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## Precision Agriculture Drones

### *What is Precision Agriculture?*

Precision agriculture is a farming management that observes, measures and responds to inter and intra-field variability in crops. Its main goal is to help farmers to optimize *crop science* by matching farming practices to crop needs, *environmental protection* by minimizing the farming footprint, *economics* by increasing the competitiveness through better practices and implementations. Precision agriculture measures different variables such as crop yield, terrain features, organic matter content, moisture levels, nitrogen levels, PH and other. It is considered to be a key component of new wave in modern agricultural revolutions and comes in the form of satellite imagery, weather prediction, fertilizer application, crop health indicators.

Precision agriculture is a new step for farmers as it also requires recording the farming activities, improving decision making process in agriculture, improving relationships with landlords and increasing the quality of agricultural products. The use of mentioned competitive activities created the understanding of prescriptive planting which is a type of farming system that requires data-driven planting in order to maximize yield (J. Bunge, 2014).

Precision agriculture is usually done in four sequential stages, as follows:

1. **Data collection:** Geolocating the necessary field helps the farmer to have information gathered from analysis of soils, crops and soil resistivity. Delineation of the field can be done either using an in-vehicle GPS receiver or on a basemap derived from aerial imagery.
2. **Variables:** Agricultural sphere covers number of variables that can be grouped into permanent indicators and point indicators. These include variables about climatic conditions, soils, cropping practices, weeds, disease, etc.
3. **Strategies:** Using soil maps, farmers have a possibility to implement two strategies which are predictive approach (based on crop cycle static indicator analysis) and control approach (information from static indicators is regularly updated during the crop cycle by sampling, remote sensing, etc.).
4. **Implementing practices:** The implementation of precision agriculture includes the use of technology on agricultural equipment such as sprayers, tractors and others.

### *What is the role of drones in precision agriculture?*

During the last few years new technologies and techniques are continuously being employed to turn the data collected into usable information and low-tech industries such as agriculture have also become included into these changes. The new era in agricultural activities brought hand-written notes and analysis of farmers into robotic data collection and analysis through modern software, remote sensors and drones that are being created to improve yields and profitability in line with the sustainability. These improvements required investments totaling to \$4.6 billion

(the major part in the software and technology) only in 2015 in order to bring traditional agriculture into digital agriculture (L. Burwood-Taylor, 2015).

Drones today are able to provide farmers with three types of detailed views.

1. The view of the crop from the air can make noticeable things that cannot be seen easily while using traditional methods.
2. Cameras can take multispectral images that help to create a view of crop to show the health level which is unable for a naked eye.
3. Drones survey crops every week, every day or even every hour, is able to create time-series animation, to take crop management into a higher level.

Drones will give agriculture to plan and make strategy on real-time data gathering and processing. There are six general ways that drones can be used in agriculture (M. Mazur, 2016):

1. **Soil and field analysis:** Drones can produce 3D maps for early soil analysis that can be very useful at the start of the crop. After the planting phase is done, soil analysis implemented by the drones delivers data for irrigation and nitrogen level.
2. **Planting:** Drones give an opportunity to shoot seeds and plant nutrients into the soil, providing the plant and the soil the nutrients needed for healthy life.
3. **Crop spraying:** Drone adjusts the altitude as geography varies base on the technological advances avoiding smashes. Having these characteristics drones are able to scan the ground and spray the right amount of liquid on the plants. As a result farmers have higher efficiency and lower consumption of chemicals and time.
4. **Crop monitoring:** Large fields make several obstacles for farmers as it with the size of the fields it becomes more and more difficult to monitor the crops. These obstacles become more dangerous with unpredictable weather conditions. Drones are able to help the farmers to fight also these problems giving them an opportunity to have time-series animations and unlimited photo-shoots for monitoring purposes.
5. **Irrigation:** Drones with appropriate sensors can give a chance to identify the parts of the fields that need water or other improvements. These sensors also help to calculate the vegetation index after the crop grows, showing the health and growth of the crop.
6. **Health assessment:** Agriculture always struggles to provide healthy products to the consumers so the assessment of health of agricultural products is of high importance level for all the farmers. Drones are able to scan the crops using specific lights. The outcome can be multispectral images that help to track changes in plants and indicate their health. A fast alarm can be sent to the farmer if some diseases are discovered, so farmers can monitor the sickness in a precise way. This will help the farmer to overcome the diseases in the field.

*What are Pros and Cons of drones in precision agriculture?*

Drones encountered technical controversies in the past and it has its advantages and disadvantages in the farm use which will be introduced below.

## Pros

- **Analysis:** Drones are good to be used for soil and field analysis that make available almost all the information about them.
- **Ease of use:** unlike traditional aircraft, the drones are easier and more understandable to use.
- **Mapping:** Drones make the survey of land and measurement of the area easier than farmers traditionally do. So once the drones are optimized, they can make images or spray fertilizers.
- **Prevents infestations:** Drones are able to show the farmers the currency of any animal or insect infestation which can save and increase the health of the field by ultrasonic waves.
- **Moisture monitoring:** Farmlands are usually either drier or wetter than needed and drones can help the farmers to detect both types of phenomenon in the fields that can help to save the crops.
- **Reducing operational costs:** Mainly labour costs are reduced by use of drones. Drones can be seen as alternative manpower to the farmlands that assist the farmers in different aspects.
- **Increase yields:** Potentially finding yield limiting problems can help farmers increase production and efficiencies to higher yields.

## Cons

- **Flight time and range:** Most of drones have short flight times averaging in 40 minutes which can make limits for several things such as the acreage, the radius covered during on flight, etc.
- **Initial cost of purchase:** Drones constructed for agricultural use are costlier as they are equipped with the necessary equipment and software.
- **Laws:** The use of drones for agricultural purposes is considered as commercial use of drones so the farmers need to have a remote pilot certificate or hire an operator to drive the drone.
- **Connectivity:** Most of the farmlands worldwide have little online coverage if any which means that farmers using drones have to either invest in connectivity or buy a drone capable to store data locally in order to process it later.
- **Weather dependent:** If it is very windy or rainy outside it may not be possible to fly the drones.
- **Safety concerns:** Drones can create problems if not flown properly hitting people or vehicles.

- **Time commitment:** it takes more time than most expect from someone who has passed their drones systems test.

Drones have a growing role in agriculture assisting farmers to visualize their crops across their farmlands. Farmers usually have an increase in ROI after they start using drones. Drones help to save time and crops and to avoid losses from infestation and weather changes.

It is expected by different scholars and companies that precision agriculture will fundamentally change agribusiness transforming almost everything in the value chain. Global Market Insights in its turn forecasts that the market size of drones specialized for agriculture will reach \$1 billion having around 200000 units by 2024. Farmers just need to realize that drones are the ticket to financial success and a better place to live.

## Environmental Applications

### *What is the Environmental Application of Drones?*

One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing critical and irreparable harm to the Earth. One of Environmental pollution basic types is the air pollution, which is the most harmful form of pollution in our Environment. It is caused by the damaging smoke emitted by vehicles and factories. Evidence of increasing air pollution is seen in various breathing problems and diseases along with severe and irreparable harm to flora and fauna. Even the most natural phenomenon of migratory birds has been laden, with severe air pollution preventing them from reaching their seasonal metropolitan destinations of centuries. Today many companies from different parts of the world are trying to decrease this phenomenon by reducing their environmental footprint. The industry of drones is an inseparable part of this worldwide project and tries to find environmentally friendly solutions to the current issues. Drones help to not only decrease air pollution levels, which are harmful especially for people life, but also make the lifestyle of each of us easier and more comfortable.

At first sight it is a little bit difficult to imagine how important the drones can be in environmental protection processes, as when we think of drones, most often we think them to be used for military purposes. Despite its common association with the military, drones are increasingly being used to sustain and improve the environment and already have a special mission: *saving the Planet*.

The enrolment of drones in protecting and conserving the Environment helps to gather accurate and timely information in a non-harmful way. Drone technology suits a numerous environmental protection applications - offering quick, easy and cost-effective aerial imagery. In the scope of Environmental protection there are many reasons why professionals such as environmental engineers and scientific researchers are increasingly using drones. The area of drone use may start from glacial feature modelling and erosion monitoring to animal counting and species identification. The list of projects that drones are being used for is long and continues to grow. Here are some of them which should be discussed in the scope of Environmental Applications of Drones.

- **Sustaining sustainable energy:** One of the areas we are most likely to find drones at work these days are on solar farms. Solar farms can cover anything from one to one hundred acres and maintaining them manually can be both impractical and dangerous, especially as engineers often want to inspect panels for defects when the sun is at its most powerful. As the solar electricity plants are larger, bigger and beyond the kind of scale that humans can handle the scientists have created *thermal imaging cameras* which provide an aerial overview to pin-point panels that might be damaged, covered in dust or obscured by invasive vegetation. Engineers then process this information and return to these specific locations to fix the panels at convenient times, making for more efficient maintenance. Drone inspections are keeping large-scale solar energy projects running around the world and mapping capabilities are assisting solar companies in the planning and building of solar farms.

- **A mission on emissions:** Protecting the Environment by mapping industrial emissions has its important role in drone industry. When we think of mapping it is often in relation to real

estate or agriculture: developing an in-depth view of an area that can be used for planning and modelling. But one start-up in Finland called **Aeromon** (<http://www.aeromon.fi/>) is able to detect, measure and visualize more than 70 different industrial emissions and map air quality over large areas. With their solutions you can have automatic reporting of our emissions with a 360 degree view. In the past, these emissions might have gone undetected because emissions sensors at ground level or higher altitudes would have missed them, but the flexibility of Drones means the data provided gives authorities more power when it comes to enforcing emissions legislation. With emission targets being set around the world in a bid to slow down global warming, it is easy to see how technology like this can help governments and authorities keep factories and fossil fuel companies in check. As says the **Aeromon** team *“Emissions are complicated. They may be undetectable, but their damage is real.”*

- **Environmental conservation projects:** As well as being environmentally friendly in terms of performance, drones can help in the application of environmental research projects and wildlife preservation. Their agility and compact size mean they can be quickly deployed to monitor hard to reach areas with minimal impact. This makes them ideal for environmental observation projects from monitoring and mapping natural landscapes to tracking animal migration patterns. Small and light electric-powered drones, especially fixed-wing aircraft, make little noise and are often bird-shaped, meaning animals on the ground are rarely disturbed by these tools, if they notice them at all. Equipped with infrared cameras, drones are being trialled in hot and remote locations, to detect leaks in underground water pipes in the desert.

### *What are Pros and Cons of drones in Environmental Application?*

#### **Pros**

- **Environmentally friendly:** The big advantage of using a drone in the sphere of protecting Environment is that they are doing their missions causing minimal disturbance to the surrounding environment and wildlife. In comparison to other aerial vehicles the drones have the smallest motors which help to have as fewer emissions as possible. Most drones do not operate using fossil fuels meaning that they do not produce the high levels of CO<sub>2</sub> associated with planes and helicopters which makes them a more environmentally friendly alternative for aerial works.
- **Flexible:** Another valuable advantage of drones is that they have an ability to reach areas that were before too hard to access for conservationists and environmental researchers, while also generating minimal disturbance to the surrounding wildlife and environment, make drones a powerful tool that can give researchers the freedom to gather information like never before.
- **Safety:** One of the large benefits of using a drone over alternative methods is the added safety value they can provide. People who work in remote or more dangerous locations do not have to be put in harms way if they have to do aerial surveys over parts of the jungle, or, f.e., in the Arctic. Also we can mention that the launching a drone requires a minimal amount of workers which is also a good benefit for it.
- **Non-noisy:** One of the added bonuses is that the drones make minimal noise while they realize their missions. This means that the wildlife and surrounding nature can be monitored undisturbed, which is very important thing while we do some researches in in wildlife.

- **Small sizes:** Mostly the drones are lightweight, low-cost, require little in the way of infrastructure and, crucially, use little or no fuel, as we already know. All these mentioned factors are considered to be pros for drones.
- **Drones for environmental monitoring:** Photographers and videographers have started to use drones to produce stunning images of wildlife that would be very hard or expensive to obtain otherwise. Drones can be used to perform environmental science as well. Often, scientists want to monitor one particular area for a period of time in order to track changes. For example, a buoy could listen for whales in a particular region. A robot could fly out to get that data, which then could be used to establish safe shipping lanes. A robot would be able to repeatedly see what's going on with a population or a microhabitat. Scientists probably don't have funding to send people out every day but they still could get really good readings.
- **Overall Conservation:** Drones can be used to track animals, particularly dangerous animals, without putting anyone at risk. They can also be used to watch for poachers and trespassers, increasing security in areas where there is simply too much ground to cover. Additionally, drones can be used to provide aid when natural disasters strike. Whether it is to comb an area after an earthquake or flood to look for survivors, or fighting fires by delivering payloads, drones are a powerful tool in the fight to keep wildlife, and wild areas, safe.
- **Brand new technology:** Drones are allowing people to ask questions and look at things that they may not have been able to look at before!

## Cons

When we try to speak about the negative impact of using a drone to the Environment, it is difficult to make a list and mention disadvantages, because the drone has a high level of conservative effect and almost completely has positive impact on our Planet.

In base of the above mentioned information we have already imagined the connection between the drones and the Environment, and found out that causing minimal disturbance to the surrounding environment and wildlife, the drones in the air can perform surveys, collect data and imagery, monitor wildlife and varying landscapes and even track or count animal populations. We have explored that drones – being a brand new technology hold a wide variety of advantages to those looking to aid in the protection and conservation of the environment and its wildlife. Drones most crucial advantages are that they are *timely, efficient and cost-effective* due to which now many conservationists and environmental researchers are aimed to enlarge the drones using spheres protecting our planet and making it to be more conservative. The drones have all the potential to become more widely available across the whole spectrum of environmental monitoring in near future and they will!



## Industrial Applications

### *What is the Industrial Application of Drones?*

In the beginning people were looking at drones as just another way to get pretty pictures or video, but now these people are starting to realize that these have an immense power for doing research from perspectives that we never thought we could get.

The innovation of an industrial drone is to monitor regions or terrains inside or outside a manufacturing plant which generally cannot be studied by human workers, either due to their dangerous setting or inaccessibility due to size or Environment. Factories, refineries, power grids, wastewater treatment, mines and other similar industrial sites are complex systems requiring inspection and maintenance for optimal operation and regulatory compliance. On site inspection by human workers can be time consuming and in explosive environments, next to impossible unless some complex computer systems are used. Industrial drones can operate under complex circumstances such as these and enter even the most challenging terrains and environments and carry out the operation it was designed for without so much as a scratch. From this it is clear that drones are the next generation in low-cost industrial sensors and mobile platforms in the interconnected web.

