European Commission

Business Innovation Observatory

Space Enabled Applications

UAV systems for civilian applications

Case study 58

Internal Market, Industry, Entrepreneurship and SMEs

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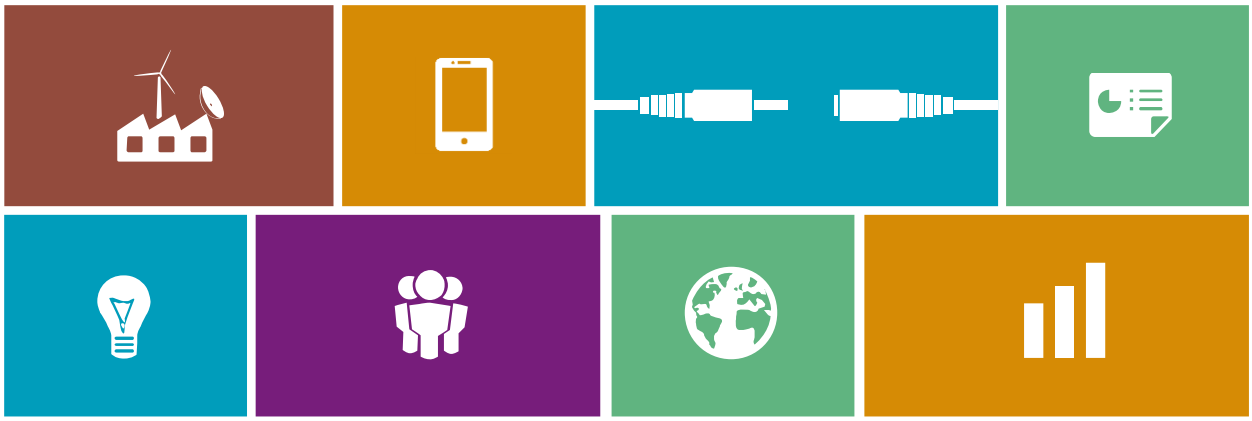


1. Executive summary

Formerly known across society for their technical capabilities and military use, today the concept of an Unmanned Aerial Vehicle (UAV) is increasingly changing and the economic and social benefits from their civilian applications are starting to be acknowledged by the population. The ability of UAVs to carry cameras, sensors and similar payloads in the air with the purpose of gathering information from an airborne perspective at reduced cost has transformed the utility of civilian products and services within industry.

Today, they are increasingly associated to the commercial exploitation of their ability to gather data from the third dimension at relative low cost rather than to consumer leisure or military tools. The increased business demand for aerial data under complex and dangerous conditions is enabling incremental innovation in the cross-industry applications of UAVs (e.g. precision agriculture, 3D mapping, surveillance of ground and physical networks, catastrophe management, traffic monitoring).

Recent changes in the framework conditions have allowed the development of the UAV sector in Europe. Several Member States have modified their regulatory framework to enable the use of unmanned aviation operations for civilian purposes. This situation has created a competitive industrial advantage for the EU with respect the rest of the world. UAV systems are characterised by their capacity to gather aerial data at lower costs. This data can increase the competitiveness of European businesses through automation, cost effectiveness and risk reduction.

A generalised vision across industry stakeholders is that integrated solutions will consolidate around the airframe as the tool to deploy aerial electronic networks, and the mathematical and statistical capacity to treat data. These provide the core services to produce data for better decision making and automation of industrial processes in different sectors. During the next years, private investments focusing on the commercial exploitation and scaling up these integrated solutions will be determinant to safeguard Europe's UAV industrial advantage.

Further development and commercialisation of UAV systems for civilian applications remains a challenge for product and service providers. Continuous improvement and homogenisation of the regulatory framework is key in this aspect. Since the main technological challenge is not related to lifting those machines in the air, but rather to building aerial electronic networks for data gathering and processing, it is important to clearly define the safety and security regulations that would protect both society (civilians on the ground) and the economic benefits for the industry.

To keep its position on the global market the EU also should act to attract the investment, keep talented human resources and SMEs in Europe, and better design public procurement procedures.

