Drone Business Development Guide

The comprehensive guide for a successful start into UAV operation

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Content

1 How to get drones to work

1.1 Why drones are a thing now

The remote radio-controlled aircraft is not a new invention. In fact, successful design of these flying machines started six decades ago. UAVs (Unmanned Aerial Vehicle), commonly known as drones, are well known nowadays but they are mainly used in the military sector to survey and intervene in dangerous territories where human beings might be exposed to a certain level of threats. In addition, public authorities started realizing the benefits of surveillance by air they started allowing the use of drones nationally. As technology evolved significantly in 2013, drones became a commercial product for recreational purposes. This evolution continued and soon platforms and payload systems advanced to such a level that it encouraged the commercial use of drones. UAVs moved from a governmental phase to the consumer phase, thus establishing new industry verticals.

There was no single technological breakthrough that made drones suddenly possible. It is the result of the aggregated effects of many incremental technological improvements.

Amongst many others, one of the main drivers that encouraged the commercial production of drones is the smartphone industry. To fly a drone you need an advanced stabilization system, which primarily relies on accelerometers and gyroscopes. Owing to the evolution of the smartphone industry, low cost micro-electro mechanical systems became available in the last decade.


military UAV

governmental UAV


commercial UAV

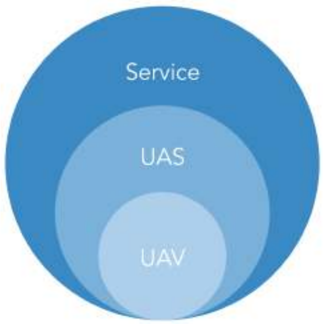

recreational UAV

Moreover, small high-torque permanent magnet brushless motors and powerful microcontrollers became affordable to hobbyists. Finally, thanks in part to the smartphone industry, there are several remarkable advancements in the GPS system that allows higher accuracies and cheaper GPS modules. As a result, the barrier for the further development of these systems has been reduced.
This technology-driven evolution has reduced the costs of producing a drone, thus making it possible to add payload like cameras even to small drones. Since small drones (<5kg) require less paperwork, they were quickly proliferated and soon they started filling the shelves of retailers and occupying the skies.

1.2 Definitions

In this chapter, we will introduce the technical terms used in the world of drones and we will explain how they are related to one another.
A drone or UAV (unmanned aerial vehicle) is an aircraft that consists of components such as a frame, engines, flight controller and batteries. When you attach a sensor such as a camera to an UAV and link it to remote controls, the result is an UAS (unmanned aerial system). In fact, in a helicopter configuration (single-rotor, multi-rotor, hybrid) this UAS is capable of VTOL (vertical takeoff and landing). Fixed wing UASs are often launched by hand or via pneumatic/ hydraulic launcher and it lands like a regular airplane.

By adding a commercial application to your UAS, you can provide unmanned-aerial industry solutions or services.



Most of the UAS are controlled within VLOS (visual line of sight). Some can fly BVLOS (beyond visual line of sight) and/or completely autonomous. In autonomous flight mode, a UAV follows a predetermined flight plan and relies on its sensors to fulfill the mission. The flight is usually controlled or observed via telemetry.

1.3 How to get things going

When you consider starting to use UAV technology there are two options: make or buy. You can either dive into UAV operation yourself and produce the results according to your needs or hire a professional service provider.
The next question you should ask yourself is this: Am I allowed to fly the intended mission and do special requirements apply? The appropriate regulatory bodies will inform you about what types of operations are allowed and what requirements must be fulfilled.