The growth of drone industrial application can be seen in its use in various industries, such as:

- **Energy and Utilities:** Part of making our electrical grid smart is getting access to real-time information on the status of power generation and transmission infrastructure. Utilities have already tested drones for inspecting transmission and distribution lines, looking for damage from storms and normal wear and tear. These tests have been run under temporary rules from the Federal Aviation Administration and utility companies are now ready to further demonstrate the value of drones. Imagine a utility that had a drone in every single line worker's truck. Workers could perform inspections without having to climb power poles or get close to dangerous wires. Drones can also inspect hundreds of miles of transmission lines in single flight - much faster than the traditional line worker having to climb several transmission poles.
- **Oil and Gas:** Drones are increasingly being used by the Oil and Gas industry for their monitoring and inspection operations. They are being used today to detect gas leaks, spot fugitive oil spills and even scout for whales. They can be used on any part of the platform where inspections typically require rope access or scaffolding. Today drones are predominantly used in the midstream oil and gas sector. But they can also be applied to almost every aspect of the industry, including land surveying and mapping, well and pipeline inspections, and for security purposes. The key benefits are that they are much safer, faster and cheaper than conventional inspection techniques such as rope access and scaffolding. The use of drones means that oil platforms do not have to shut down for

inspections. This is a huge cost benefit as shutdowns cost oil companies millions of dollars in lost revenue a day.

- **Mining:** Anyone involved in mining knows that worker safety is of paramount importance. By allowing surveyors to collect accurate spatial data from above, drone can vastly reduce risk by minimising the time these staff spend on site. Drone-based data collection can also increase productivity; surveying projects that once took days or weeks using traditional surveying techniques are now possible in just a few hours. Drones provide an efficient way to manage stockpiles and help with grading control, site exploration, and overall management. Drones can also help miners figure out more efficient ways to design haul roads, dumps, and pits so they have less of an impact on the environment. Drones can improve safety in mining applications with real-time information on mining activities:
  - Up-to-date surface surveys for optimized blast designs,
  - Rapid pre- and post-blast data,
  - Identification of misfire and wall damage.
- **Construction:** Here bellow are mentioned some reasons why construction firms want to use drones in their activities:
  - Drones are less expensive than manned aircraft. They are easier to operate and collect more data in comparison to alternative aerial vehicles.
  - Drones can be used to survey the construction site and send information back. This usually takes a long time and requires use of various equipment and personnel. Drones are cheaper and they are more accurate in terms of data gathering.
  - Companies can use drones to provide client updates. If they are unable to personally inspect the site, companies can send some images and videos and show details of the construction progress.
  - Drones are also ideal for monitoring the site. Rather than invest in loads of expensive manpower and equipment, a construction company can purchase a few drones and have them scan the area and collect information.
- **Agriculture:** Drones a natural fit with the world of agriculture, where farmers can benefit from real time information about large tracts of land. Drones can help track almost everything including water use, crop health, heat signatures and soil analysis. Expensive aerial surveillances that could previously only be done occasionally with planes can now be completed weekly or even daily with drones that cost only hundreds of dollars. Agricultural uses for drones include: remote moisture sensing to identify which parts of a field are dry or need improvements, precision agriculture like mid-field weed identification, frost mitigation, variable-rate fertilization dispersal etc.

The mentioned areas do not include the final list, the industrial application of drone is larger concept and includes more spheres. But, actually the above-mentioned information goes to show

how important drones are. From being used by the military, they quickly found a market for fun and recreational use. The coming the 4<sup>th</sup> industrial revolution will alter how people and companies interact, work and play. With the rise of the digital age, drones will change the way farmers grow crops just as it is going to revolutionize the way mining firms assess their projects. From construction, scientific research, commerce, entertainment, drones will play a significant role in near future. With cost going down, a drone has become a worthwhile investment in growing number of industrial sectors.

## Civil engineering drones

### *What is civil engineering?*

Civil engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams and buildings<sup>1</sup>. Civil engineering is traditionally broken into a number of sub-disciplines<sup>2</sup>. It is the second-oldest engineering discipline after military engineering<sup>3</sup> and it is defined to distinguish non-military engineering from military engineering.

Civil engineering takes place in the public sector from municipal through to national governments and in the private sector from individual homeowners through to international companies.

### *Using drones in civil engineering*

The horizontal nature of civil engineering lends to some practical and creative uses of drones in the industry. From planning to final construction, nearly every stage of the engineering process can benefit with the help of drones.

In fact, drones are now widely being used in the engineering and constructions fields. Many firms are using drones to evaluate the exterior conditions of their client's facilities, such as the roof and other hard to get to locations. That can mean more accurate inspections with less worry over a worker falling from a ladder during the inspection. Drones are even being used during the construction and installation portion of projects.

Drones provide better resolution when it comes to photos and video, while reducing the cost to a firm. That is a big advantage and savings over previous technologies such as satellite and other aerial resources.

Civil engineers are using drones to perform 2D and 3D mapping projects. This is achieved using laser scanning devices and can help engineers construct virtual representations of real-world projects – assisting engineers in the planning and development stages of their most difficult projects.

Drones in civil engineering can be used for aerial mapping, LiDAR scanning, pipeline surveying, aerial photography, etc.

**1. Aerial mapping:** More and more companies are using drones for surveys and mapping. For instance, DroneDeploy users have mapped over 10 million acres, which generated an

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<sup>1</sup> "[History and Heritage of Civil Engineering](#)". ASCE. Archived from [the original](#) on 16 February 2007. Retrieved 8 August 2007.

<sup>2</sup> "[What is Civil Engineering](#)". Institution of Civil Engineers. Retrieved 15 May 2017.

<sup>3</sup> "[Civil engineering](#)". Encyclopædia Britannica. Retrieved 9 August 2007.

estimated \$150 million for the commercial drone industry. Here below are mentioned some *benefits* of using drones for surveying and mapping.

- **Ease of Deployment.** Drones are capable of completing survey jobs in less than half the time of a traditional survey methods. Surveys that once took weeks to complete, can now be done in less than a few days. This allows for surveyors to complete more projects in less time.
- **Reduced Risk.** Using UAS for data collection reduces the need for workers to enter potentially hazardous areas. The small, portable size of drones make them ideal for collecting data in a variety of different environments like roadways and steep terrain.
- **Detailed Data.** Drones equipped with imaging software make it easy to turn images into a wide variety of georeferenced 2D maps and 3D models for surveying, city modeling, large-scale mapping, urban planning, cadaster and more.

**2. LiDAR scanning:** LiDAR is a laser-based remote sensing technology and stands for light detection and ranging. It is a technology widely used in the domain of geographical information system (GIS) for surveying and mapping different kind of natural resources and infrastructures.

As a matter of fact the LiDAR technology is being used in numerous scientific fields, related to geomatics, which are relying on high accuracy definition of terrestrial three-dimensional points position. This includes to combine these data with an extremely precise and faithful calculation of the distances and angles between them.

LiDAR scanning drones are well known and often chosen for their ability of producing high-resolution maps for a broad range of activities like remote sensing, atmospheric sensing, geomatics, geography, geomorphology, archaeology, forestry, contour mapping, laser altimetry, geographic informatics, etc.

**3. Pipeline surveying:** Building an oil and gas pipeline project is a major challenge for any organization to undertake. When it comes to building a successful pipeline, the costs and time requirements are high and the margin for error must be minimized. As a result, if organizations hope to complete a successful pipeline development project with no major interruptions and minimal unforeseen costs, it is essential that they take advantage of the most advanced technologies available to them to collect as much data up front as possible.

One example of a technology that can help organizations experience better results with their pipeline projects is the drones. The benefits of drones for the land surveying portion of a pipeline project are numerous.

The most important **benefits** of using drones for pipeline surveying are:

- **Completing large surveys with a high degree of accuracy:** One of the chief challenges of pipeline projects is the total amount of distance they must cover and nowhere is this challenge felt more than in the land surveying stage of the project. Of course, pipeline projects require a high degree of detail and accuracy, but organizations need a way to ensure that getting this accuracy does not slow down the project too much. Some drones can cover miles of linear coverage per day, meaning

that they can fly the large distances required by pipeline projects much faster than traditional surveyors traversing the land. At the same time, drones can fly close to the ground while using high-resolution image capturing technology that offers up detail as fine as one centimeter per pixel. Drones truly offer the best of both worlds when it comes to covering long distances and providing high levels of accuracy. By bypassing difficult terrain altogether, drones allow a land surveyor to gather all of the information they might need without actually having to put people on the ground. Instead, surveyors can operate the drones from a position of complete safety. Additionally, the amount of data that is collected is exponentially more than that collected by traditional crews.

- **Turning around survey results quickly:** Another important goal for land surveyors should be to complete their work as quickly as possible so that the pipeline can begin construction. However, this can't take place if the results of the land survey require weeks or even months of processing time before they can be used. Working with a team of experienced drone operators is not just a great way to speed up the actual data collection process; such an operator can also begin processing and analyzing that data immediately after it is captured. As a result, land surveying results captured by drones are often processed and available for use within 24 -48 hours of when they were originally captured. This extremely fast turnaround enables organizations to start building their pipelines quicker, which in turn enables them to start experiencing returns quicker.
- **Sharing the data with key contractors and stakeholders:** Collecting massive amounts of data is pointless unless decision makers have a way to access the information easily and extract what they need. Key divisions/subcontractors that should receive access to drones data at the earliest possible stages include: surveyors (internal use), engineering, environmental, land / right of way, project managers and any other companies (such as construction) who are authorized to view and bid on the upcoming project. Sharing this data will ensure that everyone is on the same page and that bids are much more accurate since the most recent conditions along the route are available for analysis.

**4. Aerial photography:** Aerial photography is one of the best ways to monitor a construction site, a building, civil engineering projects, a work of art, etc. An aerial overview with drones will be a great help for the project managers in order to, among others:

- study the site before the operations start
- monitor and control the evolution of the activities and proceedings
- present an overview of a site
- check the quality of the work
- follow the deadlines in relation with the work progress
- monitor the compliance of the works with the specifications
- promote their know-how, skills and knowledge for future projects

- bring out and underscore the quality of the work.

High technology, precision, adaptability, endurance and robustness are some of the numerous Drone qualities explaining why these devices are so needed for improving working quality on the demanding sectors of architecture and civil engineering.

## **Drones for Disaster relief**

Disaster relief (or emergency management) refers to the process of responding to a terrible situation, providing humanitarian aid to persons and communities who have suffered from some form of disaster. It involves dealing with and avoiding risks and preparing, supporting and rebuilding society when natural or human-made disasters occur.

Natural and man-made disasters destroy environments, often making conditions so difficult that relief workers are unable to access areas and provide assistance. Drones have the ability to take on roles where relief workers and manned vehicles fall short.

### ***How can drones be used for disaster relief?***

#### **1. Hazardous Chemical Spills:**

Dangerous or nuclear chemicals can leak into the environment for various reasons. Some causes include factory or power plant malfunctions, spills during transportation or even terrorist attacks. In these and similar instances, measuring the damage and providing relief must be swift and effective. These events, known as CBRNE events (chemical, biological, radiological, nuclear or explosive) make for unsafe conditions, not only for the people exposed to the hazardous materials in nearby areas, but also for relief workers.

#### **2. The Need for Mapping:**

Areas that are prone to large-scale disasters such as earthquakes and flooding benefit greatly from visual imaging and 3D mapping. Manned aircraft are often too expensive to use, satellite mapping does not meet high-resolution needs, and both take too much time during emergency situations.

The use of drones to map disaster areas provides greater advantages in costs and in rapid response times when compared to traditional methods. Drones can be deployed quickly, generate high-resolution and 3D mapping, identify hotspot areas that have sustained the most damage and upload the data in real time to coordinate relief efforts.

#### **3. Assessing Structural Damage:**

Relief workers often find it difficult and dangerous to assess structural damage from natural disasters. They often encounter buildings that are on the verge of collapsing, potential explosions due to chemical leaks and places that are hard to access such as tunnels and bridges. After an F-5 tornado in Wichita, Kansas, drones were used to identify infrastructure that was critically damaged. Equipped with “sniffers” to detect high levels of methane, they were able to locate broken gas lines. Workers then shut down the lines and fixed the breaches before an explosion could occur.

#### **4. Delivering Emergency Infrastructures and Supplies:**

Often after natural disasters or terrorist attacks, infrastructure supply lines are cut and disabled. When roads, bridges, communication cables and gas and water lines are compromised, the safety



of residents in the area is also compromised. To mitigate suffering and further damage, rescue teams can utilize drones to support infrastructures, deliver supplies and establish communication.

In areas that are nearly impossible to reach, drones can deliver supplies such as water and food to those in need, eliminating the risks of placing human-operated aircraft in harm's way. AWACS, or airborne warning and control systems, allow for temporary establishment of Wi-Fi and cellphone access to environments without power lines or functioning cell towers.

### **5. Extinguishing Wildfires:**

Drones can eliminate the risks that pilots face and can increase the effectiveness of battling fires. Unmanned aircraft are able to fly in low visibility and can drop fire retardants more accurately and safely. Bigger drones can transport people and supplies, while large numbers of smaller drones can be deployed to provide greater situational awareness. Drones that are outfitted with communication systems have the added benefit of being able to sustain contact between the command center and firefighters on the ground.

For these reasons and beyond, drones are being used more often in emergency and disaster response situations. This forward-thinking unmanned technology has vast potential. It is already proving its ability to save lives and prevent damage in dire situations.

## Safety and Security

Day by day drones are becoming increasingly more commonplace in the Globe, from aerial photography to assisting search and rescue operations, drones can be put to a variety of beneficial uses. However, the use of drones also carries concerns relating to both safety and security.

The idea of having drones in the national airspace raises serious safety concerns for nearly the entire spectrum of society, which ranges from government facilities and aviation authorities to regular individuals. The safety concerns that have caused to limit the use of commercial drones, including only granting a few permissions on a case-by-case basis, are primarily related to the capabilities of a drone, the potential for accidents and the possibility of privacy rights becoming an issue.

According to the “Washington Post,” more than 400 U.S. military drones have fallen out of the sky since 2001. Drones are not just harmless toys – even some high-end consumer models reach speeds of around 80 km/h, which is very fast for a remote-controlled piece of ballistic metal and carbon fibre. While a car may be larger and travel faster, the big difference is that the drone pilot is not personally at physical risk in the case of a collision, and may therefore put the drone into situations that are extremely dangerous in search of that perfect YouTube footage – such as the flight path of an aircraft ( <https://www.refund.me/drones-much-safety-risk/>).