2. UAV systems for civilian applications

2.1. Trend presentation

UAV systems are new tools to gather aerial data and sources often utilised for surveillance, inspection, mapping and 3D modelling. They comprise two principal components: the hardware, which is a generic aircraft designed to operate with no human pilot on board, and the control software, which allows remotely guide themfrom a ground station.

This case study is part of a series on space enabled applications. It focuses on the potential applications of UAV systems, in particular for the purpose of remote sensing, measuring, and data collection from a three dimensional perspective, limiting the costs and dangers of manned aviation.

In spite of its military origins, UAV systems have slightly shifted in application during the past decade opening up to a number of solutions to obtain data and imagery in complex conditions for civilian use. As remote sensing and measurement instruments, UAVs offer the opportunity to develop real time surveying applications in a number of domains such as civil engineering, traffic monitoring, precision agriculture, and environmental conservation etc.[1]

UAVs are capable of providing benefits to the private industry and public services by rapidly and accurately acquiring real time information on its surroundings. The aerial vehicles (the UAV) can be characterised by either rotary or fixed wings, which determines their capacity to fulfil two of the principal needs of users: optimised embarked payload, and optimised autonomy range.

The remote sensing technology embarked on the vehicles is often used to assess changes in the surface of the earth and perform surveying and mapping.[2] The advantage of this technology is its cost effectiveness compared to classical aerial photography or to the exploitation of satellite imagery and sensors.[3] As a result, UAV systems are complementary means to gather 'high ground information', and provide a cost advantage over other forms of space enabled means for data acquisition and the production of real time georeferenced imagery and surveillance depending on the specificity of the missions and tasks to be performed.

Given that early developments of the technology were motivated by military applications, UAV systems have mainly been used in the past for specific tasks of surveillance, reconnaissance, and mapping of hostile areas targeted by military operations. Tactical tasks required the development of medium altitude (500 Km) and long endurance (up to 3 days flight) –*MALE*- systems, while strategic tasks required the development of high altitude (up to 20Km) and long endurance –*HALE*- systems. The technical knowledge derived from these developments can now be focused on commercial applications with economic and social benefits.

The knowledge generated by these military origins enabled designers, developers and suppliers of flying unmanned platforms to adapt the technologies in use (hardware and software) for civilian purposes and to propose a number of UAV systems related products and services at lower costs. Furthermore, the demand for these products and services has extend to short and close range applications (average of 25 minutes and 1.5Km) operated through autonomous and preprogramed, semi-automated, or manual missions.

Figure 1: UAV for search and rescue exercises

Source: Aerialtronics4

Products and services in demand include, but are not limited to, photogrammetry (digital surface modelling), imagery and recognition, flight operations for inspection (in particular for industries with physical networks – railways, pipelines, electrical networks, etc.).[5] Examples of specific cases in which UAV systems are increasingly used include:

- Agriculture and forestry for precision framing to take reliable decisions, identify damages in the earth's surface, and monitor species and vegetation.
- 3D surveying in the fields of architecture and archaeology to map sites and structures at low altitude.[6]
- Emergency management enhanced by the rapid acquisition of images to provide evidence for early impact assessments and define rescue planning.
- Traffic monitoring and surveillance, time estimation, lane occupation and incidence response.

A selection of companies active in the UAV industry is presented in Table 1.

2.2. Overview of the companies

Table 1: Overview of the company cases referred to in this case study

Company	Location	Business innovation	Signals of success
Aerialtronics	Netherlands	The company develops UAVs for commercial applications. The principal idea is a complete redesign of UAVs that are often commercialised as leisure objects and apply their capabilities to businesses.	- Participation in projects under H2020 - Wide base of large commercial customers
UAV Factory	Latvia	UAV Factory is specialised in fixed wing UAVs for long range and long endurance missions. The company provides a fully integrated solution comprising design, development and production, subsystems, engines, avionics, and mission related services.	- Beneficiary of ERDF funding for research and development - Media coverage in *Unmanned systems technology magazine*
Redbird	France	The company specialises in solutions for the quarry mining industry by providing thorough information combining raw imagery form UAVs, crossing it with geo-information systems, and processing it using mathematical and statistical analysis.	- Founding member of the French Professional Federation for Civilian Drones - Media coverage
Defendec	Estonia	Defendec develops new technologies for border protection and surveillance of border lines based on geo-location. In particular, these innovations focus on radio based communications and low power consumption devices.	- Participation in the FP7 project TALOS - Media coverage - Prestigious institutional clients