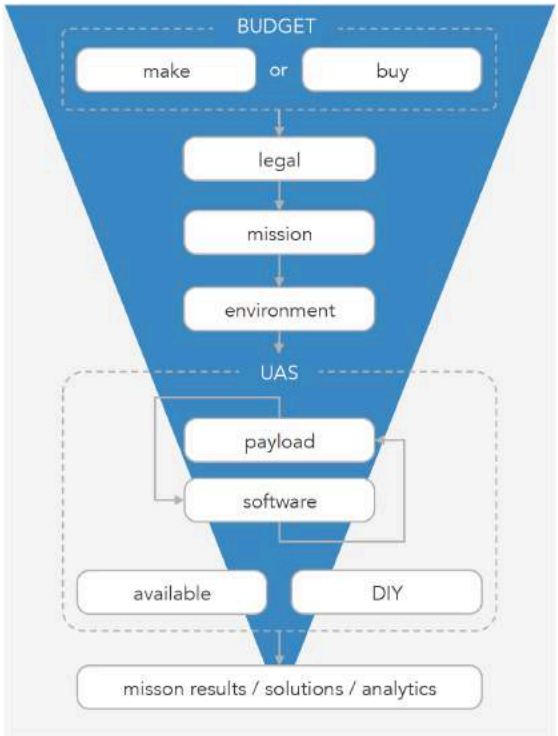
UAS follows mission

A precise definition of your mission will define the UAS. Therefore, it is important to collect as many parameters as possible to guide your plans. It is also important to consider under what conditions the UAV is going to fly (urban area, freezing-, or tropical conditions).

After defining your aims and objectives, you can then focus on the UAS. Collect all the specifications for payload (weight, power consumption, quality of results, costs, etc.) and software (system requirements, cloud-solution, costs, etc.).
Make sure platforms are able to carry the intended payload (camera, sensor, etc.) within the mission requirements (flight-time, etc.).
In addition, you have to make sure that the data analysis software is compatible to your chosen payload. Sometimes, you may find a software suiting your mission first.

Platform follows payload

After listing all the specifications, define the platform. To achieve that, check if commercially available platforms meet your requirements in flight performance. If not, consider do-it-yourself- or customized solutions.



With the UAS defined and price tags attached (don't forget costs for training, authorization, insurance and maintenance) you can now assess if the intended quality of data can be acquired in a more cost efficient way.

If all these procedures seem to be too challenging, you can hire a professional service provider for the intended tasks. Even though by out-sourcing the job you need to compromise on flexibility and operational costs, it can save you – depending on the repetition rate of the task – a great deal of time and energy.

2 Legal

The UAV market already has fantastic hardware, software and operational products to offer. However, the key element for global UAV success story is not just defined by these aspects – it largely depends on local regulation.

2.1 Regulatory progress

As it shows in the development and success of commercial UAV operations, the progress of existing (or non-existing) domestic UAV operation regulations is essential.

1. Several countries, which have already implemented a regulatory framework, show a significant increase in UAV market activities and investment shares.
2. Some countries (e.g. France and UK) have implemented a risk-oriented framework that allows complex UAV framework that allows complex UAV operations (BVLOS, autonomous) if special safety requirements are fulfilled.

The figures illustrated above and below show the current regulatory progress within the European region and highlight regulatory differences among the most sophisticated UAV operation countries:

General requirements						
country	altitude limit	operation permission	UAV pilot certificate	critical MTOW[1]	BVLOS	no. of permission holder[2]
Australia (CASA)[3]	120m (400ft.)	✓	✓	150kg	-	550
EU (EASA)[3]	120m (400ft.)	✓	-	25kg	✓	N/A
France (DGAC)	120m (400ft.)	✓	✓	25kg	✓	2160
Germany (LBA)	100m (300ft.)	✓	-	25kg	-	not published
Singapore	60m (200ft.)	✓	-	7kg	-	not published
Spain (AESA)	120m (400ft.)	✓	✓	25kg	✓	1288
Sweden (TS)	120m (400ft.)	✓	✓	7kg	✓	not published
UK(CAA)	120m (400ft.)	✓	✓	20kg	-	1557
USA (FAA)[3]	120m (400ft.)	✓	-	25kg	-	not published

