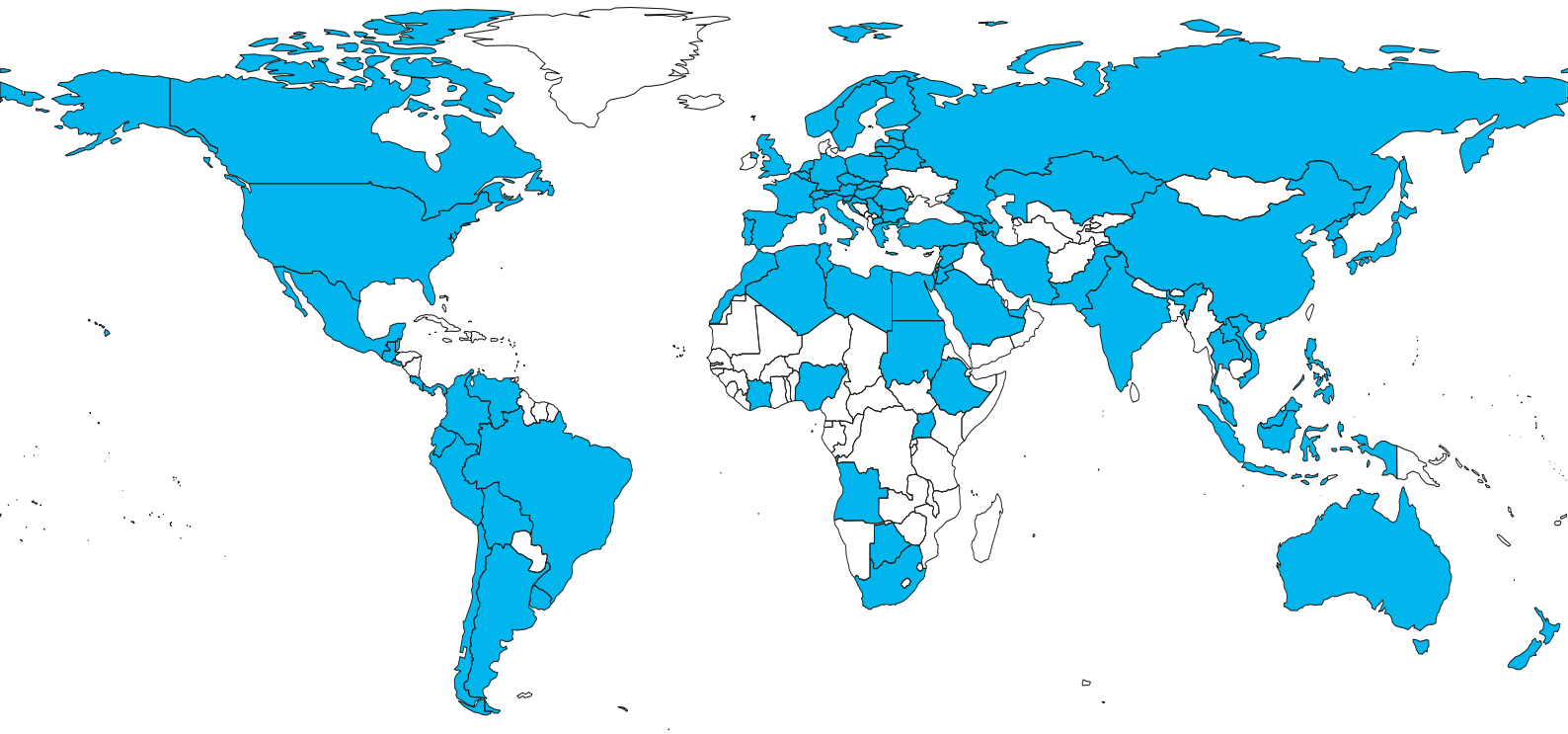


Figure 7 **Map of countries that acquired UAV capabilities by 2014** Sources: US Government Accountability Office (GAO), own research.

675 types of drones. Compared to 2011, the number of countries producing UAVs grew by about 30%, the number of companies by 20%, and the number of different aircraft produced by over 40%.[35]

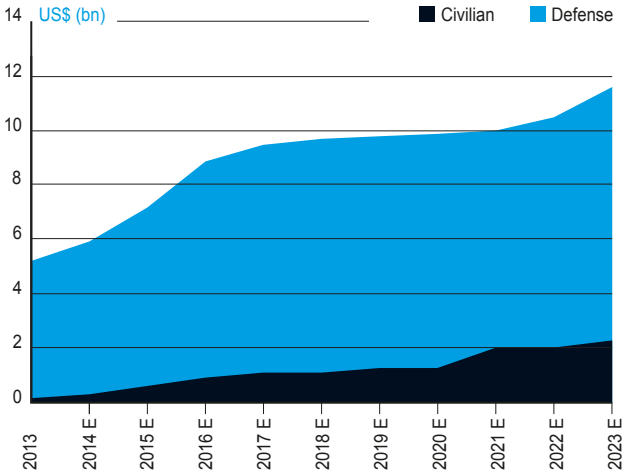


Figure 8 **Global Aerial Drone Market Forecast until 2023**
Source: Teal Group, Michael Toscano, BI Intelligence estimates

Put differently, 12% (US$ 11,76 billion) of an estimated US$ 98 billion in cumulative global spending on aerial drones over the next decade will be aimed at civilian applications.[38] Within the civilian market, Teal Group expects the largest single portion over the next decade to be shaped by non-military government use of UAVs. This is due to the easier access to airspace for governmental UAVs, as well as the higher value of those UAVs compared to small-sized UAVs operating in the commercial market.[39]

Teal Group further estimates that investments in the UAV industry will nearly double over the next decade from a current US$ 6,5 billion annually, to US$ 11,5 billion.[36]

A sign of the industry's rapid growth is the number of unmanned aircraft designs registered with UVS international, a non-profit society that promotes unmanned systems. Between 2005 and 2011, the number of registered unmanned aircraft designs more than doubled. Whilst "most air-based reconnaissance systems are currently used for military purposes, it is the civilian and commercial use of UAS which has shown the strongest growth during this period."[37]

At present, the global UAV market is dominated by North America. A projection of the global UAV market by region in 2017 conducted by Eurosmart lists Europe as the second largest market with a 15% share of the global market, against 66% for North America. American dominance is further illustrated in projections carried out by Teal Group, which place the USA far ahead of other regions in the world when it comes to the production of UAVs (see Figure 9).

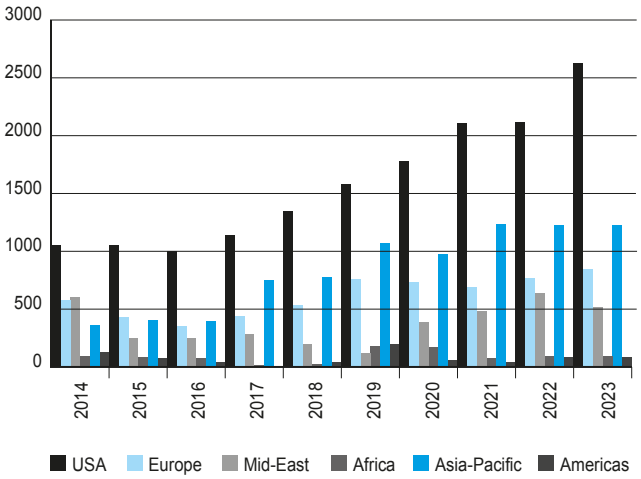


Figure 9 **World production forecast by region (UCAVs excluded)**
Source: World Unmanned Aerial Vehicle Systems, 2014. Teal Group

This image is no different when it comes to R&D expenditure. Figure 10 shows the relative distribution of total R&D expenditure on Unmanned Aerial Systems (UAS) in the period 2011-2020. Compared to the US, China and Israel, Europe lags far behind. This is painfully illustrated by the fact that in the period 2011-2020, Israel's share of total R&D expenditure is expected to equal that of Britain, France, Italy and the pan-European initiatives combined.