Problem 1 – Redesigning UAVs: from leisure objects to business tools

Innovative solution 1 – Aerialtronics originated in 2012 with the purpose of developing UAVs for commercial applications and delivering specific commercial benefits. Redesigning existing products in the market of UAVs for leisure implied technical challenges in terms of robustness, performance and safety to ensure the utilisation of the hardware on a day to day basis. Next step involved shifting from the leisure towards commercial utilisation of UAVs, by giving business access to a new method of data collection.

The primary competitors within the industry share the view that UAVs are 'flying platforms or servers' that enable users to collect richer data by exploiting this third dimension. The future of the industry is not focused on UAVs as hardware, but rather as tools to provide services, with particular focus on the ability to process the collected data and the ability to exploit a network of information enabled by flying servers.

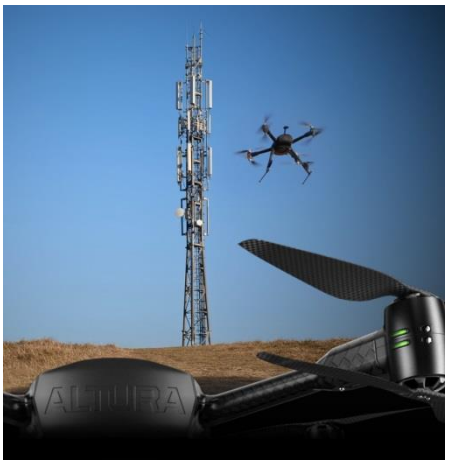
The commercial applications vary across two types of UAVs, depending on the tasks to be carried out. Multirotor UAVs with close range capabilities but higher payload and steadiness, and fixed wing UAVs with larger range.

In the views of CEOs in the UAV industry, today, the non-military market for UAVs is largely dominated by recreational products over commercial ones. This recreational market of UAVs as general consumer goods was vital for the redesign and development of commercial and business oriented UAVs. It opened up the market by helping to change the mentality of general public.

In the past the concept of UAV was purely associated to military operations and their economic potential was not fully understood. As the recreational market grew, the concept was better understood and new applications emerged (e.g. mapping and surveying, inspection, security, search and rescue,).

One of the first UAVs Aerialtronics sold was applied in security surveillance for sports events, others have been applied to recognition for fire departments or as 'sniffers' to detect the quality of the air. UAVs have also been applied within the context of catastrophe management by safety and security organisms but also by insurance companies as means of recognition and data collection. Their ability to rapidly react and collect data in complex situations and difficult access and danger for the human is a key feature, but the added value lies in our capacity to process and interpret the acquired data.

Aerialtronics Altura Rotorcopter for site inspection



Source: Aerialtronics

Problem 2 – Providing products and services for long range and long endurance unmanned aerial missions using fully integrated solutions.

Innovative solution 2 – UAV Factory is specialised in fixed wing UAVs for long range and long endurance missions (up to 20 hours with light airframes of less than 25 Kg). In addition, the company provides a fully integrated solution comprising not only the design, development and production of the airframes but also includes the subsystems, engines, avionics, and mission related services. This vertical integration is the base of UAV Factory's main value proposition of accurate long term and wide range UAV missions for several applications such as mapping, surveillance, acquisition of 3D data, precision agriculture, control and monitoring of infrastructure, catastrophe management, and environmental monitoring.

The ability of fixed wing long range UAVs to carry out long missions makes them a cost effective alternative to manned aviation since they can endure long flights and reduce any human related risks associated to aerial missions in complex environments and situations.

UAV Factory's Penguin B - Fixed wing UAV

Source: UAV Factory

Problem 3 – Quarry mining industry operations require highly precise information that can be enhanced by aerial data.