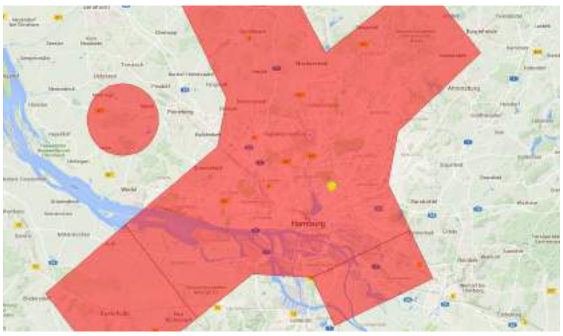
1) maximum takeoff weight: every MTOW above requires manned aviation requirements | 2) demonstrates the UAV traffic | 3) proposal only – not published conditions

France, Spain and UK are the leading European countries in UAV operation. The regulatory frameworks in these countries have evolved for some years and have reached an advanced status. Although our insights show that the US have the strongest funding (60% of worldwide UAV investment value) and the largest UAV platform sales, they have yet to deal with challenges regarding unapproved regulation.

2.2 Airspace integration

To ensure safety, environmental protection, as well as security and privacy, limited flight zones and criteria for the usage of these zones cooperatively are mandatory. In addition, many authorities separate unmanned aircraft operations from normal manned aviation by limiting UAV operation capabilities (VLOS, altitude limits, etc.).

A full integration of UAVs into non-separated airspace requires essential technologies which do exist but are not yet mature enough for cross-regional implementation due to missing technical standards.



Restricted UAV operation zones will be considered in the future (Source: Altitude Angel, www.altitudeangel.com)

2.3 Privacy protection and security

There are diverging opinions about UAVs. Mainly because they possess the potential of surveillance at a degree former methods of video surveillance were unable to achieve. These new features have a high impact on peoples' acceptance of UAVs.

Regulative and technical standards, as well as transparency and constant promotion of the safety aspects are good methods to mitigate the fear of UAV operation:

- operators self-registration on a web based application
- chip, SIM-card, transponder installation on the platform
- standardized tools to inform the public about local regulations and temporary restrictions
- registration and announcement of operations in controlled airspace
- mandatory commercial UAV insurances

All actions have the same approach: collecting data to ensure transparency of the unmanned air traffic below 150m and to avoid harm to privacy and security of local communities.

3 Commercial applications

Today, there are many ways to use an UAS professionally and as the technological evolution continues it can be expected that a lot more use cases will emerge. From the industry's point of view, UAVs are enabler – for new business areas and for streamlining existing business processes. There are already many highly sophisticated solutions on the market while research and development is still progressing.

UAV platforms are becoming increasingly capable to carry heavier payloads and fly longer distances, while payloads (cameras, detectors, etc.) become smaller and lighter. These two complementing developments will accelerate the growth of the UAV industry over the next decade, opening unprecedented opportunities.
Some of these applications will only be efficient if BVLOS/autonomous operation become available. Generally, only manually controlled VLOS operation is authorized (BVLOS/autonomous on individual authorization). Even though, there are some highly advanced concepts around, UAS for delivery are still in the testing phase.

There are plenty of niches waiting to be occupied but the predominant question remains:

Is using UAV technology the most economical way to do things in your business?

UAVs offer huge advantages to many business processes. The possibilities of air-transported-payloads provide new opportunities at a relatively small investment. Yet, time- and cost-related advantages must exceed the potential disadvantages. To quantify these issues and to make your entry into the UAV world as smooth as possible, we provide the necessary guidance for you and your business.

4 Payload

Payload mainly consists of active systems like sensors, but it can include passive utilities like cargo or spraying-mechanisms as well. The following chapter will give a brief overview of the most typical payloads.

4.1 Passive payload – cargo

UAVs are used in combination with passive payloads to transport cargo from one point to another. Passive payloads can include a large variety of goods and equipment.