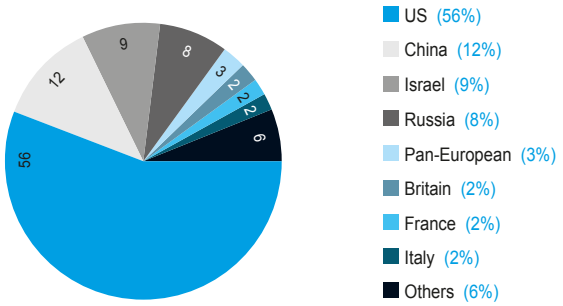


Figure 10 **Rise of UAS - R&D by country (%) 2011-2020 forecast**
Source: IHS Industry Research and Analysis; Teal Group

3.2 Development in the Netherlands

At present, there are no established figures on the size of the Dutch UAV market, nor on the number of customers being served at home and abroad. There are, however, several companies active in this area, among them multiple start-up ventures. According to the Dutch Association for Remotely Piloted Aircraft (DARPAS), there are as many as 200 companies active in this field in the Netherlands today, many of which are small-sized.[40]

Whilst there are many companies active in this area, there are currently only seven permits in force, one belonging to a research institute and one to a foreign company. Four of the remaining five permits belong to DARPAS members. Some 20 Dutch companies currently enjoy a project permit, on the basis of which they can receive approval for a single project from the *Inspectie Leefomgeving en Transport* (ILT, Inspectorate for Living Environment and Transportation). Five organisations enjoy limited permits to undertake training exercises with drones.[41] Although a sizeable majority of UAV operators in the Netherlands is not complying with or unable to comply with legal and regulatory requirements, only few operators have been fined so far.

In terms of market potential, demand from the private sector is expected to be the main driver in the diversification in applications of UAV technology the coming years, the main beneficiaries being agriculture and inspection services. Demand from public bodies such as police and fire departments is potentially important; however, it will less likely become a real market driver because decision-making procedures on use and procurement of UAVs are time consuming. Hence, it is the private sector that will have to provide—and is providing—an impetus to the development of the Dutch UAV market as a whole. At the same time, the Dutch government noted that the defence sector should be involved in research into civilian applications of UAVs, if only because this sector has extensive knowledge and experience that can be drawn upon for civilian purposes. The result could be 'dual-use' application of UAV technological expertise.[42]

3.3 Market Developments Elsewhere

United States

Although the United States commercial market for drones is relatively less advanced compared to some other countries, it dwarfs all other markets worldwide in terms of investments, both real and potential. This is because while the FAA has closed American airspace for UAV trial flights, there is a lot of investment potential in this sector. The restrictions on private exploitation of UAVs make that today, "[t]he vast majority of civil UAS operations in the US are performed by government agencies."[43]

Defence spending still dominates investments into UAV technology in the United States. In spite of reports that defence spending on drones is decreasing[44], total spending was around US$ 3bn in 2012, according to *The Wall Street Journal*.[45] US trends thus appear to buck global trends, since in the coming decade, global military spending on drones will in fact surge ahead of commercial/civilian spending, the latter making up 8.7% of total spending in 2011. By 2020, figures are projected to be around 5.64%.[46] The opportunities presented by the drone industry have also attracted significant investments. Another study, conducted by PricewaterhouseCoopers and the National Venture Capital Association, concluded that US venture investors had poured US$ 40,9 million into drone-related start-ups in the first nine months of 2013, more than double of what they invested in all of 2012.[47]

The economic impact of an opening up of the UAV market in the US is projected to be significant. A recent study by the Association for Unmanned Vehicle Systems International (AUVSI) concluded that by 2025, the UAV market would have added over 100,000 jobs to the American economy, and generated an economic impact of around US$ 80bn between 2015 and 2025.[48] What is more, many of the jobs to be created are expected to be aimed at people with bachelor degrees or higher, earning salaries of over US$ 40,000. Another remarkable finding of this report is that it estimates that the biggest growth potential lies above all in agriculture, and secondarily in public safety activity. While the agriculture market is projected to be about ten times the size of the public safety market, together they will likely account for about 90% of 'known potential markets.'[49] Although contested for its pro-industry bias and methodology, the report nevertheless serves as an indicator of the potential of the domestic UAV market in the US.[50]

As in the Netherlands, in the US there are also calls for forging 'an interagency UAV research and development strategy'.[51] This is not only important in terms of spurring development, but also to stay ahead of the curve compared to market developments elsewhere. A recent report by the Stimson Centre acknowledged that "[t]he state that becomes the 'first-mover' to fully integrate UAVs into their national airspace may, if given enough of a lead, become a centre for the development and sale of UAVs, giving a competitive edge to its domestic manufacturers". While as such, this is a relatively minor consideration, the report also adds that from a military perspective, this gives rise to a potential worry: "If another state gains such an advantage, the US would then be in a position of playing catch-up in terms of establishing its market for commercial UAVs, restoring American manufacturers' edge on the global market, and ensuring US military UAVs remain technologically more advanced than those of other nations".[52]

In terms of rules and regulations, the FAA is currently in a review process, soliciting comments to the newly proposed drone regulations. Until recently, drone use for commercial purposes was banned altogether, while only the Department of Homeland security was authorised to use drones for security purposes. However, under strong pressure, the FAA decided to adjust its regulations, and allowed the first commercial drone flight in July 2014. For the time being, waivers will be granted under exceptional circumstances.[53] The new rules that are currently under review are expected to enter into force by September 2015.

But it is already admitted that regulations will not be able to keep pace with technological development, leading many concerned states to restrict the use of drones ahead of pending

federal legislation: “While Congress has been slow to pass legislation regulating UAVs, states have responded much more quickly in restricting the scope and use of unmanned aircraft. Since early 2013, 13 states have passed legislation which range from a moratorium on UAVs to prohibiting a person from using an unmanned aircraft system without first obtaining a warrant, according to Farber. In 2014, new rules were introduced in 26 states (see Figure 11).”[54]

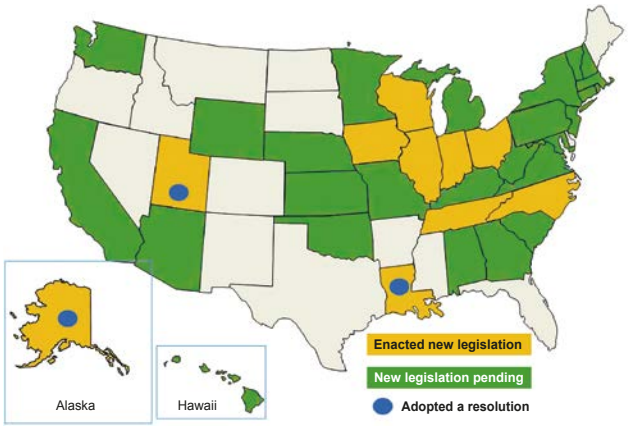


Figure 11 **States with UAV laws on the books**
Source: National Conference of State Legislatures[55]

Israel

In Israel, the development of the drone market continues to be highly influenced by developments in the defence sector. Since possibly half of all flights executed by the Israeli armed forces are now done with drones, the domestic military market is becoming saturated. This means that the commercial market is the area where strong growth can be expected in the coming years.[56]

Israel is already the largest exporter of drones and drone technology according to one recent report.[57] One reason for this is that, unlike the US, Israel does not have very strict export limitations. Interestingly, Israel exports many drones for non-military use to Brazil, which is now at the forefront in the use of drones for commercial or civilian purposes worldwide.