Innovative solution 3 – Redbird specialises in solutions for the quarry mining industry by providing thorough information combining raw imagery form UAVs, crossing it with geo-information systems, and processing using mathematical and statistical analysis.

The cross industry nature of the technology is reflected by synergies in the areas of topography, data acquisition and processing. Redbird is capable of implementing cross industry solutions such as precision guidance of ground operating machines or surveillance along physical networks (electrical networks, railways, pipelines). Their ability to gather and process aerial data proves that UAVs are the tools for monitoring and data collection, but it is the process of transforming the data that ensures cost effectiveness and accuracy of operations in the ground for the quarry mining industry.

Redbird's quadrotor for quarry monitoring

Source: Redbird

Problem 4 – UAVs have the capacity to acquire 3D imagery data; however, for the purpose of ground surveillance and control UAVs' capabilities are limited and require enhancement by automated detection technologies.

Innovative solution 4 – Defendec develops new technologies for border protection and surveillance of border lines based on geo-location. In particular, these innovations focus on radio based communications and low power consumption devices.

UAVs are combined with robust surveillance and detection technologies and provide support for tactics, planning and strategy. Today, one of the principal challenges of using UAVs is that although they are able to gather aerial data, they lack the ability of knowing exactly where to look when parameters have not been predetermined. The combination of UAV aerial capabilities with border protection and detection systems enhances the technical capacity to survey wide areas.

3. Impact of the trend

The economic impact commercial UAV applications will have on businesses and society is likely to depend on the increase of cost effectiveness in numerous operations across industries, the improvement of safety regulations, and the reduction of risk in the collection of high ground information across complex or inaccessible environments compared to the traditional manned aviation.

3.1. The market potential of the trend

The European UAV industry is likely to develop faster with respect to the rest of the world given progress in the regulatory framework (although highly variable) across Member States. The development of regulations will allow the industry to provide clear types of products and services. Currently, progress in the regulatory framework are being shaped with respect to three different types of utilisation: 1) open and simple missions, 2) specific or targeted missions, and 3) certified or authorised missions.[7]

Simple products and services will not need to fulfil complex authorization procedures from aviation authorities for as long as boundaries and rules are respected. In the case of simple and open UAV services, approvals and licenses for operators or pilots will not be a burden to the industry. However security standards will be applied to meet airworthiness requirements involving safety features like parachutes or mitigation of failures through failsafe software procedures such as sense-and-avoid technology[1].

Specific products and services are normally related to operations implying significant aviation risks on the population. These types of UAV products and services will require compliance with risk mitigation mechanisms validated by aviation authorities or accrediting bodies. Safety risk assessments will need to be conducted to ensure that specific mission operators in the UAV industry comply with safety standards and satisfy the necessary mitigation of risks. These assessments will also indicate whether or not specific limitations on the operations are required.

Certified products and services will involve operations that pose aviation risks similar to those of regular manned aviation. UAVs (aircraft and systems) related to services in this category require the same standards as any other ordinary aviation product and service. These types of operations includes services such as remote piloting or UAVs using sense-and-avoid technology which comprises embarked systems to prevent mid-air collisions using electro-optical cameras, laser radar (LIDAR) devices or transponders.

Studies forecast that worldwide expenditures in the market of UAVs will double from EUR 5.7 billion to EUR 10.3 billion per year by 2020. In 2014, the distribution of this market was estimated to be 89% military and 11% civilian, although this distribution is shifting in favour of civilian applications and it is likely these will grow up to 16% of the market of UAVs within a 10 year horizon.[8]

Future development and market uptake will benefit from current funding for the development of wide range UAVs capable of transporting heavy payloads, and from improvement of sensors, radars and other systems adjusting to geographic constraints and the needs of users across different areas[9] (e.g. clear skies in Asia vs. restrictive topography in Eastern Europe).

Market potential in aerospace payload and transportation will therefore stem from the development of wide range UAVs, increased payload capacity, and improved sensors and navigation systems. Commercial applications already include 3D mapping, commercial pipeline observation, border patrol, package delivery, photography, and agriculture.