These include the following items:

passive payload	typical mission type
parcels	logistics
medical equipment, defibrillator, blood, vaccine	medical
life raft, first response (infrared camera)	rescue
candies, banners	marketing
pesticides/herbicides, biological control agents	agriculture
various	on mission requirement

4.2 Active payload – sensors

UAVs usually carry active payload that records and relays data. On top of the list are optical cameras, but other payloads also provide extensive benefits. The following table describes the most common active sensors:

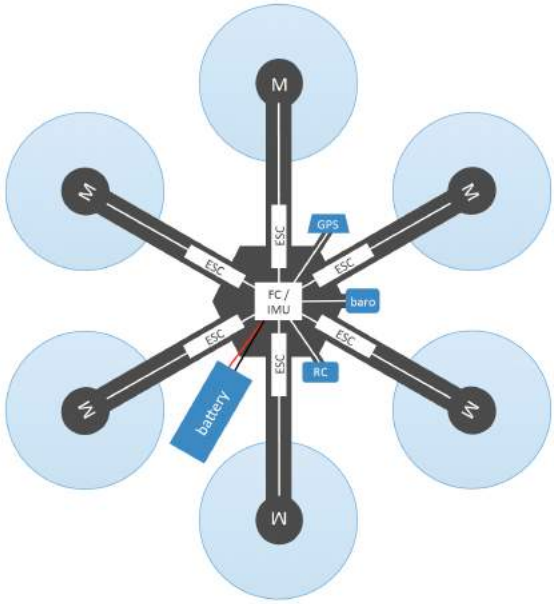
type	description	typical mission type
optical camera	These sensors capture the visible light rays. It can be distinguished between operator cameras which are used for situational awareness and cameras for mission fulfillment. There is a big variety of optical cameras from compact fixed lens, action video cameras, DSLRs up to cinema cameras like REDs.	photography, photogrammetry (mapping, 3D-modeling)
thermo-graphic/ IR cameras	These cameras sense radiation in the long-infrared range (~9,000–14,000 nm). Detecting heat signatures offers a lot of opportunities in finding everything from heat leaks, broken solar panels to runaway life stock.	inspection of housing and solar cells, search and rescue, wildlife protection
multispectral / hyperspectral cameras	These sensors enable the operator to combine different areas of the electromagnetic spectrum to interpret the recorded data. Multispectral cameras capture visible light (red, green and blue), heat (infrared) and a small range of the UV-spectrum (ultraviolet). Hyper-spectral cameras offer a finer resolution of the respective bands. The information gained from these data can be used in agriculture, forestry and mining.	precision agriculture, crop health monitoring
laser scanner / LiDAR / LADAR	Laser scanners or LiDAR (Light Detection And Ranging) is a surveying technology. Here, a laser is used to measure distances and point clouds can be generated subsequently. This technology is used as a tool for surveying and to produce high-resolution maps.	surveying, high resolution mapping
particle sensors	These specialized devices sense emissions/rays of radiation, gas, electromagnetic, vapor and other emissions.	environmental services
other types		on mission requirement

5 Technology

UASs can have very different characteristics. Thanks to this diversity there are good chances for you to find just the right platform. This diversity comes from different configurations and components. Let's have a closer look at the single components of an UAV.