Europe

In view of the rapid developments in the market for UAVs, the EU has taken the initiative to start creating rules not just to regulate the use of drones across Europe, but also to promote integration between countries so as to forge a single European market for UAVs, the goal being that “UAVs should be able to fly like ‘normal’ air traffic and be integrated among ‘normally piloted’ aircraft in non-segregated airspace, i.e., airspace open to all civil air transport.”[58] To this end, the Commission issued a roadmap in 2014 for integrating UAVs into European airspace by 2016.[59]

The EU recognises the great potential of civilian use of UAVs: “Just as the internet technology in the early nineties gave rise to many different applications, UAV technologies should lead in the coming years to the development of a wide variety of different services, especially if combined with other technologies (…). Experience shows that markets can rapidly develop once an enabling policy framework is adopted. The number of Japanese UAV operators was multiplied by 18 to about 14,000 between 1993 to 2005, with a spectacular increase after the entry into force of regulations on agricultural use.”[60]

At this stage, the EU acknowledges that although “[a] number of Member States have started developing national rules to facilitate this authorization process, […] in the absence of European standards, to be developed by EASA, a true European Market will not emerge, hampering drastically the development of this sector.”[61]

In its approach, the EU appears ambitious: “[t]he regulatory framework should reflect the wide variety of aircraft and operations, keep rules proportionate to the potential risk, and contain the administrative burden for industry and for the supervisory authorities. The regulatory framework would first focus on areas where technologies are mature and where there is sufficient confidence. Regulatory measures will be introduced step by step and more complex RPAS operations will be progressively permitted.”[62] Hence, the Commission wants to adopt a ‘flexible approach’, and not apply the same rules to all unmanned aircraft, or issue regulations that will apply rigidly for an indefinite period of time.

An earlier ‘roadmap’ by the European RPAS Steering Group, issued in 2013, included a target year of 2028 for the full integration of drones over 150kg into commercial airspace. Regulations for drones below 150kg are generally handled by Member States themselves.[63] The main rationale behind the newly proposed policy is to push for a coherent action plan to remove regulatory and technical barriers that currently limit the flight of drones in civilian airspace.[64] Civilian drones are foreseen as key to Europe’s plans for immigration control and may become a key tool not only for Frontex but also for EUROSUR, the European Border Serveillance System, which seeks to incorporate drones and other sensors, radars, satellite imagery into controlling EU member states’ border surveillance systems.[65]

Full integration of UAVs into European airspace would not only be a boon for companies, but it could also provide an additional boost to employment figures. The EU projects that this could lead to adding up to 150,000 jobs to the European economy in 2050.[66] What is more, Europe is already in an advantageous position given that out of an estimated 471 UAV manufacturers worldwide, some 176 are European.[67]

United Kingdom

While there are no definite figures about the size of the commercial drone market in the UK—the present estimate puts it at 200 operators[68]—there are various initiatives under way that seek to make the UK a key country in the global UAV market. The most significant among these is the ASTRAEA flagship research programme, which received public funding of £32 million matched by the private sector. ASTRAEA sought to develop the technology necessary to allow routine drone flights in domestic airspace. Another boost is expected from the launching of the National Aeronautical Centre in Wales.[69]

In spite of these developments, the responsible agency, the Civil Aviation Authority (CAA), has put a ban on all UAVs that weigh over 20kgs to fly in civilian airspace. For smaller drones, restrictions apply: the vehicle must be within eyesight at all times, not fly above 400 feet (about 120m), and the purpose must be non-commercial. Current regulations do not stipulate the need for certification; however, it is the responsibility of the pilot of the vehicle to ensure that it is operated in a safe way.[70] Since UAVs are not allowed to be operated in or near urban areas, or near airports, they have mostly been used in the countryside.[71]

France

In 2012, France became the first country in the world to adopt regulations enabling privately-owned UAVs to be flown, producing a dramatic increase in licensed operators.[72] Recent reports show that over 600 operators are active.[73] Since 2013, manufacturers, operators, and stakeholders in the French civilian UAV industry have decided to unite to create the Fédération Professionnelle du Drone Civil (FPDC) (Professional Civilian UAS Association).[74] This association supports the growth of this innovative industry.[75]

As a result of this early lead, some of the small ventures are already attracting large customers. An example is construction company Monnoyeur, which together with a UAV operator called Redbird, concluded a contract to support public works for SNCF, the French national railway company.[76] What is more, the French government, aware of the early lead that it has in this field, has put a policy in place to consolidate its headstart. It has made drone technology one of the 34 focal points for economic comeptitiveness (pôle de compétitivité), which will, among other measures, expand the number of test areas.[77] However, some observers have doubts whether France will be able to maintain this lead, as its legislation is allegedly framed around the more cautious principle of 'prudence' (précaution), while the upcoming American legislation is based on the principle of 'innovation.'[78]

Germany

Given that drone development in Germany is only of recent date, no accurate figures are available about its current market size, albeit that one report estimates the number of operators to be around 400.[79] Nor is there much known about future growth projections or niches in which technological developments are taking place, although some companies have been able to market their products abroad, including Bavaria-based Astec, Hesse-based Aibotix and Microdrones, also from Hesse.

Until recently, there was no legislation in Germany governing drones. This changed however with alterations of aerospace legislation in 2012 and 2013. Today, drones may be flown for commercial or civilian purposes if they weigh no more than 25kg and do not fly above 100m. At the same time, they may not be flown above people, and the vehicle must remain in eyesight at all times. In addition, individual permits are required. Beyond the requirements above, checks will also be made with the owner of the land from which the flights are to take place and with the local public order office.[80] If an aircraft weighs less than 5 kg, rules for model planes apply, and restrictions are far fewer.[81] However, companies using commercial drones weighing up to 5 kg must apply for a flight permit from the relevant federal state authority (§ 16(1) no. 7, German Aviation law). What is more, a specific kind of insurance for third-party liability needs to be obtained as well.

Other Markets

Beyond these key markets, there are many more—some of which are rapidly evolving. Among the most advanced markets are Australia and Canada. By mid-2014, Australia had 94 UAV operator certificate holders that are involved in projects in aerial photography, surveillance of power lines, spotting, and crop applications. Canada for its part already established two test centres in 2011, which have been in operation for two full years.[82]

On the other side of the globe, the Japanese government has been very active for over ten years in pushing a domestic drone market, and gained extensive experience with operating UAVs. Having disavowed the building up of a full-fledged military, Japan has many more commercially operated than government-operated UAVs in the skies. One of the areas in which this technology has come to be used extensively is the crop spraying industry.

In some markets, such as Russia, China and the UAE, growth is predominantly driven by military need and investments into related technology. In other countries, specific niches are providing lots of opportunities. For instance, large agricultural nations with lots of inaccessible areas such as Brazil can draw great benefits from UAV technology.[83] In terms of technological development, innovation is rapidly spreading across the world. Among the key players are Brazil's Embraer, Canada's Bombardier and Japan's Mitsubishi and Yamaha.[84] Hence, in spite of current American dominance of the market in terms of technological development, UAV technology is rapidly becoming a truly global affair.[85]

'UAVs have great commercial potential mainly because of their ability to gather data. In essence, they provide a platform for carrying sensors and engaging in data analysis. Hence, there is a lot of potential for synergies with big data applications including advanced camera technologies.'

4 – Opportunities for Using UAVs

While UAVs have been used for a long time exclusively in the military domain, the market developments discussed in the previous chapter make clear that UAV technology and its applications are rapidly spreading to other domains. This accelerated growth of the UAV industry has prompted both public authorities and commercial entities to explore further opportunities for using drones. Public authorities are particularly interested in how UAVs can be used to enhance national security and safety. Commercial entities are looking for ways in which UAVs could raise the efficiency of their business operations.

4.1 National Security

From the viewpoint of national security, UAV technology offers a wide range of opportunities (see Figure 12). Although by no means exhaustive, the sections below provide a number of examples of how UAVs could be used to the benefit of national security.