The market for data collection and observation for real time information and monitoring benefits from major cost advantages in speed, detail, and accuracy. with respect to the use of other tools, like satellite imagery UAVs offer. Cost effective acquisition of data and observation enabled by the take-up of the UAVs market is already applied in a number of areas with economic relevance, including agricultural monitoring, disaster management, power line surveying, law enforcement; weather monitoring, aerial mapping, environmental monitoring, oil and gas exploration; and freight transport.

The market of public safety applications is also likely to increase given the capacity of UAVs to provide cost effective data for observational purposes in real time. That is especially relevant for public sector professionals with civil responsibilities such as police officers, firefighters, or medical service providers.[10]

But other sectors are also using UAVs for surveying and monitoring. As an illustration, remote sensing and precision applications are currently exploited in precision agriculture. These applications are used to observe and treat plants during the farming cycles. They allow collecting datasets concerning parameters and measures needed to control

[1] Sense-and-avoid systems are embarked technologies to protect against mid-air collisions. For this purpose, they use electro-optical cameras, laser radar (LIDAR) devices or transponders.

farming operations (e.g. growth rates, hydration, temperature) and locating disease outbreaks. Precision applications are particularly useful for crop farmers and horticulturists who benefit from effective and efficient selective spraying techniques. These features allow farmers to provide only required nutrients to each plant, improving cost effectiveness and reducing environmental impacts.

3.2. The socioeconomic impact of the trend

The European space sector provides SMEs with numerous potential business opportunities, also leading to an innovative and competitive European UAV industry creating jobs and growth.

The UAV sector is absorbing qualified engineers and is providing direct jobs created from the design production and manufacturing of UAVs and sensors, and design and maintenance of control systems.

According to the UK House of Lords' Sub-Committee on EU Internal Market, Infrastructure and Employment, nearly 150,000 potential jobs could be created from the UAV industry and its associated applications in Europe by the year 2050[11]. However, depending on how policy makers will design incentives for investment within the industry, regulate the market and respond to safety issues, the creation of new jobs could be slow and varied across Member States.

Investments and development in the UAV industry will continue to increase significantly over the next years, making UAVs the trend in the aerospace industry with the biggest potential of job creation. However, the economic impact is not limited to just the jobs it may generate. The increasing demand for services it creates will not only imply new jobs and revenues, but will also stimulate existing markets following an increasing spending power of the newly employed population transmitting these effects throughout the economy[12].

Member States which already have a developed airspace industry and infrastructure will benefit the most from the UAV industry. But the creation of new jobs will also be stimulated by advantageous policies, laws, tax incentives and increasing adoption of UAV technology by end users.

Issues of social relevance also include safety risk assessments associated to the machines and human resources involved in UAV operations. That also determines the technical specificities and skills of staff involved in the delivery of UAV related services. It also has an impact on the codification of operating procedures, airworthiness and staff competences, and addresses not only the aircraft, but also ground command and control systems. In the case of simple and open UAV services, approvals and licenses for operators or pilots will not be a burden to the industry

.

4. Drivers and obstacles

If the UAV industry is currently gaining visibility on the military segment, its civilian applications still needs to be recognised by the public. Furthermore, security and safety concerns need to be addressed for UAV systems to expand on a large-scale market.

4.1. Challenges to understand UAVs as tools to deploy aerial data networks

For some time regulation has been a major barrier for the development of the market of commercial UAVs, but the situation has been changing lately with modern legislation regarding UAVs used for commercial tasks.

The market development has led to a redefinition of the solutions supplied by principal actors in the industry. Today the market is directed towards the commercialisation of integrated solutions that tend to fully automate the data acquisition, treatment and decision making process.

Fully integrated solutions comprise not only the hardware (UAVs), but also and most important the services (selection of vehicles, software and flying operations), the data acquisition and treatment, and insurance services needed to deal with risks associated to the nature of the machine. As a particular illustration, the commercial application of UAVs in precision agriculture currently raises the interest of agronomists rather than farmers. It is the case because the added value resides in the acquisition and treatment of data. The data collected through a 'network of flying servers' is more valuable to the agronomist who is able to interpret it and provide advice based on the information. However, in the case of full automation, the whole system can perform all stages of the process: data collection, interpretation, and decision making.