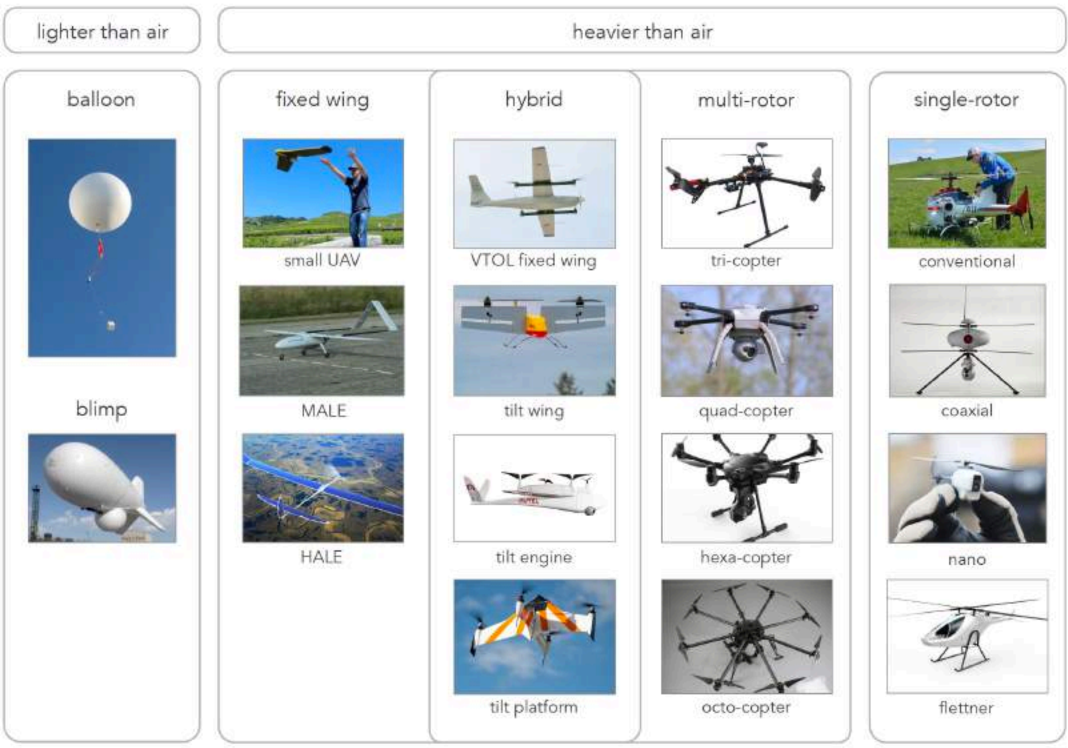
5.1 Basic components

Let us look at a basic hex-copter. The flight controller (FC) including the inertial measurement unit (IMU) is the brain of the platform. It obtains data from subsystems like global position (GPS), barometric air pressure (baro) and commands from the remote control (RC). Based on its' configuration it manages the electronic speed controllers (ESC), which control the speed of the electric motors. Systems and motors are both powered by a battery.



5.2 Vehicles

The basis for safe operation is always is a reliable platform that suits the mission in endurance, speed, payload and range.
Shape and design of an UAV have enormous influence on the execution of the mission. The following UAV categories can be distinguished:



MALE: medium altitude long endurance (15.000 – 45.000 ft.), HALE: high altitude long endurance (>45.000 ft.)

UAV class	UAV platform	description	pros	cons	typical applications
lighter than air	balloon	the most simple UAV with long endurance due to the lifting gas	▪ endurance ▪ simple control by adjusting flight level	▪ no operation in windy conditions close to the ground ▪ usually tethered	surveillance, weather observations, relay-station
	blimp	basically a steerable balloon	▪ endurance	▪ very slow ▪ no operation in windy conditions	marketing
heavier than air	fixed wing small UAV	often mono-wing structures for higher efficiency	▪ endurance/range	▪ can not hover ▪ landing area required ▪ mediocre stability in windy conditions	mapping, agriculture
	fixed wing MALE UAV				military, coast guard, surveillance
	fixed wing HALE UAV				
	multi-rotor (tri-copter, quad-copter, hexa-copter, octo-copter)	a flying platform with more than two rotors - the more rotors, the higher the redundancy	▪ ability to hover ▪ low maintenance ▪ stable flight characteristics	▪ partly redundant (>6 rotors) ▪ low endurance	film making, inspection, 3D mapping
	hybrid (VTOL fixed wing, tilt wing, tilt engine)	combines the advantages of fixed wing configurations (endurance) with the VTOL capabilities of multi-rotor platforms	▪ can hover ▪ low maintenance ▪ redundancy (glides if engine fails)	▪ complex transition ▪ prone to windy conditions at startup and during transition	mapping, logistics
	hybrid tilt platform	advancements in autopilot technology enabled this design reducing the mechanical complexity	▪ ability to hover ▪ low maintenance ▪ redundancy (glides if engine fails)	▪ prone to windy conditions at startup and during transition	mapping, logistics (testing)
	single-rotor - helicopter	classic helicopter design with tail-rotor.	▪ ability to hover ▪ auto-rotation	▪ many moving parts ▪ danger of large rotor ▪ noise	agriculture (spraying), surveillance
	dual-rotor - helicopter (flettner or coax)	intermeshing rotors (synchropter) or coaxial aligned rotors with counteracting yaw effects	▪ ability to hover ▪ auto-rotation ▪ no tail rotor necessary	▪ many moving parts ▪ danger of large rotor ▪ noise	agriculture (spraying), surveillance