Law Enforcement

When in pursuit of suspects, law enforcement units can use UAVs for observation, tracking and identification purposes. Also, the police can benefit from such aerial observation when tasked with surveillance operations. According to Rob de Wijk, Director of HSD, "it is an interesting question therefore to ask whether the siege of the Dutch 'Laakkwartier' in The Hague of November 2004 would have proceeded differently if the police had had such UAVs at their disposal. It is conceivable that the direct impact on the residents in the area of similar operations in the future would be far less, whilst also requiring fewer police units."[86]

In 2012 and 2013, Dutch law enforcement units requested the use of the Army operated 'Raven' drone twenty-one times in total.[87] In July 2013, new legislation was proposed—and subsequently adopted in April 2014—to allow law enforcement authorities at the municipal level in the Netherlands to use UAVs for crowd control purposes.[88] One advantage of using UAVs for these ends is that they require significantly less manpower than traditional methods, and help reduce costs as a result. However with the current ban on professional use of UAVs still in place, such use will be restricted to the occasions where temporary exemptions are granted.

Long Distance Patrol and Continuous Surveillance

Long distance patrol and continuous surveillance with UAVs can help the border police and coast guard in their patrolling duties. UAV surveillance cannot only help bust smugglers, but it can also track maritime traffic patterns or illegal fishing operations.[89] For example, the US established an operation centre of Predator UAVs in the fight against drug trafficking in Honduras. The centre provided 24-hour coverage of the western half of the Caribbean for three months. UAV operators collaborated closely with Nicaraguan patrol boats that on a regular basis intercepted and arrested smugglers. Over the three months period of operations, a total of 2162 kilograms of cocaine was seized, resulting in 57 arrests.[90]

UAVs can also act as an effective tool in promoting nature conservation. In 2012, a South African defence manufacturer Denel Dynamics provided a drone to park rangers in Kruger National Park, which had helped them track down poachers.[91] The World Wide Fund for Nature (WWF) and its partners in Namibia are currently implementing bungee-launched UAVs in some of the country's national parks to help park rangers detect poaching activity. A similar project is underway in Nepal to counter illegal poaching and logging.[92]

Crisis Response

UAVs can be highly valuable in the immediate aftermath of severe crises and natural disasters. For example, UAVs equipped with Synthetic Aperture Radar (SAR) or Infrared (IR) devices can be used to scan large areas of land for missing persons, or for large-scale search and rescue missions following a natural disaster and thus enlarge the reach of emergency services.[93] Similarly, in the event of a plane crash with debris scattered over a large area, overhead surveillance with UAVs can help in locating potential survivors and strengthen the capacity of emergency services. Equally, in the event of a nuclear disaster, UAVs equipped with radiation and/or substance detection devices can be used to carry out environmental mapping in hard-to-reach areas where the extent of contamination is yet unknown, thus limiting the risk of needing to confront health hazards.[94] Finally, UAVs also offer logistical benefits to emergency services. Data gathered from UAV surveillance can be used to regulate traffic flows, re-route vehicles and respond swiftly to emergencies for a fraction of the cost of piloting a helicopter.[95]

Public and Personal Safety

UAVs can also play a role when it comes to enhancing the safety of people on the ground. Fire fighters, for example, are dangerously exposed when fighting forest and industrial fires. In Spain, the Andalusian authority for the management of wildfires uses UAVs equipped with infrared sensors to track wildfires at night. Fire departments could use it for exploring buildings that are at risk of collapse, and thus keep firefighters out of harm's way.[96]

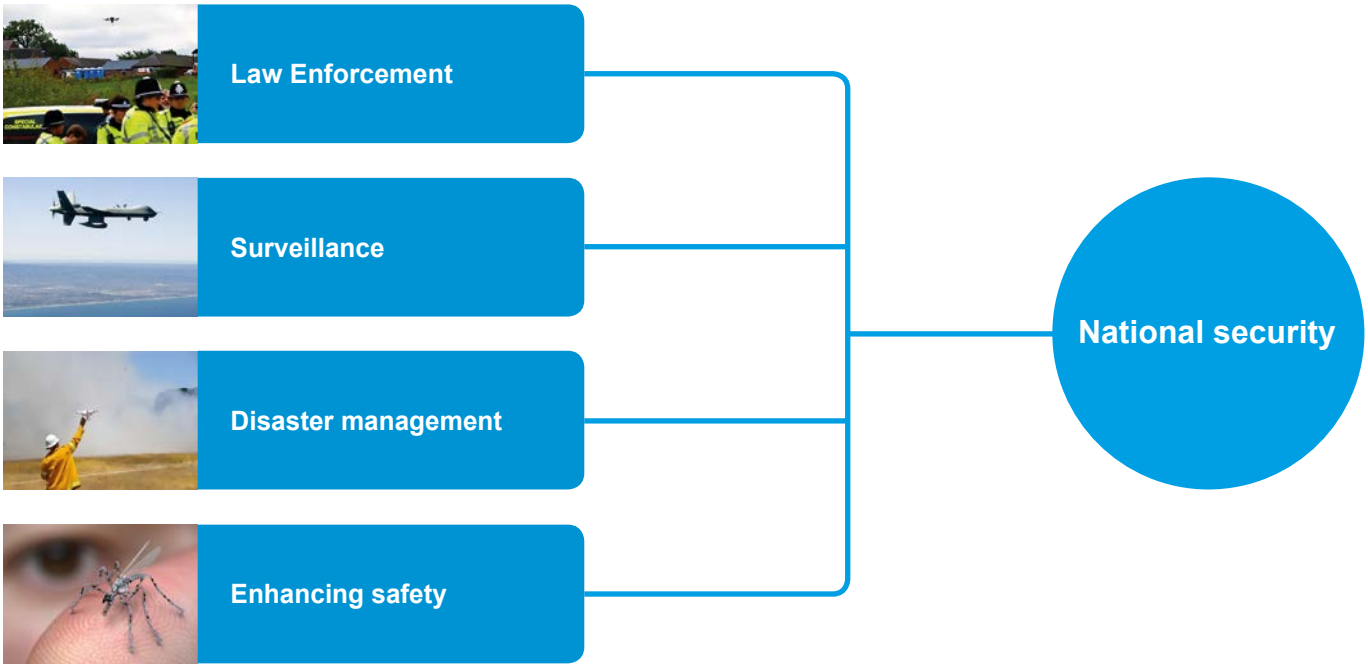


Figure 12 **Opportunities for using UAVs (national security and commercial uses)**

The fire that took place at Chemie-Pack in the Dutch area of Moerdijk on 5 January 2011 was one of the largest industrial fires ever to take place in the Netherlands. Wilbert Kleijer of the Dutch fire department said that "in fighting such a large (industrial) fire, I believe my colleagues could have benefited greatly from the use of small-sized UAVs in order to create a full overview of the disaster area. Had we had such a view of the fire and the surroundings via UAV imaging, we probably could have responded differently to the fire, we could have been more efficient and it could have required significantly less manpower in dangerous operating conditions."[97]

The use of small-sized UAVs can greatly enhance situational awareness and provide timely information on the development of a fire.[98] Delft University of Technology in the Netherlands developed such a micro drone that is capable of flying into and within buildings. The 'Milfly', as the drone is called, can be used for a variety of tasks. The police could use such a drone for example for surveillance purposes in buildings where a hostage situation is taking place.