The technical barriers related to UAVs have been overcome during recent years. In a knowledge economy where products and services are in general software, hardware is not that important anymore. However, by shifting towards a concept where UAVs are part of a network for data collection, the industry has managed to raise interest for their production

and derived services. There is a need to educate people about the actual applications and utility of this technology and prepare the market for the future developments.

The end users tend to focus only on the acquisition of data points; given the costs and resources associated with the acquisition of UAV data, visibility amongst a professional set of end users is required. Therefore helping the UAV data providers gain visibility amongst business rather than individuals as end users by clarifying through that this technology is not just about lifting a device in the air for leisure purposes, but rather about developing the means and planning strategies to obtain, process, and package data in an operational manner for business purposes is vital and challenging.

4.2. When a ground machine fails, it stops working; when an airborne machine fails, it falls from the sky

Security and safety are a major challenge for the industry. It is important to notice that UAVs are machines operating in the air, and as such, if a system fails the damages on the ground may be important depending on the energy and safe distance from people on the ground. Danger and fear of flights above crowds call for an assessment of circumstances under which such operations may or may not be prohibited. To which extent flights above people in cities or populated areas will be allowed? Under which safety framework and with what purpose?

In contrast to ground machines that can be repaired when they fail, when a UAV suffers a malfunction and fails it falls on the ground, causing possible damages. Therefore safety and trust are also barriers for market development. Since the risk was so important during the early years of the technology development, it was also difficult to convince consumers and regulators about its potential benefits.

Security and safety also need to take into account the risk of invasion of the manned aviation airspace. Specifically, depending on the mission and its utility, UAVs may be required to fly within direct visual line of sight of the operator, at an altitude not to exceed 150 meters above the ground or water, and outside specified areas (such as airports, areas protected for environmental purposes, or areas like military installations that are cordoned off for security purposes).

Cyber security also has implications in the development of a regulatory framework since UAVs can be hijacked and their initial purpose and utility can be detoured for other ends[13].

The assessment of air worthiness and security risks is closely related to the environment in which specific and certified UAV operations are conducted. UAV products and services operating near or above crowds can be socially acceptable if the vehicle integrates safety functionalities such as risk mitigation procedures when control links are lost. As a general challenge, the industry will need to demonstrate that potential damages will be prevented before society significantly accepts and supports the technology and its applications within dense and populated areas. Potential damages also bring to discussion the role of the insurance sector in this type of situations.

A starting point for better and homogeneous regulation would be the development of mechanisms and incentives for the rapid diffusion of safety technologies and the accompanying rules that would enable safe UAV missions over crowds. Nevertheless, as it was the case with manned aviation, regulation is likely to lag behind and will only be properly designed and adopted as accidents take place.

The future of the UAV industry will be shaped by the ability of manufacturers and service providers to reach new customers and enlarge the base of commercial activities. This enlargement will naturally take place as the benefits and reduced risks with respect to manned aviation are acknowledged by the population.

4.3. Need for commercially oriented investments and resources

Since the industry requires heavy investment for proof of concept; its growth rate is rather small. As a consequence, access to different financial sources is vital to companies in the industry (which are mostly represented by SMEs rather than large aviation groups). Alternative sources to banks represent nearly 50% of resources, including Business Angels and Venture Capital.

On the other hand, financing rounds also involve private investors. Government loans are seen as administratively burdensome during the early stages of a start-up. Other incentives and instruments such as tax credits on the basis of jobs and salaries have been useful, while on the other hand subsidies are ‘a no-go’ since they often benefit large companies with small developing units. In case of SMEs they restrain them to concentrate only in the research and development, hindering the commercial orientation.

As a result, SMEs have difficulties in developing their business vision, and they risk being locked in a dynamic where subsidies are required to survive. For this reason, in spite of significant availability, government guarantee schemes and other forms of public funding represent a potential distortion. They create a dependence on public aid for research and development instead of increasing commercial orientation.