Drones are already more widely used in the security industry. Whilst much attention is being given in the media to countering the threat posed by drones should they stray too close to sensitive sites like airports, whether by accident or design, on the other side of the coin drones have proven that they can have a positive impact. The performance of these systems, with the added dimension they bring in terms of situational awareness via high definition cameras and even thermal imaging, and in-use economics compared to other aerial solutions like helicopters, means that investment in such assets by the emergency services as well as security professionals is really taking off.

What about the ***Security Requirements*** they exist in order to protect the confidentiality and integrity of a drone’s acquired and communicated information and to ensure its ability to adhere to its operational requirements. Securing the information of the system refers to protecting it from disclosure, disruption, modification, and destruction.

For a secure drone operation, let’s identify the following security requirements:

- **Authorized access:** The drones must provide means to ensure that only authorized operators are granted access to its resources including both the ground control station and the aircraft.
- **Availability:** All the elements of the drones should be guaranteed to perform their required functions under defined spatial and temporal circumstances such that the system sustains its availability without disruption during its operational period. For instance, the

drone must adopt measures such as anomaly-based intrusion detection systems to distinguish normal communications from those resulting from denial-of-service attacks.

- **Information confidentiality:** The drones should employ mechanisms to mitigate unauthorized disclosure of the telemetric and control information.
- **Information integrity:** The drones should be able to ensure that the telemetric information and the GPS and control signals are genuine and have not been intentionally or unintentionally altered. Authenticated encryption cryptographic primitives may be used to ensure both the integrity and confidentiality of such information.
- **System integrity:** The drones should be able to guarantee the authenticity of its software and hardware components. Techniques from trusted computing such as memory curtaining, sealed storage, and remote attestation can be used to ensure the authenticity of the system's firmware and sensitive data. The deployment of intrusion detection systems, antivirus software, firewalls, and strict policies regarding the use of external storage media can aid in the detection and prevention of malware.
- **Accountability of actions:** The drones should employ mechanisms that enforce non-repudiation to ensure that operators are held responsible for their actions. Digital signature algorithms may be used to both authenticate the operators and to bind them to an issued action. Moreover, logging procedures that are used to chronologically track the sequence of actions and changes in the system should be implemented.

### *Some solutions of drone for safety and security*

1. **Better visibility.** Drones help to minimise unwanted surprises, provide useful insights and help emergency personnel stay out of harm's way.
2. **Multifunctional design.** Drones adapt to the demands of the situation at hand faster and easier than ever before with the click and go payload system.
3. **Easy to deploy.** Drones deploy in a matter of seconds of arriving on scene, to respond faster and minimise the danger to those in need of assistance.
4. **Real-time awareness.** Equipped with infrared and VOC sensors, drones detect individuals and radiation that would otherwise go unseen.

### *Different functions of drones for safety and security*

- **Saving lives (drone-assisted rescues for coast guards).**
  - **Faster response:** Drones can be deployed in a matter of seconds and minimise the danger to those in need of rescuing.
  - **Optimised visibility:** Drones improve a coast guard's overall visibility of an expansive sea to locate vulnerable persons faster.

- **Thermal detection:** Drones are equipped with thermal sensors to maximise the operator's ability to quickly spot individuals lost at sea.
- **Accident mapping (a safe, affordable and reliable method of documenting crashes).**
  - **Faster documentation:** Drones can help to document car accidents much faster, lowering the risk of further accidents happening to police and passersby.
  - **Accurate evidenc:** Drones easily document crash sites by collecting measurable and reliable data to determine the cause of the incident.
  - **Less invasive:** Drones easily deploy kilometers away from the scene to reach hard to access areas while reducing the level of disruption to traffic.
- **Surveillance (monitor subjects of interest without risk).**
  - **30x zoom:** Drones are equipped with 30x zoom cameras to effortlessly spot subjects of interest from a great distance.
  - **Less sound pollution:** Deploy drones to be more difficult to detect by suspects than manned helicopters.
  - **Thermal IR vision:** Drones track individuals that blend into their surroundings or are active at night by utilising infrared sensors.
  - **Stream & record:** Drones can simultaneously record both the visual and thermal video streams.
- **Helps to be aware of invisible threats (protect yourself from gas and radiation leaks).**
  - **Gas monitors:** Drones can monitor hazardous materials like toxic and combustible gases, VOCs and oxygen levels from a safe distance.
  - **Radiation monitors:** Drones can detect gamma radiation levels from afar with parts per billion precision.
- **Helps to stay safe and alert (livestreaming capabilities ensure you are well informed).**
  - **Real time analytic:** Drones can help to stay protected from unexpected and unseen dangers with augmented livestream video. Whether it's thermal detection, or tracking a subject of interest.
- **Drones are built to perform in any environment (drones guarantee your mission's success in every environment).**
  - **Are for all weather performance:** The fuselage effectively shields the components inside against heavy rain and dust intrusion to ensure reliable operations.

- **Are capable of flying in wind speeds** of 14 m/s and tested in both the harsh cold of the arctic and blistering heat of the desert to ensure it will perform in any environment.

All these mentioned points are important while using a drone. If we maintain our safety procedures, maintenance and best practices nobody is saying we will never have an incident, but we are definitely minimizing our risk and getting much better odds!

# ՄԵԽԱՆԻԿԱՄԵՔԵՆԱՇԻՆԱԿԱՆ, ՏՐԱՆՍՊՈՐՏԱՅԻՆ ՀԱՄԱԿԱՐԳԵՐԻ Ա ԴԻՉԱՅՆԻ ԲԱԺԻՆ



Course materials presentation  
Overview of UAVs

Անօդաչու թռչող սարքեր



***Educational for Drone (eDrone)***

574090-EPP-1-2016-1-IT-EPPKA2-CBHE-JP

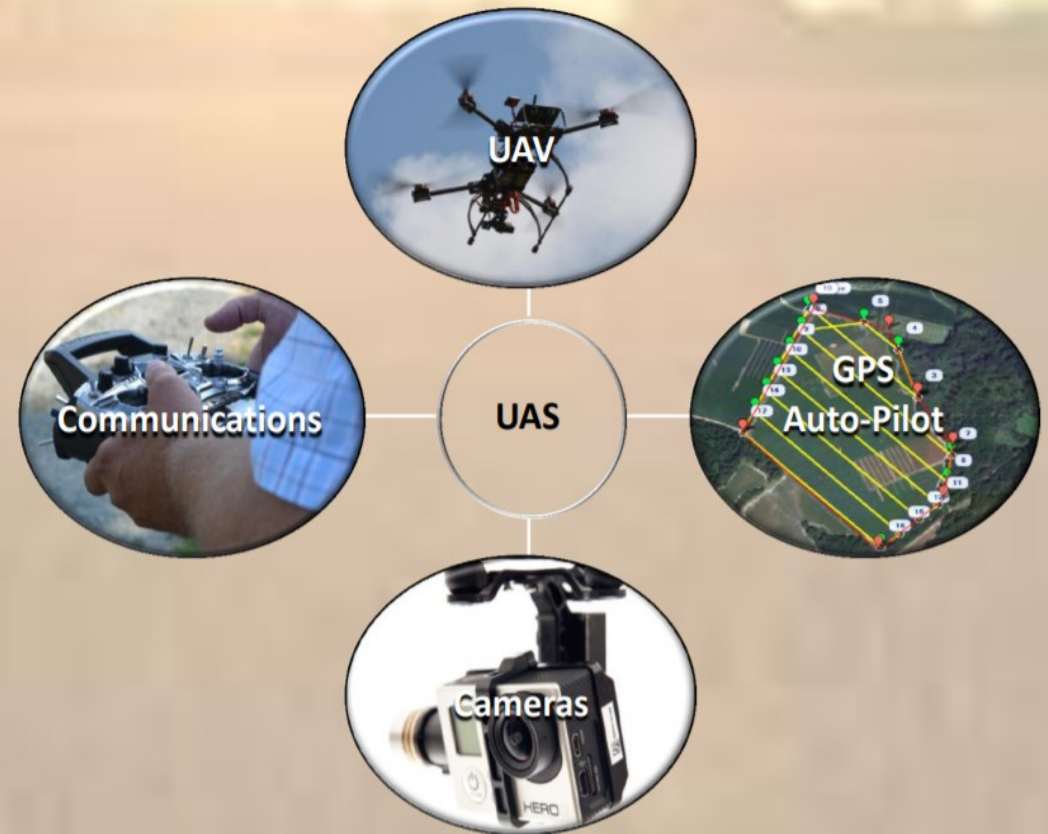


Co-funded by the  
Erasmus+ Programme  
of the European Union



# Ի՞նչ է ԱԹՍ-ն (դրոն)

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## ԱԹՍ-ի դասակարգումը

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Ըստ կառավարման ձևի

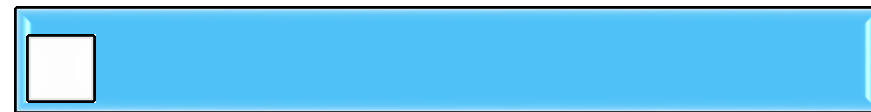


☐ Զկառավարվող

☐ Հեռակառավարվող

☐ Ավտոմատ

Ըստ չափերի և զանգվածի



☐ Միկրո

☐ Միջին

☐ Միջին

☐ Ծանր



# Ըստ նշանակության



☐ հետախուզական,

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☐ նշանառու,

☐ ռադիոէլեկտրոնային  
պայթարի,

☐ հեռակառավարվող  
☐ վերահսկողության և  
դիտարկման համակարգի,

☐ օդային վերահաղորդման,

☐ հարվածային,

☐ քաղաքացիական,

☐ բազմանպատակային:

# ԱԹՍ-ներն ըստ կառուցվածքի

Պտուտակավոր – multi-rotor/drone



Թևավոր – fixed-wing



Հիբրիդ – hybrid/VTOL



## ԱԹՄ-ների քաղաքացիական կիրառման ոլորտը

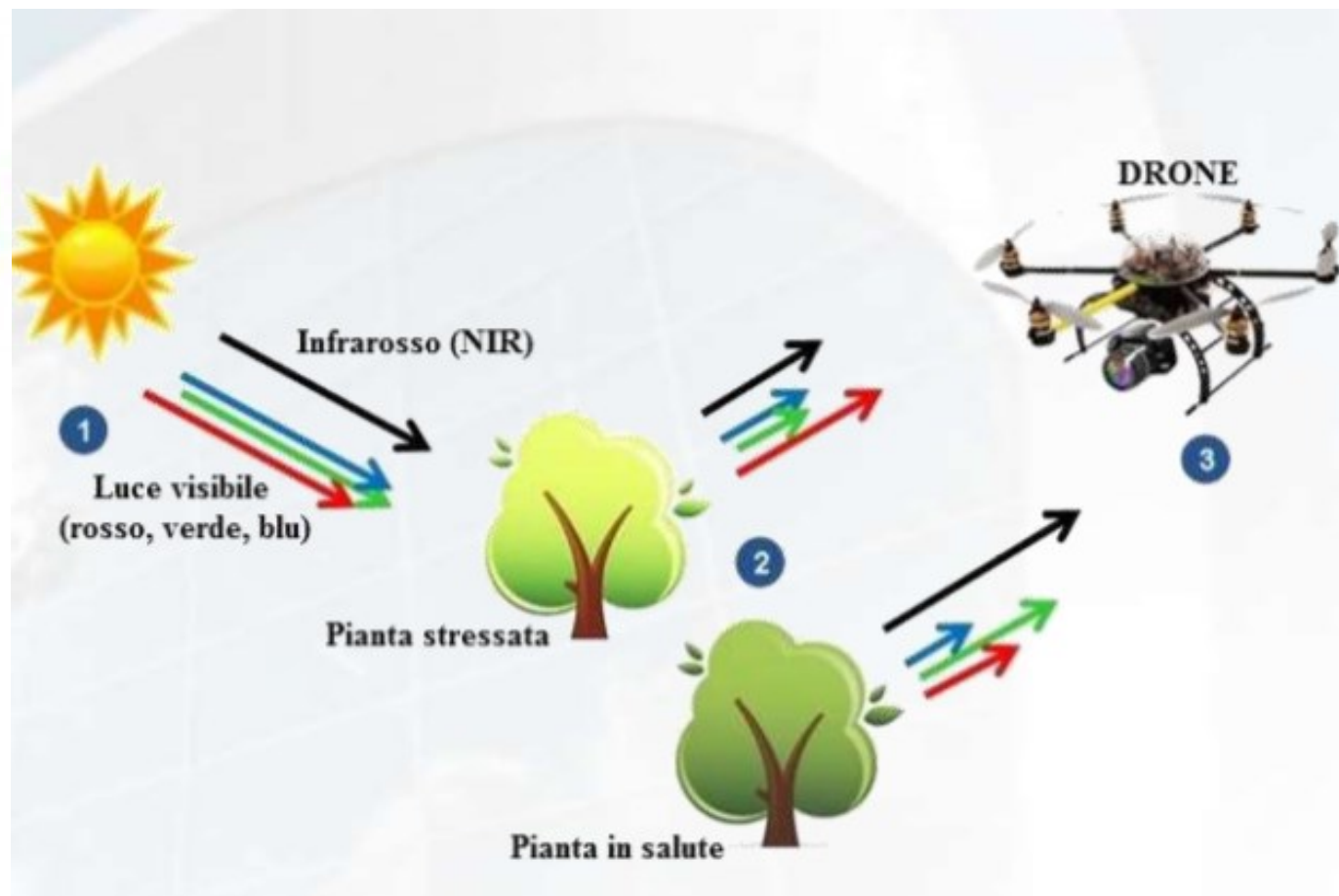
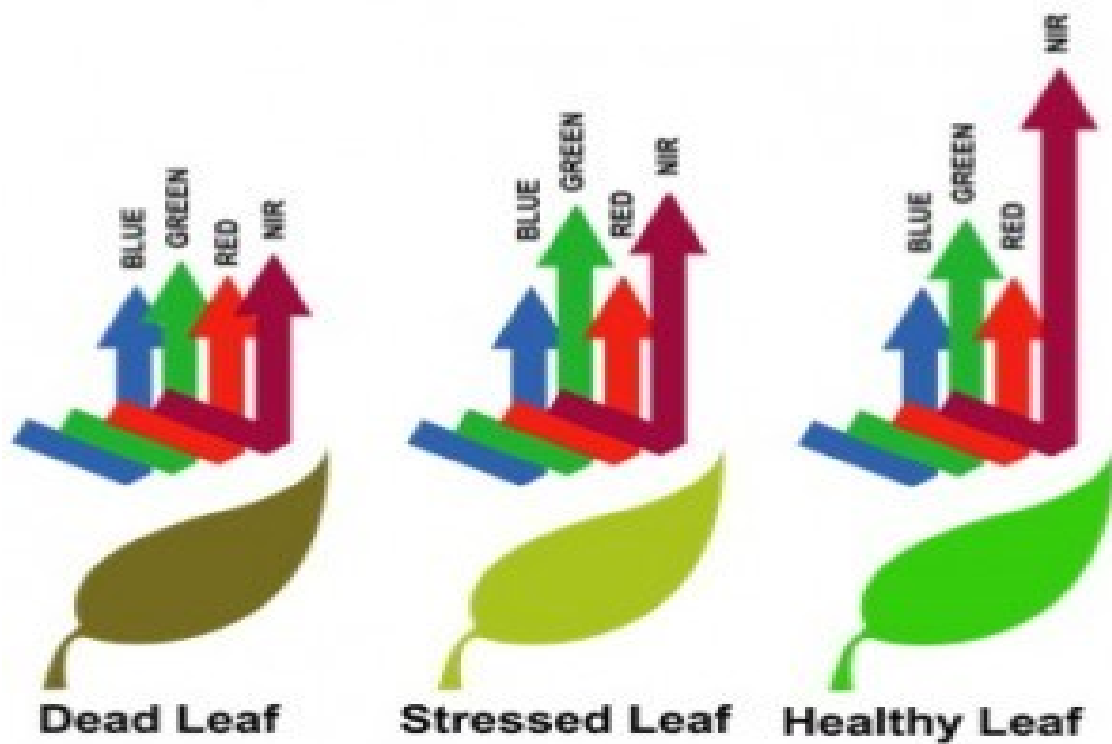
- ☐ անվտանգության ապահովում,
  - ☐ փողոցների, տրանսպորտային ուղիների և այլ տարածքների հսկում,
- 
- ☐ արտակարգ իրավիճակներում տարբեր կառույցների կառավարում (հրշեջ ծառայություն, փրկարար ծառայություն, շտապ օգնության ծառայություն և այլն), իրավիճակի օպերատիվ գնահատում և այլն,
  - ☐ գյուղատնտեսություն,
  - ☐ տեղանքի քարտեզագրում,
  - ☐ դժվար հասանելի վայրերի ուսումնասիրություն,
  - ☐ շինարարություն և շինարարության վերահսկողություն,
  - ☐ շինությունների վիճակի ուսումնասիրություն,
  - ☐ զանգվածային լրատվամիջոցներ,
  - ☐ կապի ապահովում,
  - ☐ բեռնափոխադրումներ և այլն:

# ԳՅՈՒՂԱՏՆՏԵՍՈՒԹՅՈՒՆ

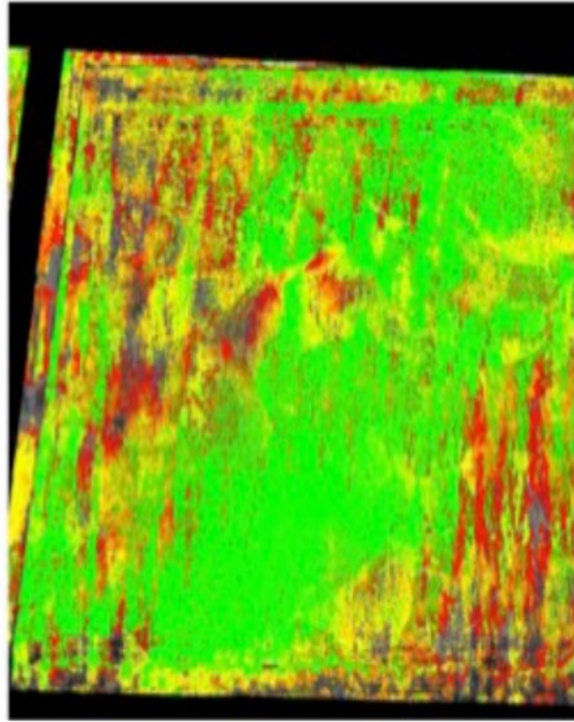
Անօդաչու թռչող սարքերի կիրառությունը հնարավորություն կտա իրականացնել օդային պատկերների վերլուծություն և աշխատելով գյուղատնտեսության ոլորտում՝ օգնելով ֆերմերներին ստանալ ճշգրիտ տեղեկատվություն, դրանց հիման վրա կայացնել հիմնավոր որոշումներ:



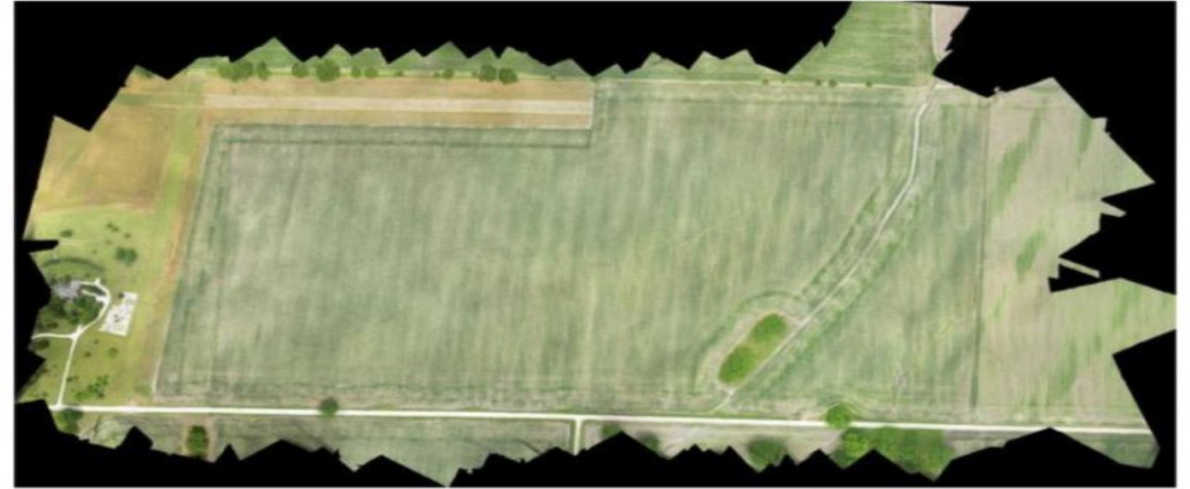
# NDVI



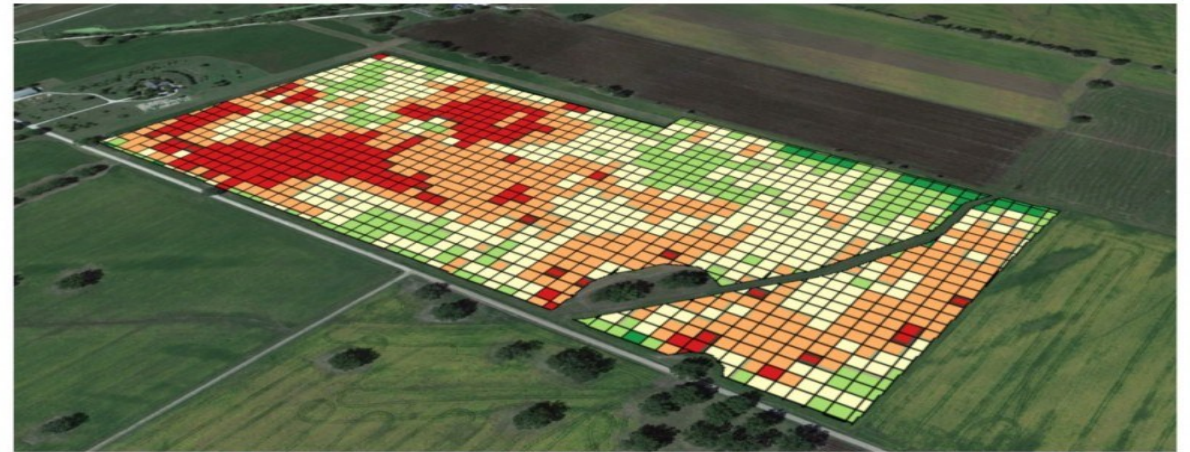




*The same field photographed in color (RGB) image at left and in false color (NDVI) at right. The NDVI image reveals variation not seen in the color image.*



*Stitched RGB photo reveals only subtle in-field variation.*



*Shapefile indicates five distinct levels of field health.*





[https://youtu.be/IH\\_kGijV8so?t=31](https://youtu.be/IH_kGijV8so?t=31)

AgriDrones- ի կողմից մշակված գյուղատնտեսական դրոն, որը կարող է տեղապահել մինչև 25 կգ: Արագությունը՝ 40 անգամ ավելի քան ավանդական հեղուկացիրը: Այն կապահասի 90% ջուր եւ 30% -40% թունաքիմիկատ:



TTA- ի ՑԱՆՔԻ copper- ը TTA- ի կողմից մշակված նոր մեքենա է, որին հատուկ է՝ լայնածավալ աշխատանք, բարձր էֆեկտիվություն և հուսալիության:



### Ֆերմային հսկողություն

Անտառների և վնասատուների բռնկումը, օգտագործված ոռոգման և պարարտանյութի պակասը կարող են վերահսկվել TTA UAV- ով, որը հագեցված է բարձրակարգ hyperspectral տեսախցիկով:



# ՀՀ-ում ԱԹՍ կիրառման բնագավառները

Course materials presentation

Legal frameworks of UAVs application

- Արտակարգ իրավիճակներ
- Գյուղատնտեսություն
- Շինարարություն և քարտեզագրում
- Ոստիկանություն
- Զանգվածային միջոցառումներ
- Հեռուստատեսություն
- Փոստի առաքում և այլն

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Ըստ կոնսորցիումի կատարած հետազոտությունների  
ներկայումս շահագործվող դրոնների

- 52%-ը ունեն ֆիքսված թևեր
- 48%-ը բազմաշարժիչային են՝ հիմնականում  
կվադրոկոպտերներ
- 68%-ը աշխատում են էլեկտրական շարժիչներով
- 32%-ը՝ ներքին այրման շարժիչներով

Դրոնները պատրաստվում են հիմնականում  
կոմպոզիտային նյութերից, որի շնորհիվ ունեն փոքր  
զանգված և բարելավված անրոդինամիկա:

Ամենատարածված դրոնները ունեն 500-ից 5.000 մմ  
ռոտորի տրամագիծ:

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- Կիրառվող դրոնների առավելագույն թռիչքային զանգվածը հիմնականում չի գերազանցում 25կգ:
- Հիմնականում օգտակար բեռնվածքը կազմում է մինչև 15կգ:
- Հորիզոնական թռիչքի արագությունը շուրջ 70կմ/ժ:
- Շահագործվող դրոնների թռիչքաժամանակը կազմում է 1-5 ժամ:
- Թռիչքային առավելագույն բարձրությունը` մինչև 5.000 մ:
- Թռիչքի հեռավորությունը` 10 – 50 կմ:

Այս խնդիրները լուծելու համար, դրանք պետք է ունենան ավտոմատ հսկման համակարգեր, որոնք կապահովեն երկարատև և անվտանգ շահագործում:

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Այսպիսով դրոնների և դրանց կառավարման  
համակարգերի զարգացումը պահանջում է  
օպերատորների շարունակական ուսուցում,  
գիտելիքների խորացում:

Դրոնների կատարելագործումը պահանջում է նաև  
դրանց անվտանգության համակարգերի զարգացում,  
որը հնարավորություն կտա կրճատել դրանց  
վթարների ռիսկը, ինչպես նաև պաշտպանել գետնի  
վրա գտնվող մարդկանց հնարավոր վնասվածքներից:

Նույնիսկ ամենահոլսալի անվտանգության համակարգի  
առկայության դեպքում դրոնների վթարների ռիսկը չի  
կարող զրոյացվել, ուստի անհրաժեշտ է դրոն  
շահագործողներից պահանջել  
պատասխանատվության ամպահովագրություն:

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Դրոնների պահանջարկի արագ աճին զուգահեռ,  
անհրաժեշտություն է առաջացել պատրաստել  
օպերատորներ, որոնք պետք է ունենան բազային  
գիտելիքներ հետևյալ բնագավառներում՝

- Ֆիզիկա և մաթեմատիկա
- Աերոդինամիկա
- Թռիչքների դինամիկա
- Ավիոնիկա
- Էլեկտրոնային սարքերի կիրառման հմտություններ

Սրա համար պահանջվում է երկարատև ուսուցում և  
գործնական պարապմունքներ:

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Նախատեսվում է օպերատորների դասընթացներում  
ուսուցանել հետևյալ առարկաները՝

- Drone architecture and Aerodynamics
- Drone avionics
- Drones equipment for measurement and monitoring
- Piloting techniques
- Processing of measurement data
- Laws and regulatory items
- Drones maintenance
- Civil applications
- Internship

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# Դրոնների կիրառության օրենսդրական կարգավորումը

Օրենսդրական կարգավորման համար ավիացիոն անվտանգության եվրոպական գործակալությունը առաջարկում է կիրառել հետևյալ սկզբունքները՝

- Թռիչքի բարձրությունը՝ ոչ ավել 120 մետրից
- Հեռավորությունը մարդկանցից՝ ոչ պակաս 20 մ
- Չթռչել օդանավերին մոտ
- Չթռչել օդանավակայանների, հասարակական անվտանգության և արտակարգ իրավիճակների վայրերին մոտ

Name of presenter

meeting/event name  
date



Erasmus+



- Չօգտագործել դրոնները վտանգավոր նյութերի փոխադրման համար
- Թռիչքի նվազագույն հեռավորությունը այլ անձանց գույքից՝ 20մ
- Չնկարահանել, տեսաձայնագրել այլ անձանց՝ առանց նրանց համաձայնության
- Չթռչել ռազմական օբյեկտների, անվտանգության ուժերի, ոստիկանության տարածքների մոտով
- Ինքնուրույն չձևափոխել դրոնները
- Օպերատորի նվազագույն տարիքը՝ 16 տարեկան

Name of presenter

meeting/event name  
date



Անօդաչու թռչող սարքերի էությունը և դասակարգումը  
Գ. Բաբայան, Հ. Կարապետյան

Բովանդակություն

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1 Անօդաչու թռչող սարքերի նշանակությունը

Անօդաչու թռչող սարք է կոչվում առանց անձնակազմի թռչող սարքը (ԱԹՍ):

Հեռակառավարման միջոցների ստեղծումը հնարավորություն տվեց կատարել տարբեր նշանակության առաջադրանքներ՝ առանց մարդու անմիջական ներկայության: Արդյունքում շատ առաջադրանքներ սկսեցին իրականացվել ավելի արագ, արդյունավետ և որ ամենակարևորն է, առանց մարդու առողջությունը և կյանքը վտանգելու: Ինքնաթիռների լայն տարածում ստանալուց հետո, երբ դրանք ամբողջովին կառավարվում էին մարդկանց կողմից, 20-րդ դարի կեսերից ինժեներները սկսեցին մտածել դրանք հեռակառավարվող՝ այսինքն անօդաչու դարձնելու մասին: Արդյունքում սկսեցին տարվել տարբեր աշխատանքներ այդ ուղղությամբ, սակայն անօդաչու թռչող սարքերը լայն տարածում գտան միայն Երկրորդ Համաշխարհային պատերազմից հետո:

Վերջին մի քանի տասնամյակում թռչող սարքերի (ԹՍ) կիրառության մեջ անօդաչու թռչող սարքերի դերն անընդհատ մեծանում է: Ժամանակակից ԱԹՍ-ներն ունեն տարատեսակ կառուցվածք, դրանցից ամենահզորներն ընդունակ են օդում՝

մոտ 20 կմ բարձրության վրա, մնալ ավելի քան 40 ժամ: ԱԹՄ-ները հեռակառավարմամբ և ծրագրով ինքնուրույն կատարում են բազմազան մարտական խնդիրներ:

Համաշխարհային շուկայում նման սարքերի պահանջարկը 2004թ. կազմել է \$6,87 մլրդ, այն դեպքում, երբ վեց տարի առաջ այն հազիվ էր անցնում \$2 մլրդ-ն: Միայն ՆԱՏՕ երկրներում կիրառվում է մոտ 60 հազար ԱԹՄ, որը կազմում է վերջին 15 տարում աշխարհում արտադրված նման սարքերի մոտ 80%-ը:

ԱԹՄ - ները առավելապես զարգացել են որպես ռազմական ոլորտում կիրառվող սարքեր: Ստորև բերված են տարբեր երկրներում ստեղծված և տարբեր զինված հակամարտություններում դրանց օգտագործման առավել հայտնի օրինակներ:

ԽՍՀՄ-ում գործող Տուպոլևի կոնստրուկտորական բյուրոն 1957 թվականին, միջին հեռավորության, մոբիլ, գերձայնային թևավոր հրթիռի մշակման պետական պատվեր ստացավ: Արդյունքում ստեղծվեց Ty -121-ը, որը օդ բարձրացավ 1960 թվականի օգոստոսին: Սակայն շուտով ԽՍՀՄ ղեկավարությունը հրաժարվեց այդ նախագծից: Բայց Տու-121-ի ուղղությամբ տարված աշխատանքները, ինչպես նաև նրա կառուցվածքը օգտագործվեցին հետագայում անօդաչու հետախույզ ինքնաթիռներ ստեղծելու համար, ինչպիսիք էին Ty-123, Ty-143 և Ty-141-ը: Այս ԱԹՄ-ներից մի քանիսը դեռևս օգտագործվում են:

ԽՍՀՄ-ը 1970-ից 1980-ական թվականներին հանդիսանում էր ԱԹՄ արտադրող առաջատար պետությունը: Միայն Ty -143-ից արտադրվել էր մոտավորապես 950 հատ:

1960-ականներին ԱՄՆ-ը նույնպես օգտագործում էր հեռակառավարվող թռչող սարքեր: Դրանք օգտագործվում էին Կուբայում՝ ԽՍՀՄ հրթիռների տեղակայմանը հետևելու համար: Երբ ԽՍՀՄ տարածքում խոցվեցին Ս-2 հետախույզական ինքնաթիռները, ԱՄՆ որոշեց հետախույզական աշխատանքների համար օգտագործել

ԱԹՍ-ներ և սկսվեցին տարվել աշխատանքներ Red Wadon բարձրաթիչք հետախուզական ԱԹՍ-ի մշակման ուղղությամբ:

Վիետնամում պատերազմի ժամանակ, վիետնամական զենիթահրթիռային համակարգերի կողմից ամերիկյան ինքնաթիռների կորուստներին զուգահեռ սկսեց աճել ԱՄՆ-ի կողմից անօդաչու թռչող սարքերի կիրառումը: Հիմնականում ԱԹՍ-ները օգտագործվում էին ֆոտոհետախուզության համար, երբեմն նաև ռադիոէլեկտրոնային պայքարի համար: Մասնավորապես ռադիոտեխնիկական հետախուզության համար կիրառվում էին 147E ԱԹՍ-ները:

Պատերազմի ընթացքում ամերիկյան ԱԹՍ-ները կատարեցին գրեթե 3500 թռիչք, ընդ որում նրանց կորուստները կազմեցին ընդամենը 4%: ԱԹՍ-ները օգտագործվում էին ֆոտոհետախուզության, ազդանշանի վերահաղորդման, ռադիոէլեկտրոնային միջոցների հետախուզության, ռադիոէլեկտրանային պայքարի համար, ինչպես նաև որպես կեղծ թիրախներ:

Անօդաչու թռչող սարքեր Իսրայելի կողմից օգտագործվել են 1973 թվականի արաբաիսրայելական հակամարտության ժամանակ:

Իսրայելական ԱԹՍ-ները օգտագործվել են նաև Լիբանանում 1982 թ. ռազմական գործողությունների ժամանակ: IAI Scout և Mastiff մոդելի իսրայելական ԱԹՍ-ները հետախուզում էին սիրիական օդանավակայանները, զենիթահրթիռային համակարգերը և հետևում զորքերի տեղաշարժերին: Արդյունքում իսրայելական օդուժը հարվածներ հասցրեց այդ օբյեկտներին, ինչի հետևանքով Սիրիան կորցրեց զենիթահրթիռային համակարգերի 18 մարտկոց:

Հեռակառավարվող թռչող սարքերը ակտիվ օգտագործվել են Պարսից ծոցի պատերազմի ժամանակ երկու պատերազմող ուժերի կողմից: ԱՄՆ-ը, Մեծ Բրիտանիան և Ֆրանսիան օգտագործում էին Pioneer, Pointer, Exdrone, Migde, Alpilles Mart, CL-89, իսկ Իրաքը Al Yamamah, Makareb-1000, Sahreb-1 և Sahreb-2 մոդելների ԱԹՍ-ներ:

Այդ գործողությունների ժամանակ կռալիցիոն ուժերի ԱԹՄ-ները կատարել են ավելի քան 530 թռիչք 1700 ժամ ընդհանուր թռիչքային տեվողությամբ: ԱՄՆ-ի կողմից օգտագործվող 40 Pioneer մոդելի ԱԹՄ-ների 60%-ը ստացել էին վնասվածքներ, բայց դրանց 75%-ը հաջողվեց վերանորոգել: Նրանցից ընդամենը 2-ն էին ոչնչացվել հակառակորդի կողմից, մյուսները վնասվել էին կամ տեխնիկական անսարքությունների կամ օպերատորների սխալի պատճառով: Քիչ կորուստները հիմնականում կապված էին ԱԹՄ-ների փոքր չափսերի հետ, ինչը դժվարեցնում էր դրանց հայտնաբերումը և խոցումը:

ԱԹՄ-ները լայն օգտագործվում էին ՆԱՏՕ-ի կողմից 1992 թ. Հարավսլավիայի դեմ իրականացվող մարտական գործողությունների ժամանակ: Դրանք իրականացնում էին շուրջօրյա հետախուզություն, հայտնաբերում գորքերի տեղակայման վայրերը, հակառակորդի օդանավակայանները, զենիթահրթիռային համակարգերը, որից հետո դրանք խոցվում էին ՆԱՏՕ-ի ուժակոծիչների կողմից:

1992 թվականին Իսրայելը “Հեզբոլա” խմբավորման առաջնորդի ոչնչացման համար առաջին անգամ օգտագործեց ԱԹՄ-ն որպես նշանատման միջոց: ԱԹՄ-ն գտավ առաջնորդի մեքենան և լազերային նշանատման սարքի միջոցով այն առավ նշանառության տակ, որից հետո գրոհիչ ուղղաթիռից արձակված հրթիռը խոցեց այն:

2000-2005 թվականներին Իսրայելը ակտիվ օգտագործում էր ԱԹՄ-ներ Գազայի հատվածում հոտախուզության, նշանատման և «Համաս» խմբավորմանը կետային հարվածներ հասցնելու համար:

Հեռավոր գործողության ԱԹՄ-ները օգտագործվել են Իսրայելի կողմից Միջերկրական և Կարմիր ծովերում հետախուզություն իրականացնելու համար, ինչի արդյունքում հայտնաբերվել են հակառակորդի համար զենք-զինամթերք տեղափոխող նավեր:

Իրաքում և Աֆղանստանում ամերիկյան զինված ստորաբաժանումները լայն կիրառում էին փոքր չափսերի անօդաչու թռչող սարքեր, որոնք շատ հարմար են շահագործման համար և ունեն պարզ կառուցվածք: Այդ ԱԹՄ-ները ունեն

համեմատաբար փոքր թռիչքային հեռավորություն, արագություն և բեռնատարողություն: Նման անօդաչու թռչող սարքերը թույլ են տալիս ստորաբաժանումներին օպերատիվ կերպով տեղեկություն ստանալ հակառակորդի և մարտի դաշտում տիրող իրավիճակի մասին: Այդպիսի սարքերից առավել տարածվածը RQ-11 «Raven» ԱԹՄ-ն է:

2015-2016 թվականներին ԱԹՄ-ները օգտագործվել են Ռուսաստանի զինված ուժերի կողմից Սիրիայում «Իսլամական պետությանը» օդային և հրթիռային հարվածներ հասցնելու ընթացքում: Դրանք հիմնականում օգտագործվում էին որպես վերահսկող և խոցումը հաստատող սարքեր, իսկ ԱԹՄ-ներից նկարահանված տեսանյութը հրապարակվում էր, որպես խոցման ապացույց: Ռուսաստանը օգտագործում էր Ֆորպոստ (հանդիսանում է իսրայելական IAI Searcher ԱԹՄ-ի լիցենզավորված պատճենը), Օրլան 10, T23 Էլեբոն, Պչելա-1T, Դոգոր-100 մոդելների ԱԹՄ-ները:

Վերը նշվածները ԱԹՄ-ների օգտագործման առավել հայտնի դեպքերն են: Հարկ է նշել, որ ԱԹՄ-ները լայն կիրառում են ստացել ամբողջ աշխարհով մեկ և ներկայումս գրեթե ոչ մի զինված հակամարտություն չի անցկացվում առանց ԱԹՄ-ների կիրառմամբ: ԱԹՄ-ների զանգվածային կիրառման վերաբերյալ ավելի լավ պատկերացում կազմելու համար բավական է նշել, որ 2012 թվականին ԱՄՆ զինված ուժերի թռչող սարքերի ավելի քան 40%-ը կազմում էին անօդաչու թռչող սարքերը: Այն դեպքում, երբ օդաչուի կողմից կառավարվող թռչող սարքերի քանակը 10767 էր, ԱԹՄ-ների քանակը կազմում էր 7494 միավոր:

## **2 Անօդաչու թռչող սարքերի դասակարգումը:**

Քանի որ գոյություն ունեն տարբեր տեսակի և նշանակության ԱԹՄ-ներ, դրանց մասին ավելի հեշտ պատկերացում կազմելու համար ընդունված է ԱԹՄ-ները դասակարգել ըստ կառավարման ձևի, նշանակության, զանգվածի և չափսերի:

Ըստ կառավարման ձևի ԱԹՄ-ները լինում են՝

- անօդաչու չկառավարվող,
- անօդաչու հեռակառավարվող,
- անօդաչու ավտոմատ:

Ըստ չափերի և զանգվածի ԱԹՄ-ները լինում են՝

- միկրո,
- մինի,
- միջին,
- ծանր:

Ըստ նշանակության ԱԹՄ-ները լինում են՝

- հետախուզական,
- նշանառու,
- ռադիոէլեկտրոնային պայքարի,
- հեռակառավարվող վերահսկողության և դիտարկման համակարգի,
- օդային վերահաղորդման,
- հարվածային,
- քաղաքացիական,
- բազմանպատակային:

Ստորև բերվում է ԱԹՄ-ների դասակարգման ավելի մանրամասն նկարագրություն

Անօդաչու թռչող սարքերը ըստ կառավարման ձևի:

Չկառավարվող ԱԹՄ-ները լինում են միանգամյա օգտագործման և հաճախ ծառայում են որպես թիրախ ՀՕՊ զորքերի և օդաչուների պարապմունքների ժամանակ: Շատ դեպքերում որպես այսպիսի ԱԹՄ օգտագործում են շահագործումից դուրս եկած ինքնաթիռները:

*Հեռակառավարվող ԱԹՄ-ները ներկայումս ամենատարածվածներն են: Որպես կանոն ունենում են օպերատոր, ով գտնվելով ինչ-որ հեռավորության վրա հեռակառավարման սարքերի միջոցով ղեկավարում է ԱԹՄ-ն:*

*Ավտոմատ ԱԹՄ-ները ունեն համեմատաբար ավելի բարդ ծրագրային ապահովում: Այս ԱԹՄ-ները նախորոք ստանալով հրամանները որոշումները կարող են կայացնել ինքնուրույն կամ հաստատում ստանալուց հետո: Ավտոմատ ԱԹՄ-ների առավելությունը կայանում է նրանում, որ հնարավորություն կա ամբողջ թռիչքը իրականացնել առանց մարդու միջամտության: Նրանք կարող են ինքնուրույն փնտրել նշանակետեր կամ իրականացնել հետախուզություն և այլն:*

*Անօդաչու թռչող սարքերը քստ չափերի և զանգվածի:*

*Միկրո ԱԹՄ-ներ են կոչվում այն սարքերը, որոնք ունեն մինչև 10 կգ զանգված, թռիչքային ժամանակը կազմում է մոտավորապես 1 ժամ, իսկ թռիչքային բարձրությունը մինչև 1 կմ: Այսպիսի ԱԹՄ-ները որպես կանոն ունենում են փոքր զաբարիտային չափեր ինչի արդյունքում բավականին դժվար է լինում նրանց բացահայտել: Փոքր զանգվածը թույլ է տալիս հեշտությամբ տեղափոխել ձեռքով, առանց որևէ լրացուցիչ տեխնիկայի օգտագործմամբ: Օգտագործվում են հիմնականում տեղային հետախուզության համար: Շատ տեսակներ կարող են բաց թողնվել մարդու ձեռքից:*

*Մինի ԱԹՄ-ներ են կոչվում մինչև 50 կգ զանգված, մի քանի ժամ թռիչքային տեվողություն և 3-5 կմ թռիչքային բարձրություն ունեցող սարքերը: Այս ԱԹՄ-ները սովորաբար ունենում են մի քանի հարյուր կիլոմետր թռիչքային հեռավորություն և մինչև 200 կմ/ժ արագություն: Սովորաբար թռիչքի համար օգտագործում են հատուկ թռիչքային հարմարանքներ կամ ուղղակի օդանավակայաններ: Մինի ԱԹՄ-ները սովորաբար օգտագործվում են հետախուզական, նշանառության և ռադիոէլեկտրոնային պայքարի համար:*