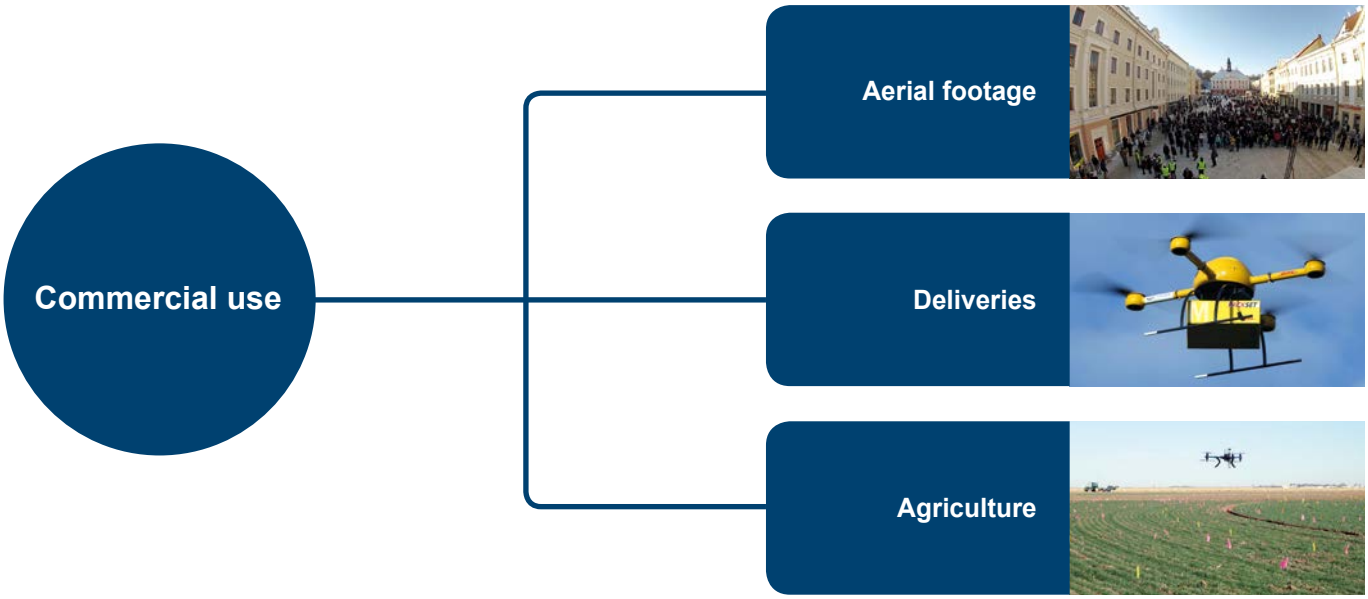
4.2. Commercial Use

Out of the three classes of UAVs (see Table 1, page 14), Class I and Class II drones show the biggest potential to be used for commercial applications, in view of their lower weight and easier controls when compared to the much larger and heavier Class III UAVs. UAVs have great commercial potential mainly because of their ability to gather data. In essence, they provide a platform for carrying sensors and engaging in data analysis. Hence, there is a lot of potential for synergies with big data applications including advanced camera technologies.[99] From a business perspective, the projected growth of the commercial market also offers ample opportunities for companies that are keen to take part in the development of commercial drone applications. This would be good news for a European and Dutch economy which is slowly emerging from a deep economic crisis. Figure 12 lists a number of different applications that can be thought of when using UAVs for commercial purposes.

Aerial footage

UAVs were extensively used during the Sochi Olympic Winter Games to produce aerial footage of the numerous sports events. Given the lower operating costs of a UAV compared to that of a helicopter, and the greater flexibility over a cable-suspended camera system, UAV coverage of sports events is likely to increase firmly in the coming years.[100] Step by step, small-sized drones are making their way into all types of sports. In American Football for example, UAVs are being used to create images of game play in action, both for TV as well as for analysis and training purposes.[101] In the Netherlands UAVs are being tested for this very purpose.[102] Another sport where small-sized UAVs are making inroads is rock climbing. One of the advantages of using UAVs to capture images of rock climbing is that compared to helicopters, UAVs have a lower risk of to cause dust, snow or wind that might push a climber off balance.[103]

UAVs also lend themselves well to be used for aerial news coverage. So-called 'drone journalism' has seen a veritable rise in recent years. Many of the images capturing the protests in Kiev, Bangkok and Venezuela, and forest fires in Australia in recent years, were taken by means of hovering



UAVs. Moreover, using drones to perform this kind of tasks enables journalists to overcome logistical hurdles, whilst staying out of harm's way and still being able to provide eye-catching pictures. At the same time, it makes it harder for governments to deny access to journalists.[104] Finally, aerial footage can also be beneficial for urban planning purposes, or maintenance of public works. Interestingly, municipalities in the Netherlands often use commercially-owned UAVs for this purpose.[105]

Aerial Deliveries

In late 2013, the online retailer Amazon announced it was testing UAVs to perform deliveries.[106] It was swiftly followed by a similar announcement by DHL, the German express delivery company, which in September commenced deliveries by drone to an island in the North Sea.[107] Soon after, however, Amazon's ambitious plans were dashed by the US Federal Aviation Administration (FAA) which ruled 'model aircraft' unfit to be used for 'delivering packages to people for a fee'.[108] Current FAA regulations ban flying drones for commercial purposes in the US, which means it is unlikely that we will witness large-scale drone deliveries anytime soon.[109] That said, however, more and more companies and individuals around the world are campaigning to get the drone delivery idea off the ground.[110]

Unmanned Cargo Aircraft (UCA) constitute an interesting development in this regard. UCAs are expected to be cheaper to operate and more productive than small manned cargo aircraft. There are many areas worldwide that are deprived of high-quality transport either because demand is too low, or because of limited ground infrastructure. In the future, UCA could for example allow companies in Central and Eastern Europe, which are currently constrained by the lack of proper ground infrastructure, to export their goods through small UAV airfields to Western European or American markets. Similarly, small companies in China that are far away from the major urban centres could sell their goods via the internet to customers in Europe by using small UAV airports for export purposes. At the moment, UCAs are not capable of shipping cargo volumes large enough to create an alternative for existing forms of transport. In the future, however, UAV technology could be beneficial to companies wishing to transport goods when faced with inadequate transport infrastructure.[111]

Agriculture

Today a lot of farmers still 'walk the field' to survey their crops. Farmers with vast estates likely would want to use manned aircraft or even satellite imagery. However, such methods are often deficient because of image quality in combination with high altitudes, and/or due to the fact that they are time consuming and costly. Analysing data can take a long time which puts crops at a higher risk in the event of a rapid disease outbreak.[112]

UAV technology could be a good solution to tackle these issues. In the US, Japan and Brazil, farmers are already using UAVs fitted with cameras to monitor crops, check for diseases or to precision-spray pesticides and fertilisers. Other tasks for which UAVs can be used include warding off birds from fields, pollinate trees, do snow surveys to forecast water supply, monitor irrigation, or plant and harvest crops.[113] Farmers can also use UAVs to optimise the use of pesticides, herbicides and fertilisers based on how much is needed for particular area, thus saving money and lessening the impact on the nearby streams and rivers caused by runoff.[114]

'... there are worries that drones can be used by individuals to spy on others. Some on-line electronic equipment shops already sell drones fitted with cameras that can upload their pictures directly onto Facebook or Twitter. The increase in the use of UAVs by private individuals has already led to the development of technology to track whether one is being followed by a drone.'

5 – Concerns over UAV Proliferation

In public discussions about UAVs, concerns about their use have frequently dominated the discourse. In some respects, this is not surprising given that global public awareness about drones only truly emerged in the wake of aerial strikes with UAVs by the US government in its war against terrorism in Pakistan, Afghanistan, Yemen and elsewhere. Some of these concerns have also percolated into discussions about drones used for civilian purposes, for instance regarding the extent to which damage could be done to persons or goods, up to the point of—accidentally—killing someone. Another issue concerns the extent to which the use of drones could lead to violations of basic rights of civilians. Thirdly, concerns focus on potential proliferation of UAVs if their use remains unconstrained and the unintended consequences such proliferation could have.