Moreover, procurement and tendering processes are not entirely suited for the purchase of innovative technology. These processes are usually long and burdensome, in

particular in the field of surveillance which is the principal market for UAV products. Incremental innovations take place rapidly with respect to the timespan of a procurement process – by the time a public agency finally decides to purchase a given technology, it is likely to have significantly improved. In consequence, technical changes may lead to changes in price and utility for both parties affecting the purchasing procedure.

Finally, access to investment is also problematic in Europe. Market for Venture Capital and risk finance is often not well developed and varies across several Member States. In this situation, finding investors that could rapidly step in is difficult.

The limited capacity to attract large investments for structural development and international scalability will have a negative impact on the competitive advantage that some European countries have over the rest of the world in terms of technology and existing rules for commercial exploitation (e.g. even if the European regulatory framework is not homogeneous, rules on commercial UAV operations are more advanced with respect to the USA).

4.4. UAV systems form an industry that requires global visibility and informal collaboration

Access to networks of informal collaboration with other companies in the industry as well as with universities is vital for companies developing UAV technologies. Collaborative R&D benefits from the involvement of expert advisory boards within technology development projects. A demand driven approach is ultimately intended to stimulate a viable commercialisation technologies developed with a business oriented vision. It helps frame the scope of ideas to be explored according to what is relevant and what is not for technical implementation.

Support for networking and internationalisation is also important. Without support to attend international exhibitions and matchmaking events, it is difficult to get visibility in the global market and secure clients or cooperation with other companies.

One of the most important drivers for the growth of SMEs in the industry is the access to networks of informal cooperation among companies within the sector. For start-ups the typical business support is important. For example they benefit from the support offered by incubators (workspace, administrative paperwork, accounting, etc.). It helps to reduce costs, and gives access to close cooperation with other start-ups.

"Networks of informal cooperation provide access to knowledge and technological solutions at at hand when needed; they represent 'a modern way of doing businesses" ***- Aerialtronics***

Access to exhibition events and trade fairs is also important, in particular to demonstrate the technology and gain future clients, although access fees are usually high and regarded as a substantial investment. As a consequence, companies within the industry take the initiative of sharing costs and exhibition space therefore cooperating and reducing the size of investment. More reasonable costs for start-ups would be welcome.

Internationalisation events would be more useful if instead of adopting a pay-to-show approach they would adopt a help-to-show approach where all support is provided to the SMEs, from the fund raising for the event, to the set-up of the exhibition, to the ex-post communication about the outcome.

5. Policy recommendations

UAV systems have a strong potential and could have a substantial impact on many industries. However, the role of public procurement could be enhanced to further support their development. The industry also requires resources and help to recruit a talented workforce.

5.1. Tailoring Public Procurement for the purchase of UAV integrated solutions

Today, the market for UAV services and missions for surveillance and mapping is highly institutional. Advancement in innovation and technologies related to the development of these vehicles is usually sponsored through institutional purchases and support. However, when the innovation is not ready, the most important challenge for an SME is to gain access to supporting sources such as early stage public procurement. Unfortunately, this process is often seen as too long, burdensome, and not tailored to address the uncertainty, risk and need for flexibility in the development of innovative products as is the case of UAVs.

Adjusting Public Procurement to the characteristics of UAV products and services

The principal issue regarding the purchase of technology by the public sector is that very often purchasing agents do not understand what the technology is actually about and are therefore unable to describe the technical specificities they require and the prices they are willing to pay correctly. Adapting procurement procedures to the uncertain nature of innovation would be useful to increase support for SMEs, and avoid non optimal utilisation of public resources. Procurement should therefore be broken down into smaller 'innovation stages' in contrast to current practices where by the time a decision is reached on whether to buy a technology, the innovation has already moved forward rendering the object of the procurement process obsolete. Breaking down procurement into tailored lots with smaller purchasing amounts for the acquisition of technologies at different stages of an innovation process, which can optimise the public support for their development rendering is more dynamic.

5.2. Incentives to improve the UAV industry's attractiveness to risk capital

The development of UAV technologies is capital intensive for companies. At the same time in this particular market, access to funding is difficult because of its novelty, and underestimation of potential economic benefits coming from commercial use of the technology (generally thought of as either military or leisure machines). It is therefore necessary to develop support mechanisms and resources to accelerate faster growth of the industry.