*Միջին ԱԹՄ-ները ունենում են մինչև 1000 կգ զանգված, 10-12 ժամ թռիչքային տևողություն և 9-10 կմ թռիչքային բարձրություն: Սրանք հիմնականում ունեն*

տակտիկական նշանակություն: Սովորաբար այս դասի ԱԹՄ-ների թռիչքային հեռավորությունը գերազանցում է 1000 կմ-ը, իսկ արագությունը կազմում է 250-400 կմ/ժ: Բացի հետախուզական, նշանառու և ռադիոէլեկտրոնային պայքարի միջոց հանդիսանալուց միջին ԱԹՄ-ները կարող են օգտագործվել հակառակորդին հարվածներ հասցնելու համար: Նրանք կարող են կիրառել տարբեր տրամաչափի բարձր ճշգրտության հրթիռներ և ռումբեր: Շատ դեպքերում կառավարման համար օգտագործում են արբանյակային կապ:

*Ծանր ԱԹՄ-ները* կարող են կշռել մի քանի տոննա, ունենում են 24 ժամ և ավելի թռիչքային ժամանակ, իսկ թռիչքի բարձրությունը կարող է հասնել 20 կմ և ավելի: Այս ԱԹՄ-ները կարող են առաջադրանք կատարել թռիչքի վայրից մի քանի հազար կիլոմետր հեռավորության վրա և ունեն ստրատեգիական նշանակություն: Հիմնականում օգտագործում են մեծ թռիչքային բարձրություններից հակառակորդի խորը թիկունքում հետախուզություն իրականացնելու համար: Հազվադեպ են օգտագործվում որպես հարվածային և որպես կանոն ունեն մեծ ինքնաբժեք: Սպասարկման համար պահանջվում է մեծ ծախսեր և բարձր որակավորում ունեցող անձնակազմ: Բարձր թռիչքային բարձրությունը թույլ է ԱԹՄ-ին աննկատ մնալ և անհասանելի լինել հակառակորդի միջին և փոքր հեռահարության ՀՕՊ միջոցներին:

### **3 Անօդաչու թռչող սարքերի կիրառելիությունը**

*Հետախուզական ԱԹՄ-ները* օգտագործվում են հակառակաորդի զորամիավորումների, զինտեխնիկայի, ամրացումների և տարբեր նշանակության օբյեկտների հայտնաբերման համար:

Նախկինում հետախուզության համար հիմնականում օգտագործվում էին հատուկ մասնագիտացված ինքնաթիռներ՝ հետախույզ ինքնաթիռներ: Նման առաջադրանքները չափազանց վտանգավոր էին և հաճախ ավարտվում էին ինքնաթիռների ոչնչացմամբ, որի արդյունքում օդաչուներ էին զոհվում: Մարդկային կորուստներից խուսափելու համար սկսեցին շատ դեպքերում նման



առաջադրանքների համար կիրառել ԱԹՄ-ներ, որոնք բացի անօդաչու լինելուց ավելի դժվար էին հայտնաբերվում: Հետախուզական ԱԹՄ-ները համալրում են տարբեր տեսակի դիտարկման սարքերով՝ տեսախցիկներով, գիշերային տեսողության սարքերով, ջերմացույցներով, հեռավորության չափման սարքերով և այլն:

*Նշանառու ԱԹՄ-ները* օգտագործվում են հակառակաորդի զորամիավորումների, մեծ դերակատարություն ունեցող անձանց, զինտեխնիկայի, ամրացումների և տարբեր նշանակության օբյեկտների նշանառման համար:

Հակառակաորդի թիկունքում գտնվող թիրախների խոցման համար, որպես հարմար միջոց օգտագործում են օդային հարվածները, որոնք հիմնականում իրականացվում են ինքնաթիռների միջոցով: Ժամանակակից խոցման միջոցները օգտագործելու համար նախ հարկավոր է նշանառության տակ վերցնել թիրախը: Սակայն այս առաջադրանքի իրականացման տիրույթը սահմանափակվում է ինքնաթիռի նշանառման համակարգի հնարավորություններում, ինչի արդյունքուն նման առաջադրանքները շատ վտանգավոր են դառնում ինքնաթիռի անձնակազմի համար, քանի որ ինքնաթիռի հայտնաբերման վտանգ է ստեղծվում: ԱԹՄ-ները համդիսանալով ավելի դժվար հայտնաբերվող թռչող սարքեր ավելի քիչ են ենթարկվում նման վտանգի և որ ամենակարևորն է չի վտանգվում մարդու կյանքը: Նշանառու ԱԹՄ-ները թափանցելով հակառակաորդի թիկունք նշանառության տակ են առնում խոցման օբյեկտը, որից հետո անվտանգ հեռավորությունից արձակված հրթիռը, արկը կամ ռումբը խոցում է այն: Այս ԱԹՄ-ները բացի դիտարկման սարքերից նաև համալրված են լինում նշանառման սարքերով: Հիմնականում օգտագործվում են լազերային նշանառման սարքեր:

*Ռադիոէլեկտրոնային պայքարի ԱԹՄ-ները* օգտագործվում են հակառակաորդի ռադիոէլեկտրոնային միջոցների խանգարման, ինչպես նաև դրանց հայտնաբերման համար:

Ռադիոէլեկտրոնային միջոցներից առավել կարևորներից են ռադիոլոկացիոն կայանները: ՌԼԿ-ները հանդիսանում են ՀՕՊ միջոցների «աչքերը» և առանց դրանց

չափազանց բարդանում է թոշոդ օբյեկտների հայտնաբերումը: Ռադիոլոկացիոն կայանները օբյեկտների հայտնաբերման համար օգտագործում են ռադիոալիքներ, որոնք անդրադառնալով փնտրվող օբյեկտից ցույց է տալիս նրա գտնվելու վայրը: Ռադիոէլեկտրոնային պայքարի ԱԹՄ-ները արձակում են ռադիոալիքներ, որոնք խանգարում են ՌԼԿ-ներին «կուրացնելով» դրանց: Բացի դրանից այս ԱԹՄ-ները կարողանում են որսալ ՌԼԿ-ներից արձակված ռադիոալիքները և որոշել ՌԼԿ-ի գտնվելու վայրը, ինչը կարող է որոշիչ նշանակություն ունենալ հետազայում տարվելիք օդային գործողությունների համար: Ռադիոէլեկտրոնային պայքարի ԱԹՄ-ները, որպես օգտակար բեռ վերցնում են հատուկ ՌԷՊ կոնտեյներներ:

*Հեռակառավարվող վերահսկողության և դիտարկման ԱԹՄ-ները* հիմնականում օգտագործվում են պետական սահմանները հսկելու և սահմանախախտներին հայտնաբերելու համար:

Սահմանի մեծ երկարությունը կամ անտառներով ծածկված լինելը բավականին դժվարացնում է սահմանի վերահսկողությունը և դիտարկումը վերգետնյա միջոցներով: Հաճախ սահմանախախտները սահմանը հատելու համար, որպես քողարկման միջոց են օգտագործում բուսականությունը: Գիշերային պայմաններում նրանց բացահայտումը դառնում է շատ բարդ խնդիր: Հարկ է առաջանում առավել լավ դիտարկման համար օգտագործել թոշոդ սարքեր և այս առաջադրանքը ԱԹՄ-ները կատարում են գերազանց:

Հեռակառավարվող վերահսկողության և դիտարկման ԱԹՄ-ները համալրվում են տեսախցիկներով, գիշերային տեսողության սարքերով և ջերմացույցներով, որոնք թույլ են տալիս հայտնաբերել սահմանախախտների թե ցերեկային, թե գիշերային ժամերին:

*Օդային վերահսկողության ԱԹՄ-ները* օգտագործվում են որպես միջնորդ տարբեր տեսակի ազդանշանների փոխանցման համար (ռադիոազդանշանների, հեռուստաչափական և այլն):

Հաճախ լեռնային լանդշաֆտ ունեցող վայրերում ալեհավաքները վատ են աշխատում և հարկ է առաջանում կապ հաստատելու համար օգտագործել հատուկ միջոցներ: Որպես այդպիսի միջոց կարող է ծառայել ԱԹՄ-ն, որը գտնվելով օդում կարող է ընդունել ազդանշանը և փոխանցել այն նշանակման վայր: Այսպիսի ԱԹՄ-ները նաև օգտագործվում են քաղաքացիական նպատակներով, որի մասին գրված է ստորև:

*Հարվածային ԱԹՄ-ները* օգտագործվում են զինված խմբերի, զինտեխնիկայի, կարևոր օբյեկտների ոչնչացման համար:

ԱԹՄ-ների հնարավորությունները և արդյունավետությունը բացահայտելուց հետո դրանք սկսեցին օգտագործվել նաև որպես հարվածային միջոց: Հարվածային ԱԹՄ-ները ունեն լայն կիրառման տիրույթ, քանի որ կարող են կրել տարբեր տրամաչափի չկառավարվող ռումբերից մինչև գերճշգրիտ կառավարվող հրթիռներ: Այսպիսի ԱԹՄ-ները հաճախ օգտագործվում են կարևոր օբյեկտներին կետային հարվածներ հասցնելու համար: Հարվածային ԱԹՄ-ների բարձր արդյունավետությունը ստիպեց մասնագետներին առավել խորը ուսումնասիրություններ իրականացնել այս ուղղությամբ: Ներկայումս մեծ աշխատանքներ են տարվում գերձայնային հարվածային ԱԹՄ-ների ստեղծման և կատարելագործման ուղղությամբ:

*Բազմանպատակային ԱԹՄ-ները* իրենցից ներկայացնում են վերը նշված ԱԹՄ-ների հնարավորությունների համախումբ:

Ժամանակակից տեխնոլոգիաները թույլ են տալիս ստեղծել բավականին փոքր զանգված և զաբարիտային չափեր, բայց մեծ արդյունավետություն ունեցող սարքեր, ինչպիսիք են տեսախցիկներ, կառավարման բլոկները, կապի միջոցները, ռադիոլոկացիոն կայանները և այլն: Արդյունքում՝ հատուկ մասնագիտացված ԱԹՄ-ների փոխարեն, կարելի է ստեղծել բազմաֆունկցիոնալ ԱԹՄ-ներ, որոնք կարող են նույն հաջողությամբ կատարել տարբեր նշանակության գործողություններ: Օրինակ ԱԹՄ-ն կարող է իրականացնել հետախուզություն, այնուհետև համաբաժանաբար

օբյեկտ հայտնաբերելու դեպում նշանառության տակ վերցնել այն կամ ինքնուրույն ոչնչացնել, կամ օրինակ հայտնաբերել ռադիոլոկացիոն կայանը և խոցել այն հակառադիոլոկացիոն հրթիռով և այլն: Ժամանակակից ԱԹՄ-ները իրենցինքն ներկայացնում են բազմաֆունկցիոնալ սարքեր, որոնք կարող են առաջադրանքներ կատարել լայն տիրույթում:

*Քաղաքացիական ԱԹՄ-ները* օգտագործվում են տարբեր բնագավառներում՝ ֆոտո նկարահանումներ, գյուղատնտեսություն, կապի համակարգեր և այլն:

Սկզբնական շրջանում ԱԹՄ-ները կիրառվում են որպես ռազմական նշանակության միջոցներ, բայց շուտով դրանք լայն կիրառություն ստացան նաև քաղաքացիական տարբեր ճյուղերում: Քաղաքացիական ոլորտում հատկապես լայն կիրառում են ստացել մինի և միկրո չափերի ԱԹՄ-ները:

ԱԹՄ-ների քաղաքացիական կիրառման ոլորտը շատ լայն է: Դրանցից են՝

- անվտանգության ապահովում,
- փողոցների, տրանսպորտային ուղիների և այլ տարածքների հսկում,
- արտակարգ իրավիճակներում տարբեր կառույցների կառավարում (հրշեջ ծառայություն, փրկարար ծառայություն, շտապ օգնության ծառայություն և այլն), իրավիճակի օպերատիվ գնահատում և այլն,
- գյուղատնտեսություն,
- տեղանքի քարտեզագրում,
- դժվար հասանելի վայրերի ուսումնասիրություն,
- շինարարություն և շինարարության վերահսկողություն,
- շինությունների վիճակի ուսումնասիրություն,
- զանգվածային լրատվամիջոցներ,
- կապի ապահովում,
- բեռնափոխադրումներ և այլն:

ԱԹՍ-ները օպերատիվ կերպով կարող են տեղեկություն հաղորդել տիրող իրավիճակի մասին: ԱԹՍ-ների այս հնարավորություններից ներկայումս օգտվում են ոստիկանությունը և այլ կառավարման և վերահսկողության մարմինները:

ԱԹՍ-ները վերջին ժամանակներս լայն կիրառություն են ստացել նաև գյուղատնտեսական ոլորտում: ԱԹՍ-ների միջոցով ստեղծվում են դաշտերի ճշգրիտ էլեկտրոնային քարտեզները, վերահսկվում և գնահատվում են կատարված գյուղատնտեսական աշխատանքները, իրականացնել տարբեր նշանակության մոնիթորինգներ, կանխատեսել բերքը, գտնել վնասված կամ վարակված հատվածները և այլն:

Նկարահանող ԱԹՍ-ն օդ է բարձրանում, շարժվում է նախօրոք տրված հետագծով և իրականացնում տեղանքի նկարահանում, այնուհետ վայելչք է կատարում մեկնարկի վայրում: Արդյունքում ստացված որակյալ նկարներ օգտագործվում են տարբեր տիպի ուսումնասիրությունների համար:

ԱԹՍ-ները օգտագործվում են քարտեզագրության մեջ: ԱԹՍ-ների միջոցով կատարված լուսանկարներից ստեղծվում են տարբեր տեսակի տեղանքի ճշգրիտ քարտեզներ:

ԱԹՍ-ները նաև օգտագործվում են դժվար հասանելի երկրաբանական վայրերի ուսումնասիրության համար, ինչպիսիք են ժայռերը և քարանձավները:

Շինարարության ժամանակ ԱԹՍ-ները օգտագործվում են վերահսկման և դիտարկման համար: Հատկապես մեծ մասշտաբի շինարարական հրապարակներում, երբ աշխատանքների տիրույթում ընդգրկվում են մեծ տարածքներ և այդ ամենը վերահսկելը դժվարանում է, մասնագետները օգտագործում են ԱԹՍ-ներ, որոնց միջոցով կարողանում են արագ հայտնաբերել թերությունները:

Զանգվածային լրատվամիջոցները ԱԹՍ-ները օգտագործում են լուսա և վիդեո նկարահանումների համար:

ԱԹՍ-ները լայն կիրառում են ստացել կինոնկարահանման ոլորտում:

Ներկայումս ԱԹՄ-ներն իրենց առօրյա գործունեության մեջ են ուզում մտցնել տարբեր ձեռնարկատերեր՝ գտնելով դրանց համար կիրառման նորանոր ոլորտներ: Այսպես՝ Ավստրալիայում 2013 թվականին «Zookal» ընկերությունը սկսեց օգտագործել ԱԹՄ-ները, որպես տպագրական գրքերի արագ առաքման միջոց: Պատվիրատուն շնորհիվ հատուկ ծրագրի կարող է հետևել ԱԹՄ-ին օնլայն տարբերակով և նույնիսկ հրաման տալ արձակելու բեռը:

Հայաստանում անօդաչու թռչող սարքերի ոլորտը բավականին երիտասարդ է և նոր է սկսում իր զարգացումը: Ինչպես ամբողջ աշխարհում այնպես էլ Հայաստանում այս ոլորտի զարգացումը սկիզբ է առել ռազմական ուղղվածությամբ:

Այս ուղղությամբ առաջինը սկսել են աշխատել ՀՀ Ռազմաօդային ինստիտուտի մասնագետները, որոնց մի քանի տարիների ընթացքում հաջողվել է ստեղծել և աշխարհին ներկայացնել հայկական մշակման և արտադրության առաջին հետախույզ ԱԹՄ-ները: Դրանցից առավել հայտնի են «Կռունկ»-ը և «Բազե»-ն:

Ներկա փուլում տարվում են աշխատանքներ նոր տիպի ԱԹՄ-ների ստեղծման և դրանց ղեկավարման համակարգերի բարելավման ուղղությամբ:

Հայաստանում ԱԹՄ-ների օգտագործումը քաղաքացիական ոլորտում դեռ բավականին զարգացած չէ: Դրանք, հիմնականում օգտագործվում են նկարահանումների իրականացման համար տարբեր անհատների և լրատվամիջոցների կողմից: Այդ նպատակի համար օգտագործվում են այսպես կոչված քուպտերները (չորս, վեց կամ ութ շարժիչ ունեցող ոչ աերոդինամիկ իրանով սարքեր): Այդ սարքերի ղեկավարումը իրականացվում է կիսաավտոմատ ռեժիմով:

Ներկայումս հայաստանում կան մի քանի կազմակերպություններ, որոնք զբաղվում են ԱԹՄ-ների ղեկավարման համակարգերի մշակմամբ և ստեղծմամբ: Հայտնի է, որ քննարկվող սարքերի առավել կարևոր հատվածը դրանց ղեկավարման համակարգն է, որ փաստացի հանդիսանում է սարքի (ռոբոտի) «ուղեղը»:

Հայտնի է, որ Հայաստանում վերջին տարիների ընթացքում բավականին զարգացել է ԻՏ ոլորտը և դա հնարավորություն է տալիս ենթադրել, որ շուտով հայ

մասնագետներին կհաջողվի ստեղծել ԱԹՄ-ների ղեկավարման արդյունավետ համակարգեր, որոնք կլինեն մրցունակ համաշխարհային շուկայում:

Վերոնշյալ համակարգերի ստեղծումը հնարավորություն կտա ԱԹՄ-ների շահագործումը դարձնել առավել անվտանգ և մատչելի, ինչը իր հերթին կխթանի դրանց ավելի խորը ներդրումը և օգտագործումը քաղաքացիական տարբեր ոլորտներում:

Հաշվի առնելով ՀՀ տարածքում բարձր լեռնային գոտիներում բնակավայրերի գոյությունը և ճանապարհային ցանցի ու տրանսպորտի ոչ բավարար զարգացածություն, բեռներ տեղափոխով ԱԹՄ-ները կարող են ունենալ մեծ պահանջարկ (բուժօգնություն, փոստային ծառայություններ, կապի միջոց):

Պետք է նշել, որ ԱԹՄ-ների ոլորտի զարգացումը իր հետևից, որպես քարշակ, առաջ է տանում տնտեսության և գիտության մի շարք ուղղությունների զարգացումը և այն Հայաստանի համար կարող է դառնալ տնտեսության աճի կայուն բաղադրիչ:



eDrone

*Educational for Drone (eDrone)*  
574090-EPP-1-2016-1-IT-EPPKA2-CBHE-JP

# Educational for Drone (eDrone) **ASUE**

**Lilit Dadayan**



*Educational for Drone (eDrone)*  
574090-EPP-1-2016-1-IT-EPPKA2-CBHE-JP



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# Different National Economic and Market Strategies



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# Main areas of applications



- **Precision Agriculture**
- **Environmental Applications**
- **Industrial Applications**
- **Civil engineering**
- **Disaster Relief**
- **Safety and Security**

# The drone role in national economy and market combination



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The drone industry has been captured many markets and is already being used in a variety of applications, most of them we have referred previously:

- ✓ Agriculture monitoring,
- ✓ Disaster management,
- ✓ Environmental monitoring,
- ✓ Wildlife mapping,
- ✓ Oil and gas exploration,
- ✓ Thermal infrared power line surveys,
- ✓ Aerial mapping,
- ✓ Law enforcement,
- ✓ Weather monitoring,
- ✓ Television news coverage,
- ✓ Sporting events,
- ✓ Moviemaking,
- ✓ Freight transport etc.

# Three types of drone market

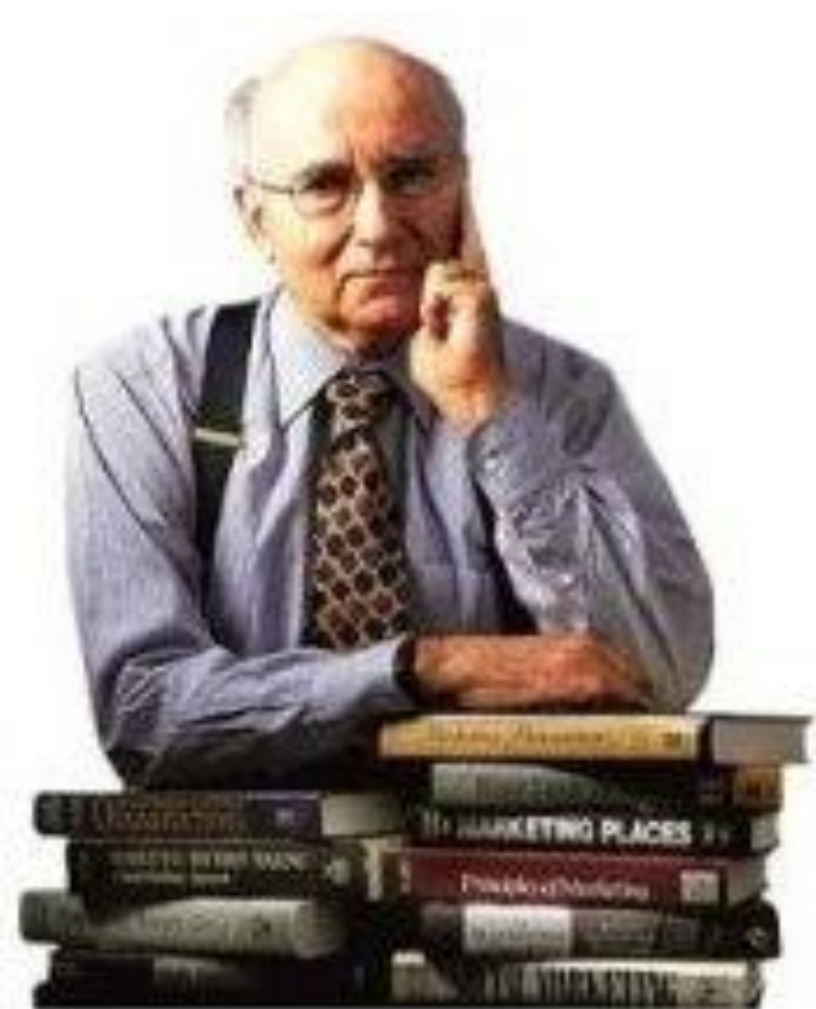
- **Consumer market**
- **Commercial market**
- **Governmental market**

# **The definition of Drone market strategies and the marketing strategy process**



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# What is Marketing?



**“Marketing** is the human activity directed at satisfying human needs and wants through an exchange process.”

***Philip Kotler***



# What is Marketing?

**“Marketing** is a social and managerial process by which individuals and groups obtain what they want and need through creating, offering and exchanging products of value with others.”

***Philip Kotler***

# What is Marketing?

**“Marketing** is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, services to create exchanges that satisfy individual and organizational goals.”

***American Marketing Association***

# What is Marketing?

**“Marketing** is the management process for identifying, anticipating and satisfying customer requirements profitably.”

***The Chartered Institute of Marketing (CIM)***



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# How to identify Marketing?



Marketing it is best identified using what are called the **4 P's** or a **mix of marketing: Product, Price, Promotion, and Place.**





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# What do we market?



- ❖ Goods,
- ❖ Services,
- ❖ Events,
- ❖ Experiences,
- ❖ Personalities,
- ❖ Places,
- ❖ Organizations,
- ❖ Properties,
- ❖ Information,
- ❖ Ideas and Concepts etc.

# Thanks for your attention!

# What is a Marketing Plan and which are the essential components of it?

- 1. Market research**
- 2. Target market**
- 3. Positioning**
- 4. Competitive analysis**
- 5. Market strategy**
- 6. Budget**
- 7. Metrics**

# What is a Marketing Strategy?

- systematic futuristic thinking by management,
- better co-ordination of company efforts  
ordination of company efforts,
- development of better performance standards for control,
- sharpening of objectives and policies,
- better prepare for sudden new developments.



# Which are the main steps of Marketing Strategy Process?

- **Mission:**
- **Situation Analysis:**
- **Objectives:**
- **Strategy and Evaluation:**



The first step in strategic marketing is to articulate the reason why the enterprise exists and how it can benefit target consumers over the long term. In particular, this mission statement is intended to anticipate the future and describe an ongoing role for the organization's product, service or expertise. For example, the mission of a **drone** might be to provide continuing innovation in global aerial system.





Organizations conduct a situation analysis, also known as a SWOT, to evaluate and prioritize their *strengths*, *weaknesses*, *opportunities* and *threats*. This second step in the strategic marketing process helps managers understand the resources they can build on and the challenges they face. Strengths and weaknesses are internal factors, under the firm's control. Opportunities and threats arise from the external environment, like a strong economy or new payroll tax.



The third step in strategic marketing is to set marketing objectives. These are clear, measurable goals that give decisionmakers a basis for making choices and assessing progress. Objectives are typically expressed in terms of one or more quantitative targets like revenue, profit, sales or market share. Importantly, each objective must be achievable within a fixed period of time.

# STRATEGY & EVALUATION

The fourth step in strategic marketing is strategy development. This involves selecting a target market, a distinct group of consumers who are highly likely to buy the company's product. Planners must also choose implementation tactics, specifically, effective ways to use the marketing mix tools of product, promotion, price and distribution to reach and influence prospective buyers. The fifth step, evaluation, means specifying how, when and by whom these tactics are to be monitored and assessed over time.



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# Why Marketing Strategy is necessary?





**While trying to build your own drone marketing strategy it's necessary to pass through below mentioned steps:**

- ☐ Identify your target audience.
- ☐ Make a Good First Impression.
- ☐ What problems we are solving for our customers?
- ☐ Meeting with our customers.
- ☐ Talk to your customers in their own language.



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**If you have right drone marketing strategy,  
you can grow our influence - and, hopefully,  
sales!**





## 2. Different National Economic and Market Strategies

### 2.1. The Drone Importance

Most common and simple definition of drone is: “Drone is any unmanned aircraft or ship that is guided remotely”. These devices have become more popular in recent times and their application increases rapidly in various fields. There is no doubt that drones are among the most advanced devices in today’s aeronautics, electronics and robotics alike. Drones come in a wide range of shapes, sizes, and with various functions. The massive majority of today’s models can be launched by hand, and they can be controlled by remotes or from special ground cockpits. There are even some models of drones which come in small sizes, have simplified construction and are suitable even for kids because they are very easy to control. There are different variations in the frame and construction of drones, but the essential components that every drone must have is a waterproof motor frame, flight and motor controllers, motors, transmitter and receiver, propellers, and batteries or any other source of energy. Drones are used in many areas, can be helpful in numerous occasions and there is no end when it comes to their possibilities. Therefore, the areas of applications are numerous today and there is the growing use of drones all around the world.

#### Main areas of applications

**Precision Agriculture:** Precision agriculture is a farming management that observes, measures and responds to inter and intra-field variability in crops. Its main goal is to help farmers to optimize crop science by matching farming practices to crop needs, environmental protection by minimizing the farming footprint, economics by increasing the competitiveness through better practices and implementations. Precision agriculture measures different variables such as crop yield, terrain features, organic matter content, moisture levels, nitrogen levels, PH and other. It is considered to be a key component of new wave in modern agricultural revolutions and comes in the form of satellite imagery, weather prediction, fertilizer application, crop health indicators. Precision agriculture is a new step for farmers as it also requires recording the farming activities, improving decision making process in agriculture, improving relationships with landlords and increasing the quality of agricultural products. The use of mentioned competitive activities created the understanding of prescriptive planting which is a type of farming system that requires data-driven planting in order to maximize yield.

Precision agriculture is usually done in four sequential stages, as follows:

1. **Data collection:** Geolocating the necessary field helps the farmer to have information gathered from analysis of soils, crops and soil resistivity. Delineation of the field can be done either using an in-vehicle GPS receiver or on a basemap derived from aerial imagery.

2. **Variables:** Agricultural sphere covers number of variables that can be grouped into permanent indicators and point indicators. These include variables about climatic conditions, soils, cropping practices, weeds, disease, etc.
3. **Strategies:** Using soil maps, farmers have a possibility to implement two strategies which are predictive approach (based on crop cycle static indicator analysis) and control approach (information from static indicators is regularly updated during the crop cycle by sampling, remote sensing, etc.).
4. **Implementing practices:** The implementation of precision agriculture includes the use of technology on agricultural equipment such as sprayers, tractors and others.

During the last few years new technologies and techniques are continuously being employed to turn the data collected into usable information and low-tech industries such as agriculture have also become included into these changes. The new era in agricultural activities brought hand-written notes and analysis of farmers into robotic data collection and analysis through modern software, remote sensors and drones that are being created to improve yields and profitability in line with the sustainability.

Drones today are able to provide farmers with three types of detailed views.