To a large extent, these and other security, safety and privacy concerns can likely be mitigated if and when proper legislation is in place and enforced. That said, the rapid technological development and the ever-increasing scope of applications for which UAVs can be deployed make that continued vigilance and the need to monitor the effectiveness of existing regulations is warranted regardless.

5.1 Security

Different security issues are at play when it comes to the commercial and private use of UAVs. The most serious concern would be whether or not Category I UAVs could be used for lethal purposes. Today, however, there are no drones available on the market, in the Netherlands or abroad, that fall into Category I (i.e. the only category in which UAVs for commercial use fall) that have an ability to use lethal force. However, this is not to say that UAVs cannot eventually be—illegally—equipped for such purposes. Moreover, it is also conceivable that UAVs could be used as instruments to facilitate lethal operations, even if the UAVs themselves do not carry shooting instruments.

A second security concern relates to the adverse ways in which UAVs can be used by third parties such as criminal groups. For instance, drones have been used for drug smuggling in countries such as Ireland[115], Colombia[116], and Brazil.[117] Beyond smuggling, drones can also be used for even more elaborate criminal purposes. In England, a criminal group equipped a drone with heat sensors so as to detect cannabis farms and extort money from cannabis growers.[118]

Finally, UAVs can also be used by terrorist networks. Indeed, there is evidence that UAVs have been 'hijacked' by certain groups in Afghanistan by uploading computer viruses into American reaper drones, enabling the 'hijackers' to follow every move of the drone.[119] Of course, once a drone has been hijacked and a third party has managed to get control over it, they can be used for cross-purposes, or be directed against buildings or people.

5.2 Safety

A second issue relates to a variety of safety concerns when operating drones. One key concern is the ability of people to properly operate and maintain control over their vehicle at all times. In many countries, and for many categories of UAVs, little or no certification is needed to operate them, rendering this activity prone to accidents. In the Netherlands, certain UAVs can as of yet only be flown without prior permission if this is for private (i.e. non-commercial) use. A number of accidents with Raven drones have already been reported in the Netherlands, some of which are attributable to faulty operation of the vehicle.[120]

Accidents can also happen if a UAV's signal is interfered with, whether accidentally or not. The ability to 'jam' the signal of a UAV is of use to the police should they wish to take control of vehicles that pose a certain imminent danger.[121] However, it is, of course, just as conceivable that this same ability can be used by parties with malicious intentions.

During the Nuclear Security Summit (see Figure 13) that took place in the Netherlands from 24-25 March 2014, multiple drones were detected in violation of airspace restrictions.[122] Other examples of accidents include that of an Australian athlete who was injured after a UAV monitoring a sporting event came down on her unexpectedly, prompting an investigation into the credentials of the drone operator.[123] The use of UAVs has also given rise to concerns about the safety of public figures. During a speech given in Dresden, for example, German Chancellor Angela Merkel witnessed the crash of a UAV only a few meters from where she was standing.[124] Finally, the sheer proliferation of drones carries the risk of mid-air collisions.[125]

Figure 13 **Nuclear Security Summit 2014** The scene of multiple airspace violations by UAVs. Source: Wikimedia Commons.

5.3 Privacy

A third concern centres on privacy and the protection of sensitive data. These concerns relate to the use of UAVs by private and commercial parties, as well as to the use of drones by public authorities. As to the first issue, there are worries that drones can be used by individuals to spy on others. Some on-line electronic equipment shops already sell drones fitted with cameras that can upload their pictures directly onto Facebook or Twitter.[126] The increase in the use of UAVs by private individuals has already led to the development of technology to track whether one is being followed by a drone.[127] That the potential for drone applications can be seemingly endless was shown during the last world cup, when the French team members alleged they had been spied on by a drone.[128]

A similar trend could be expected in industrial espionage, for instance to collect information on new prototypes of a competitor in the automobile industry while it is being test-driven in an otherwise remote and secluded location. Aerial observation using UAVs thus provides ample opportunities for a great variety of espionage tasks, be they military, commercial or private.

Finally, there are concerns about the use (and possible abuse) of drones on the part of law enforcement authorities. In the wake of the recent spying scandals, this issue has become a hot topic in many countries, including in the Netherlands.[129] In the US, the authorities were forced to admit in 2013 that the Federal Bureau of Investigation (FBI) had employed drones to spy on individual citizens.[130] This caused enough uproar for some to start actively pursuing drones and to seek to shoot them from the skies.[131] In the Netherlands, some concerns revolve around the fact that the army drones used by the police are by default equipped with cameras. Since 2009, they have been used over 130 times.[132] What is more, these drones can soon be equipped with cameras that have face recognition. According to the Dutch government, a “limited infringement” of privacy rights is likely warranted for investigative purposes under current law.[133] The Dutch Minister for Security and Justice, Ivo Opstelten, said that prima facie, and whilst respecting certain legal restrictions, using such cameras would not be unlawful.[134] In the absence of such advanced technology, the government considers that current Dutch legislation on privacy protection is sufficient when it comes to drones equipped with cameras.[135]

Taken together, the safety, security and privacy concerns that have been raised need to be taken into consideration in the technological development of drones, their market development and in their use by private and public parties. Some of the issues touch upon people's fundamental rights. At the same time, the market itself is likely to be able to develop technological solutions so as to accommodate some of the concerns, for instance through security or privacy by design. In addition, adequate regulation, once in place, should ensure that UAVs will be flown under safe conditions, but also to create clarity on the limits to the use of such devices.

'... drone operators insist that when someone uses a UAV for commercial purposes, their livelihood and businesses are on the line. This creates an incentive for safe operation. The question is, of course, whether such a self-regulatory attitude would actually be sufficient to meet the safety standards maintained by aviation authorities.'

6 – Obstacles to Developing a UAV Market

Existing regulations in the Netherlands are predominantly based on manned flight, or recreational use of model planes. Today, it is forbidden to fly UAVs for a commercial purpose unless a temporary exemption (Tijdelijk en Uitzonderlijk Gebruik, TUG) or a permit is granted by the competent authorities. Every individual or organization that wishes to fly a UAV for commercial purposes and wishes to take off from a location outside of an airport must thus request such an exemption from the Provincial authorities in the province where the flight is due to take place. The whole procedure for examining the request and granting approbation can take up to four weeks.[136] For many UAV operators and enthusiasts eager to fly this procedure is too long and cumbersome. In effect, the procedure is prohibitive for potential commercial parties, and more worryingly so for emergency services.

This section takes a detailed look at the effects that existing exemption and certification procedures have on the UAV industry in the Netherlands.

6.1 Exemption and Certification Procedures

From a business planning perspective, the procedure for obtaining a temporary permission (exemption) to fly drones is viewed as time consuming and as a hindrance to successful product development, particularly for start-up companies that are under time and financial pressure to launch their product.[137]

Despite these obstacles, representatives from the industry and UAV users alike indicate their willingness to operate legally. But they underline that existing certification and exemption procedures make this impossible at times. A processing time of up to ten months for a company exemption, plus another four weeks per flight, does not allow the necessary kind of flexibility that companies in the UAV industry need, let alone emergency services.[138]

According to the chairman of the Dutch Association for Remotely Piloted Aircraft Systems (DARPAS) Rob van Nieuwland: “Dutch companies find themselves at a competitive disadvantage due to the absence of clear regulation. There are even cases of companies filing for bankruptcy as their ability to test their product is hampered by complicated exemption and certification procedures. The main reasons for this are that the processing time required for obtaining a permit is too long and that policy on issuing flying permits differs per province.”[139]

Criticism about existing legislation is not limited to the Netherlands. In the US, the FAA issued new regulations for review in June 2014. These new regulations elicited a lot of comments, many of which focused on the distinction drawn between using drones for hobby or recreational purposes as opposed to commercial purposes. Similar to existing policy in the Netherlands, flying UAVs for private use is allowed, whereas doing so for commercial purposes is banned.[140] Many commentators view this distinction as arbitrary, too strict and giving rise to peculiar situations. For instance, and similar to the US, under the current rules it is legal for a Dutch farmer to use UAVs to monitor crops which are grown for his personal use. However, when he does so with the intent of selling the produce, it is considered illegal.[141]

Criticism to the rules in the US was so widespread that the FAA decided to extend its deadline for comments to allow stakeholders more time to examine their true implications.[142] As stated, part of the criticism relates to the fact that the rules are seen as too restrictive and that, in the eyes of drone operators, ruling on the basis of a distinction between commercial versus non-commercial use has nothing to do with flight safety.[143] Instead, drone operators insist that when someone uses a UAV for commercial purposes, their livelihood and businesses are on the line. This creates an incentive for safe operation. The risk of a public relations disaster tied to the company name is real. Therefore, their argument is that real-estate agents, farmers and others using drones for business will want to be careful about incurring unnessary business risks or lawsuits and hence will be at least as cautious as a hobbyist.[144] The question is, of course, whether such a self-regulatory attitude would actually be sufficient to meet the safety standards maintained by aviation authorities.