Support to SMEs to attract financing rounds and access public financing schemes

Even if the situation has been improving, and the industry is being taken more seriously, it is not sufficient to attract substantial resources. Supporting mechanisms for SMEs are therefore recommended, to improve their access to funding. Short loans to businesses according to the stage of development of the innovation could be a solution. However, increasing the availability of short-term loans can have administratively burdensome implications which need to be balanced against the actual benefits from wider access to financial resources.

"The future of the industry will be shaped by its current ability to attract investment ", ***Redbird***

5.3. Reinforcing support for the recruitment and retention of talent in a global industry

The availability of competent and skilled labour force and access to research resources is a determinant factor for the development of the technology. The UAV industry and its applications for surveying, mapping, and modelling are currently absorbing a large base of embedded engineers and technicians, although competition is fierce on a global scale.

Apprenticeships and 'learning-by-doing' programmes are necessary to increase the availability of a base of skilled human capital. Education is therefore one of the principal pillars for technology development. Access to technical skills and apprentices can be facilitated by a 'maneuvered education' with strong emphasis in life sciences and apprenticeship creating benefits from 'learning-by-doing' programmes and apprenticeship with strong focus on applied life sciences.

Stimulate cooperation with higher educational institutions

Initiatives designed to stimulate close collaboration between the industry and universities popular and recommended to facilitate access to talented human resources, and technical solutions where long term research is needed and expertise is missing.

Companies often establish research cooperation with universities during the development stages. This cooperation usually takes the form of research outsourcing and advisory boards to 'solve specific problems by screening relevant ideas and applying the resulting solution to the company's products and services'.

5.4. Designing rules that acknowledge responsibilities and economic opportunities

In spite of fast developments on the regulatory framework, the associated regulation across European countries regarding the exploitation of UAV technologies outside the scope of military missions is still heterogeneous across Member States. Rules for the commercial activities related to the exploitation of UAV missions are either lacking or highly variable across Member States when compared to other economic blocs. This situation is accentuated by the fact that very often decision makers are not well informed about the technical capabilities and challenges generated by technology, making it difficult to create an appropriate regulatory framework in the absence of technical knowledge. A homogenised regulatory framework is therefore needed across Europe.

"The future of the UAV industry is likely to be shaped by airspace congestion, which is why a homogeneous European regulatory framework for UAV operations that acknowledges not only responsibilities but also economic opportunities and benefits is urgently needed – ***UAV Factory***

Proposing appropriate rules about how, where and when to operate UAVs

A common legislation needs to provide a clear legal framework with details about how, where, and when UAV systems are allowed to fly over specific airspaces. In addition, privacy issues need to be dealt with by governments and companies who have the responsibility to ensure transparency in the acquisition and utilisation of UAV systems.

As an illustration, the framework recently proposed by the European Space Agency on regulations related to UAV operations must not simply transpose the existing rules on manned aviation but rather create an appropriate one for UAVs taking into account incremental innovation, investment, and risk within the industry, allowing companies, in particular SMEs, to exploit business opportunities. Since the largest share of the UAV market is currently highly institutional, the specificities of rules related to the defence sector and manned aviation make it difficult for companies to face a wide market and require them to adapt to each country's regulatory framework.

Safety issues concerning the introduction of UAVs in the civilian airspace imply the possibility that accidents may happen, therefore liability definitions and insurance mechanisms need to be considered. The need for a safety framework and the identification of obligations towards victims requires the development of a legal framework for liabilities and insurance practices.

6. Appendix

6.1. Interviews

Company	Interviewee	Position
Aerialtronics	Lucas Van Oostrum	CEO and Co-Founder
UAV Factory	Tiit Paananen	CEO
Redbird	Thibaut Miquel	Business Developer
Defendec	Jaanus Tamm	CEO

6.2. Websites

Company	Web address
Aerialtronics	www.aerialtronics.com/
UAV Factory	www.uavfactory.com/
Redbird	www.redbird.fr/en/
Defendec	www.defendec.com/

6.3. References

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