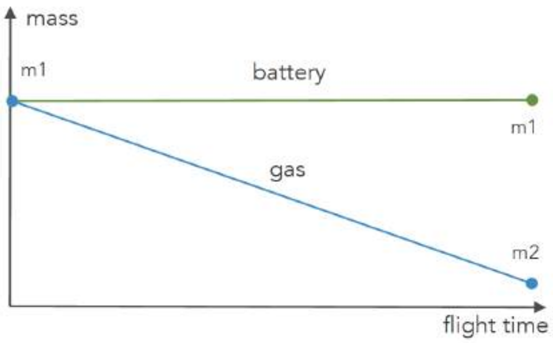
5.3 Propulsion and energy source

UAVs can be powered by a variety of propulsion systems with very different effects on flight performance and environment.

The great majority of UAVs use batteries to power the electric flight control system and motors. The most commonly used configuration for small civil UAVs is a combination of Lithium-Polymer-batteries and brushless direct-drive electric motors connected to a fixed-pitch propeller. The advantages are: no local emissions, a reduced noise level and easy thrust control.

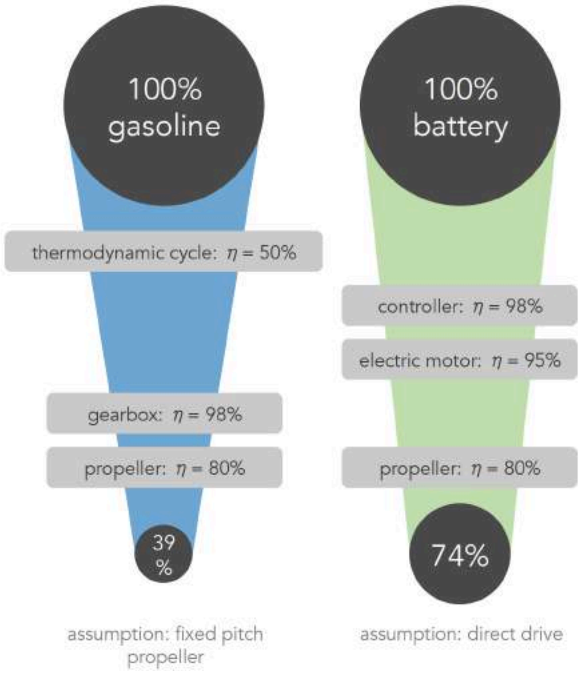
Although batteries are generally more efficient - they are heavy and remain part of the platform for the entire flight.
In addition, batteries account for a lot of weight and space when designing an UAV. They currently represent the most limiting factor for endurance. The good news is that new energy sources are currently being examined and will soon offer very powerful flight performances.
Gas-electric hybrids are not yet available for small UAVs due to lack of installation space. Hydrogen fuel cells are advancing but are not yet ready for mass production.
Solar cells can support an electric system, but they cannot power it from ground up. The big advantage is that the range can be extended simply by slowing down the discharge process of the batteries, which results in a

reduction of weight (less batteries required).
Helicopters are usually powered by gas- and/or turbo-shaft engines.
During flight the mass of burned fuel reduces the weight of the UAS, which then reduces the load on the engine and decreases the fuel flow. As a result the range will be increased on a logarithmic scale.