At this time, a single British company is contracted by the Dutch aviation authorities to test companies, UAVs and pilots in the Netherlands before issuing operating certificates. Since this foreign company maintains a monopoly in the Netherlands, it creates potential conflicts of interest and market distortions. This is something that needs to be remedied and taken into consideration when drafting new laws and regulation for operating UAVs in the Netherlands.[145]

According to the owners of a small start-up company that uses UAVs to produce aerial videos, the procedure for obtaining the exemption is not the only obstacle: “[o]n top of the need to acquire an exemption, both the UAV and its operator need to be certified. There is limited choice among institutes where you can obtain such certification and it can only be acquired at a high cost. This acts as a barrier to small companies wishing to enter the market.”[146]

6.2 Testing Facilities

When asked about the ability to test experimental UAVs, stakeholders in the Dutch defence industry, emergency services, and UAV business organisations complain about lengthy and complicated procedures in order to access test sites in the Netherlands.[147] At present, there is only one military installation in the Netherlands where military or state-operated non-military[148] UAVs can be test-flown or used for training purposes: the artillery firing range at Oldebroek.

According to Pieter Mink, Staff Officer Flight Safety, Quality and Airworthiness at the Dutch Ministry of Defence: “Complying with the procedures is time-consuming and limits companies in their ability to adequately and timely perform experiments and tests, which sometimes leads to sponsors abandoning promising projects. In other words, there is a big economic incentive for undertaking appropriate action. Terrain owned by the Ministry of Defence would be highly suitable to be designated as a testing ground for commercial operators of UAVs.”[149]

To solve a similar lack of adequate testing facilities with co-located airspace in the US, the FAA designated six unmanned aircraft systems research and test sites across the country.[150] Given space constraints, designating extensive and multiple test zones in the Netherlands could be complicated. Countries with huge swaths of empty land available therefore have a comparative advantage.

< Figure 14 **Use of the Zenith for security inspections of critical infrastructures** Source: Aerialtronics

'The challenge for lawmakers lies in establishing a regulatory framework that allows the industry to flourish, whilst at the same time making sure that the risks to our security, safety and privacy are reduced to an acceptable level.'

7 – Recommendations

The growth of the UAV industry has fed numerous concerns from a security, safety and privacy point of view. At the same time, the UAV industry also represents an important and growing business opportunity, with many companies keen to jump on the bandwagon. Developing this industry could act as a stimulus to the sluggish European economies, including the Netherlands. Apart from that, UAV technology can also undoubtedly help enhance safety and security.

The challenge for lawmakers therefore lies in establishing a regulatory framework that allows the industry to flourish, whilst at the same time making sure that the risks to our security, safety and privacy are reduced to an acceptable level. This section provides an overview of several recommendations to that effect.

Conduct an inter-agency investigation into security and safety risks of UAV proliferation

The proliferation of UAVs brings about numerous security concerns, not least in relation to possible criminal and terrorist activity, military and industrial espionage, and the trafficking of illicit goods. Aside from security risks, the general public is equally concerned about UAV proliferation from the viewpoint of safety. It is recommended, therefore, to initiate an investigation into the safety risks of proliferation, preferably by different agencies such as the Dutch Aviation Authority (Nederlandse Luchtvaartautoriteit), the National Coordinator for Security and Counterterrorism (Nationale Coordinator Terrorismebestrijding en Veiligheid, NCTV), in conjunction with the national police.

Formulate a whole-of-government policy on UAVs to better respond to issues concerning UAVs

Stakeholders in the defence industry, emergency services, and UAV business organizations all plead for the establishment of a whole-of-government policy for the management and control of UAV capacities in order to avoid unnecessary duplication of capabilities, as well as for cost-saving purposes.[151] According to one respondent, an advantage of having a system whereby UAV capacities and the management thereof are shared and properly coordinated lies in the fact that the response time for emergency services goes down.[152]

Perhaps the most important argument for a whole-of-government approach lies in the operational effectives of the newly introduced data systems. To enable security authorities and emergency services to analyse the massive flow of data and to make effective use of the information thus obtained, a network-centric approach involving all security authorities, military and civil services should be introduced, similar to data management systems operated in the military. This would not only enable all stakeholders to deal with massive data flows, but also provide an integrated network with a single data base to be used by all services within the network.

Adopt tailored legislation to ensure that safety and security standards are respected, which also facilitates —or at least not hinders— the development of a market for UAV technology in the Netherlands

In light of the growing demand for UAVs and the deficiencies of existing exemption and certification procedures, it is imperative that specific legislation and regulations be drafted that govern unmanned flight for governmental, commercial as well as private actors. A crucial aspect of such new regulation is the ability of law enforcement authorities to readily verify the credentials of a UAV operator to ensure safe operation at all times. However, it is important that this does not unduly impede the development of UAV-related activities in the business sector. Several measures can be taken to that effect. First, new legislation should put forward a simplified licensing procedure which takes up significantly less processing time. Doing so will greatly enhance the ability of companies operating in the UAV industry to plan their activities.[153]

Second, the market for certification of drones and operators should be opened up to greater competition. A greater choice among organisations which can provide training and issue a licence is likely to bring down the costs of obtaining certification and thus disincentivise unauthorised flying.

Third, in order to facilitate the safe operation of UAVs in Dutch airspace, a ‘points system’ could be introduced similar to the one used for driving licenses. Upon violation of regulations, the operator of the UAV in question is given a mark on his or her permit to use a UAV. After several consecutive penalties, the permit can be revoked. Conversely, upon showing ‘good behaviour’ over a longer period of time, the licensing procedure could be streamlined for reliable users.[154]

Share UAV capacity across government services to ensure the effective and efficient use of UAVs

Another key to ensuring the effective and efficient use of UAVs by the public authorities is the creation of a shared pool of UAV capacity. This would particularly make sense in countries with limited airspace and multiple agencies wishing to make use of UAV capacity. With the aim of reducing investment and exploitation costs, and to enhance the efficiency of air transport, air-to-air refuelling and aero medical evacuation, Belgium, Germany, France and the Netherlands put in place the European Air Transport Command (EATC) in 2007.[155] Based in Eindhoven, the Netherlands, the EATC allows participating nations to ‘pool’ their airlift capacities together.

Figure 15 **Use of the Zenith for security inspections of critical infrastructures** Source: Aerialtronics

This can lead to operations whereby Dutch troops and equipment are transported by means of a German transport plane. The whole system rests on a partial transfer of sovereignty. The command over crews and airplanes is transferred to the EATC authority, yet the operation and maintenance of the aircraft, as well as the training of qualified personnel, remains in national hands.[156] The costs associated with operating the planes are expressed in a budget-neutral financial exchange unit known as Equivalent Flying Hours (EFH). Under the EATC, it is agreed that the operating costs of a C-130 Hercules transport plane or a C-160 Transall for one hour are equal to one EFH. All other costs are then calculated based on this reference. Essentially, the more flights a country operates, the more 'credits' it earns. These credits can then be used when 'purchasing' flights by other countries.[157]

The EATC system has brought about a reduction in the costs associated with the lease of commercial airplanes and raised the coverage level of military transport planes, thus increasing the overall efficiency of operations.[158] With respect to UAVs, the establishment of a similar system in the Netherlands modelled on that of the EATC would reduce the risk of unnecessary duplication of capacities among law enforcement units, fire departments and other emergency services. This could lead to a more efficient use of UAV capacity and a similar reduction in costs, as witnessed under the EATC.

Formulate specific rules for police and fire brigades to enable them to fly UAVs over crime scenes and fires

Whereas the UAVs used by the Ministry of Defence are exempt from requesting specific permission to be operated, the Dutch police and fire units, flying state-operated drones, do need to apply for such an exemption. This hampers the ability of police and fire brigade drones to be put to use effectively and rapidly in case of an emergency.[159]

This issue could be resolved by allowing fire-fighting units and police units certified to operate UAVs to fly in close proximity and within pre-defined limits and immediately over industrial and forest fires or crime scenes, without prior case-by-case permission.

Allocate more flying zones for experimental, test and training flights to help spur technological development and application

A lack of adequate testing facilities was raised by several respondents as hindering successful product development.[160] Granting permission to UAV manufacturers and developers to use terrain owned by the Dutch Ministry of Defence as UAV test sites could offer a solution to this problem.[161]

The use of such sites by civilian UAV operators is currently being considered. However, this requires a significant change in the environmental permit of the current installation at Oldebroek. There are several other military installations in

the Netherlands that could be used to test-fly and train with both military and civilian UAVs. Two such installations are located on military airfields which have been abandoned by the Netherlands air force, but which are still considered 'military airfields' under Dutch aviation law: 'Twente' and 'De Peel'. Consequently, these airfields still have their associated volumes of controlled airspace (control zones) and environmental permits. These airfields could be made available for development, testing and training by civilian and commercial UAV developers and operators. Former naval air station Valkenburg no longer has a legal status of a 'military airfield', yet it can still be made available as temporary airfield, as was demonstrated by its extensive use during the Nuclear Security Summit in The Hague in March 2014.[162]

Establish a veritable 'triple helix' for UAV development, involving government, knowledge institutes and industry

There is fertile ground for the establishment of a UAV 'triple helix' or 'golden triangle' group, including members from knowledge institutes, industry and government for the development of UAV capacities in the Netherlands.[163] Such a consortium could provide the right impetus for further development of the Dutch aviation sector as a centre for fostering UAV technology, and thus benefit all parties involved. Leadership from a pro-active government agency serving as 'innovation leader' as well as 'launching customer' is a key precondition for such an initiative to succeed. Existing European laws and procurement regulations, however, could form a tough obstacle,[164] requiring further coordination at the EU level to create both local and European-wide competitive UAV markets and industries.

'At the end of the day, UAVs should be first and foremost seen as an opportunity, and not as a threat. (...) They offer opportunities in a number of different ways: for commercial purposes, for the sake of public services and security, but also inherently as an innovative area of technological development that merits to be nurtured. As a country with a long history in aviation, it is only appropriate for the Netherlands to partake in breaking the next frontier in aerospace technology.'

8 – Concluding Remarks

Drones are not just on their way—they are here already, they are going to stay, and they will only continue to proliferate. This is why it is important, today, for the Dutch authorities, in conjunction with relevant stakeholders, to craft policies and regulations that enable the safe use of drones in Dutch airspace, as well as to create an enabling environment for the Dutch UAV industry to flourish and to become—and remain—competitive in world markets.

All major global players, including the US, Germany and Israel, are in the process of adopting up-to-date legislation on the use of UAVs for non-military purposes in their airspace. Some countries, like France and Japan, have already put such legislation in place. Given the rapid development of UAV technology, and the strong demand from various industrial sectors to use such technology, there is strong pressure to introduce legislation in the short term. From a commercial point of view, the window of opportunity in the Netherlands to capitalise on a potentially multi-billion dollar market is small if it is not already closing. For instance, the fact that France already has legislation in place is giving its commercial operators of UAVs the opportunity not only to test their equipment, but also to develop the domestic market. This small head start could make a difference in the years to come. The US is lagging behind, but the size of its market and the level of investments seen there ensure that once the FAA puts regulations in place, this market will be able to take off soon and is likely to dominate world markets.

The Netherlands enjoys neither the head start that France has, nor the market size of the US. Hence, it needs to find its comparative (and competitive) advantage elsewhere. Such advantages can be sought in two different ways. One could be to create an enabling environment for the development of drone technology in the Netherlands that would be comparatively better than in other countries. Another could be that at the technological level, Dutch companies would seek to develop niche markets, say, in developing drones for the agricultural sector, or to develop integrated solutions in the area of security provision.

What is holding the Netherlands back at this time is the fact that legislation is inadequate or inexistent. This is the first priority to be addressed. New legislation needs to respond to two principal concerns: 1) to safely integrate UAVs into our airspace and 2) to allow the industry to develop and flourish.

Figure 16 **Quadcopter being used by the police** Source: Hollandse Hoogte

Safe integration of UAVs into our airspace is not only a matter of physical safety. In the end, it is also a matter of integrating new devices into our environment, the use of which raises concerns in the area of privacy as well as security. These concerns are not to be underestimated, and their consideration should not be subject to pressure undue from business, or even from public authorities, to open up the airspace sooner rather than later. This is so because privacy concerns essentially relate to trust—trust in what the authorities do with information they gather, as well as trust in what other citizens can and cannot come to know about you. Of course, in this day and age, privacy is already under pressure from different corners, whether it concerns tracking via satellite, our online activities, the use of smartphones, or simple CCTV cameras in shops and streets. Drones are adding a new dimension to this debate, one that needs to be understood and explained well in order to reassure citizens and to ensure respect for their basic rights.

Secondly, the malicious use of drone technology needs to be considered. This can evidently involve privacy issues. But it can also raise concerns about drug and weapons transports, spying activities or even (improvised) armed drones eventually plying the skies over the Netherlands. Preventing this is not merely a matter of having adequate laws on the books—it's also a matter of being able to police such laws.

Finally, it should be understood that insistence on safety, security and privacy concerns is not only the preserve of civil rights organisations. Business and public authorities alike have a clear interest in this as well. For respecting people's rights equals building up one's reputation. No sectors, and certainly not fledgling ones, are interested in acquiring a questionable reputation. But beyond that, a good reputation also helps to strengthen one's market position, at home and abroad. Hence the broad support from the sector for adequate legislation that properly takes into account security, safety and privacy concerns.

Once a proper framework is in place, it is important that the right kinds of synergies are achieved. In one respect, this applies to companies finding opportunities to cooperate with partners on R&D, integration of technological innovations, or in developing new applications for drone technology. At another level, this means ensuring that in acquiring UAVs, public services find a modus operandi according to which UAVs can be used for multiple purposes and, for instance, be made available through a pooling system depending on the user's needs. This would not only lead to significant cost savings, but it would also result in improved safety in the skies, as there will be fewer UAVs in the air.

At the end of the day, UAVs should first and foremost be seen as an opportunity, and not as a threat. The initial questionable reputation that they acquired ten years ago has been largely left behind. Instead, the positive ways to which drones can be put to use are increasingly highlighted and accepted today.

Moreover, UAVs offer opportunities in a number of different ways: for commercial purposes, for the sake of public services and security, but also inherently as an innovative area of technological development that merits to be nurtured. As a country with a long history in aviation, it is only appropriate for the Netherlands to partake in breaking the next frontier in aerospace technology.

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