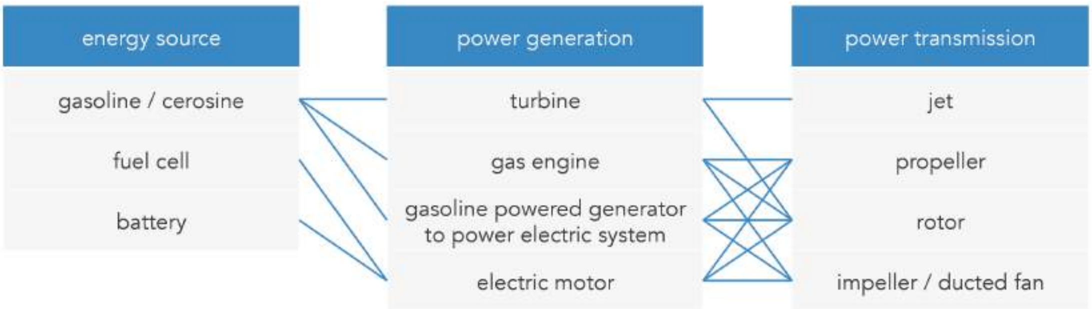
m1 = takeoff mass, m2 = landing mass

Battery powered systems are almost twice as efficient as gasoline powered systems. Yet this does not necessarily mean battery-powered systems are more desirable.



As mentioned before, gasoline powered systems lose weight over time, thus increasing the flight range. The answer to what system is more desirable lies within each individual mission specification.

The following table gives an overview of the most common propulsion systems:



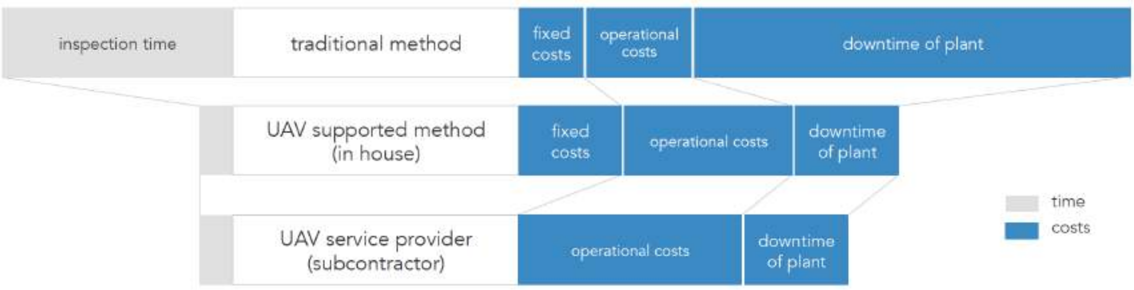
6 Use case example

In this chapter we provide an example of how UAVs represent advantages in an industrial application.
To make this straightforward we skip the part of choosing the right platform and focus on the mission and mission framework.

6.1 Wind turbine inspection

In this example we compare different methods of inspecting a wind turbine.

This is a qualitative illustration outlining three possible ways of achieving the same mission (strongly simplified). Costs are divided into fixed costs, operational costs and costs of idleness of the plant.



In the traditional method you have to shut down the plant, get an inspector to the location, prepare your gear, start roping down, perform a visual inspection, rope up, turn the turbine and start the roping process again and again. The major disadvantage is not just to involve an inspector in a rather dangerous action. In fact, what makes this whole process not just tedious but also very expensive is the prolonged downtime of the plant and the costs of idleness.

Let us compare this to a UAV supported method: you also have to proceed to the location, shut down the plant, set up your gear, gather information via camera during flight, land and analyze the results. Given the same quality of the results as in the traditional method, this process is much faster and reduces costs by minimizing the downtime of the plant. Although fixed costs and operational costs initially increase, UAV technology reduces overall inspection costs in the long term.
Another option is to buy the UAV inspection service from a specialized company (note: operational costs will be higher). However, the advantage is that you will have outsourced the fixed costs and efforts for procurement, training, insurance, maintenance and authorization.

In our frequent and comprehensive reports you will find business specific use cases, analyzed and quantified to demonstrate the full potential of UAV technology along your value chain.

About

Drone Industry Insights (www.droneii.com) is a market research and analytics company based in Hamburg, Germany. We provide insights, competitive intelligence and market data for the commercial drone industry. Our consulting services range from operational issues up to corporate strategy solutions.

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