1. The view of the crop from the air can make noticeable things that cannot be seen easily while using traditional methods.
2. Cameras can take multispectral images that help to create a view of crop to show the health level which is unable for a naked eye.
3. Drones survey crops every week, every day or even every hour, is able to create time-series animation, to take crop management into a higher level.

Drones will give agriculture to plan and make strategy on real-time data gathering and processing. There are six general ways that drones can be used in agriculture:

1. **Soil and field analysis:** Drones can produce 3D maps for early soil analysis that can be very useful at the start of the crop. After the planting phase is done, soil analysis implemented by the drones delivers data for irrigation and nitrogen level.
2. **Planting:** Drones give an opportunity to shoot seeds and plant nutrients into the soil, providing the plant and the soil the nutrients needed for healthy life.
3. **Crop spraying:** Drone adjusts the altitude as geography varies base on the technological advances avoiding smashes. Having these characteristics drones are able to scan the ground and spray the right amount of liquid on the plants. As a result farmers have higher efficiency and lower consumption of chemicals and time.
4. **Crop monitoring:** Large fields make several obstacles for farmers as it with the size of the fields it becomes more and more difficult to monitor the crops. These obstacles become more dangerous with unpredictable weather conditions. Drones are able to help the farmers

to fight also these problems giving them an opportunity to have time-series animations and unlimited photo-shoots for monitoring purposes.

5. **Irrigation:** Drones with appropriate sensors can give a chance to identify the parts of the fields that need water or other improvements. These sensors also help to calculate the vegetation index after the crop grows, showing the health and growth of the crop.
6. **Health assessment:** Agriculture always struggles to provide healthy products to the consumers so the assessment of health of agricultural products is of high importance level for all the farmers. Drones are able to scan the crops using specific lights. The outcome can be multispectral images that help to track changes in plants and indicate their health. A fast alarm can be sent to the farmer if some diseases are discovered, so farmers can monitor the sickness in a precise way. This will help the farmer to overcome the diseases in the field.

Drones encountered technical controversies in the past and it has its advantages and disadvantages in the farm use which will be introduced below.

### Pros

- **Analysis:** Drones are good to be used for soil and field analysis that make available almost all the information about them.
- **Ease of use:** unlike traditional aircraft, the drones are easier and more understandable to use.
- **Mapping:** Drones make the survey of land and measurement of the area easier than farmers traditionally do. So once the drones are optimized, they can make images or spray fertilizers.
- **Prevents infestations:** Drones are able to show the farmers the currency of any animal or insect infestation which can save and increase the health of the field by ultrasonic waves.
- **Moisture monitoring:** Farmlands are usually either drier or wetter than needed and drones can help the farmers to detect both types of phenomenon in the fields that can help to save the crops.
- **Reducing operational costs:** Mainly labour costs are reduced by use of drones. Drones can be seen as alternative manpower to the farmlands that assist the farmers in different aspects.
- **Increase yields:** Potentially finding yield limiting problems can help farmers increase production and efficiencies to higher yields.

### Cons

- **Flight time and range:** Most of drones have short flight times averaging in 40 minutes which can make limits for several things such as the acreage, the radius covered during on flight, etc.
- **Initial cost of purchase:** Drones constructed for agricultural use are costlier as they are equipped with the necessary equipment and software.

- **Laws:** The use of drones for agricultural purposes is considered as commercial use of drones so the farmers need to have a remote pilot certificate or hire an operator to drive the drone.
- **Connectivity:** Most of the farmlands worldwide have little online coverage if any which means that farmers using drones have to either invest in connectivity or buy a drone capable to store data locally in order to process it later.
- **Weather dependent:** If it is very windy or rainy outside it may not be possible to fly the drones.
- **Safety concerns:** Drones can create problems if not flown properly hitting people or vehicles.
- **Time commitment:** it takes more time than most expect from someone who has passed their drones systems test.

Drones have a growing role in agriculture assisting farmers to visualize their crops across their farmlands. Farmers usually have an increase in ROI after they start using drones. Drones help to save time and crops and to avoid losses from infestation and weather changes. It is expected by different scholars and companies that precision agriculture will fundamentally change agribusiness transforming almost everything in the value chain. Global Market Insights in its turn forecasts that the market size of drones specialized for agriculture will reach \$1 billion having around 200000 units by 2024. Farmers just need to realize that drones are the ticket to financial success and a better place to live.

**Environmental Applications:** One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing critical and irreparable harm to the Earth. One of Environmental pollution basic types is the air pollution, which is the most harmful form of pollution in our Environment. It is caused by the damaging smoke emitted by vehicles and factories. Evidence of increasing air pollution is seen in various breathing problems and diseases along with severe and irreparable harm to flora and fauna. Even the most natural phenomenon of migratory birds has been laden, with severe air pollution preventing them from reaching their seasonal metropolitan destinations of centuries. Today many companies from different parts of the world are trying to decrease this phenomenon by reducing their environmental footprint. The industry of drones is an inseparable part of this worldwide project and tries to find environmentally friendly solutions to the current issues. Drones help to not only decrease air pollution levels, which are harmful especially for people life, but also make the lifestyle of each of us easier and more comfortable.

At first sight it is a little bit difficult to imagine how important the drones can be in environmental protection processes, as when we think of drones, most often we think them to be used for military purposes. Despite its common association with the military, drones are increasingly being used to sustain and improve the environment and already have a special mission: *saving the Planet*.

The enrolment of drones in protecting and conserving the Environment helps to gather accurate and timely information in a non-harmful way. Drone technology suits a numerous environmental protection applications - offering quick, easy and cost-effective aerial imagery. In the scope of Environmental protection there are many reasons why professionals such as environmental engineers and scientific researchers are increasingly using drones. The area of drone use may start from glacial feature modelling and erosion monitoring to animal counting and species identification. The list of projects that drones are being used for is long and continues to grow. Here are some of them which should be discussed in the scope of Environmental Applications of Drones.

1. **Sustaining sustainable energy:** One of the areas we are most likely to find drones at work these days are on solar farms. Solar farms can cover anything from one to one hundred acres and maintaining them manually can be both impractical and dangerous, especially as engineers often want to inspect panels for defects when the sun is at its most powerful. As the solar electricity plants are larger, bigger and beyond the kind of scale that humans can handle the scientists have created *thermal imaging cameras* which provide an aerial overview to pin-point panels that might be damaged, covered in dust or obscured by invasive vegetation. Engineers then process this information and return to these specific locations to fix the panels at convenient times, making for more efficient maintenance. Drone inspections are keeping large-scale solar energy projects running around the world and mapping capabilities are assisting solar companies in the planning and building of solar farms.
2. **A mission on emissions:** Protecting the Environment by mapping industrial emissions has its important role in drone industry. When we think of mapping it is often in relation to real estate or agriculture: developing an in-depth view of an area that can be used for planning and modelling. But one start-up in Finland called **Aeromon** (<http://www.aeromon.fi/>) is able to detect, measure and visualize more than 70 different industrial emissions and map air quality over large areas. With their solutions you can have automatic reporting of our emissions with a 360 degree view. In the past, these emissions might have gone undetected because emissions sensors at ground level or higher altitudes would have missed them, but the flexibility of Drones means the data provided gives authorities more power when it comes to enforcing emissions legislation. With emission targets being set around the world in a bid to slow down global warming, it is easy to see how technology like this can help governments and authorities keep factories and fossil fuel companies in check. As says the **Aeromon** team *“Emissions are complicated. They may be undetectable, but their damage is real.”*
3. **Environmental conservation projects:** As well as being environmentally friendly in terms of performance, drones can help in the application of environmental research projects and wildlife preservation. Their agility and compact size mean they can be quickly deployed to monitor hard to reach areas with minimal impact. This makes them ideal for environmental observation projects from monitoring and mapping natural landscapes to

tracking animal migration patterns. Small and light electric-powered drones, especially fixed-wing aircraft, make little noise and are often bird-shaped, meaning animals on the ground are rarely disturbed by these tools, if they notice them at all. Equipped with infrared cameras, drones are being trialled in hot and remote locations, to detect leaks in underground water pipes in the desert.

## Pros

- **Environmentally friendly:** The big advantage of using a drone in the sphere of protecting Environment is that they are doing their missions causing minimal disturbance to the surrounding environment and wildlife. In comparison to other aerial vehicles the drones have the smallest motors which help to have as fewer emissions as possible. Most drones do not operate using fossil fuels meaning that they do not produce the high levels of CO<sub>2</sub> associated with planes and helicopters which makes them a more environmentally friendly alternative for aerial works.
- **Flexible:** Another valuable advantage of drones is that they have an ability to reach areas that were before too hard to access for conservationists and environmental researchers, while also generating minimal disturbance to the surrounding wildlife and environment, make drones a powerful tool that can give researchers the freedom to gather information like never before.
- **Safety:** One of the large benefits of using a drone over alternative methods is the added safety value they can provide. People who work in remote or more dangerous locations do not have to be put in harms way if they have to do aerial surveys over parts of the jungle, or, f.e., in the Arctic. Also we can mention that the launching a drone requires a minimal amount of workers which is also a good benefit for it.
- **Non-noisy:** One of the added bonuses is that the drones make minimal noise while they realize their missions. This means that the wildlife and surrounding nature can be monitored undisturbed, which is very important thing while we do some researches in in wildlife.
- **Small sizes:** Mostly the drones are lightweight, low-cost, require little in the way of infrastructure and, crucially, use little or no fuel, as we already know. All these mentioned factors are considered to be pros for drones.
- **Drones for environmental monitoring:** Photographers and videographers have started to use drones to produce stunning images of wildlife that would be very hard or expensive to obtain otherwise. Drones can be used to perform environmental science as well. Often, scientists want to monitor one particular area for a period of time in order to track changes. For example, a buoy could listen for whales in a particular region. A robot could fly out to get that data, which then could be used to establish safe shipping lanes. A robot would be able to repeatedly see what's going on with a population or a microhabitat. Scientists probably don't have funding to send people out every day but they still could get really good readings.

- **Overall Conservation:** Drones can be used to track animals, particularly dangerous animals, without putting anyone at risk. They can also be used to watch for poachers and trespassers, increasing security in areas where there is simply too much ground to cover. Additionally, drones can be used to provide aid when natural disasters strike. Whether it is to comb an area after an earthquake or flood to look for survivors, or fighting fires by delivering payloads, drones are a powerful tool in the fight to keep wildlife, and wild areas, safe.
- **Brand new technology:** Drones are allowing people to ask questions and look at things that they may not have been able to look at before!

## Cons

When we try to speak about the negative impact of using a drone to the Environment, it is difficult to make a list and mention disadvantages, because the drone has a high level of conservative effect and almost completely has positive impact on our Planet.

In base of the above mentioned information we have already imagined the connection between the drones and the Environment, and found out that causing minimal disturbance to the surrounding environment and wildlife, the drones in the air can perform surveys, collect data and imagery, monitor wildlife and varying landscapes and even track or count animal populations. We have explored that drones – being a brand new technology hold a wide variety of advantages to those looking to aid in the protection and conservation of the environment and its wildlife. Drones most crucial advantages are that they are *timely, efficient and cost-effective* due to which now many conservationists and environmental researchers are aimed to enlarge the drones using spheres protecting our planet and making it to be more conservative. The drones have all the potential to become more widely available across the whole spectrum of environmental monitoring in near future and they will!

**Industrial Applications:** In the beginning people were looking at drones as just another way to get pretty pictures or video, but now these people are starting to realize that these have an immense power for doing research from perspectives that we never thought we could get. The innovation of an industrial drone is to monitor regions or terrains inside or outside a manufacturing plant which generally cannot be studied by human workers, either due to their dangerous setting or inaccessibility due to size or Environment. Factories, refineries, power grids, wastewater treatment, mines and other similar industrial sites are complex systems requiring inspection and maintenance for optimal operation and regulatory compliance. On site inspection by human workers can be time consuming and in explosive environments, next to impossible unless some complex computer systems are used. Industrial drones can operate under complex circumstances such as these and enter even the most challenging terrains and environments and carry out the operation it was designed for without so much as a scratch. From this it is clear that drones are the next generation in low-cost industrial sensors and mobile platforms in the interconnected web.



The growth of drone industrial application can be seen in its use in various industries, such as:

1. **Energy and Utilities:** Part of making our electrical grid smart is getting access to real-time information on the status of power generation and transmission infrastructure. Utilities have already tested drones for inspecting transmission and distribution lines, looking for damage from storms and normal wear and tear. These tests have been run under temporary rules from the Federal Aviation Administration and utility companies are now ready to further demonstrate the value of drones. Imagine a utility that had a drone in every single line worker's truck. Workers could perform inspections without having to climb power poles or get close to dangerous wires. Drones can also inspect hundreds of miles of transmission lines in single flight - much faster than the traditional line worker having to climb several transmission poles.
2. **Oil and Gas:** Drones are increasingly being used by the Oil and Gas industry for their monitoring and inspection operations. They are being used today to detect gas leaks, spot fugitive oil spills and even scout for whales. They can be used on any part of the platform where inspections typically require rope access or scaffolding. Today drones are predominantly used in the midstream oil and gas sector. But they can also be applied to almost every aspect of the industry, including land surveying and mapping, well and pipeline inspections, and for security purposes. The key benefits are that they are much safer, faster and cheaper than conventional inspection techniques such as rope access and scaffolding. The use of drones means that oil platforms do not have to shut down for inspections. This is a huge cost benefit as shutdowns cost oil companies millions of dollars in lost revenue a day.
3. **Mining:** Anyone involved in mining knows that worker safety is of paramount importance. By allowing surveyors to collect accurate spatial data from above, drone can vastly reduce risk by minimising the time these staff spend on site. Drone-based data collection can also increase productivity; surveying projects that once took days or weeks using traditional surveying techniques are now possible in just a few hours. Drones provide an efficient way to manage stockpiles and help with grading control, site exploration, and overall management. Drones can also help miners figure out more efficient ways to design haul roads, dumps, and pits so they have less of an impact on the environment. Drones can improve safety in mining applications with real-time information on mining activities:
  - Up-to-date surface surveys for optimized blast designs,
  - Rapid pre- and post-blast data,
  - Identification of misfire and wall damage.
4. **Construction:** Here bellow are mentioned some reasons why construction firms want to use drones in their activities:
  - Drones are less expensive than manned aircraft. They are easier to operate and collect more data in comparison to alternative aerial vehicles.

- Drones can be used to survey the construction site and send information back. This usually takes a long time and requires use of various equipment and personnel. Drones are cheaper and they are more accurate in terms of data gathering.
- Companies can use drones to provide client updates. If they are unable to personally inspect the site, companies can send some images and videos and show details of the construction progress.
- Drones are also ideal for monitoring the site. Rather than invest in loads of expensive manpower and equipment, a construction company can purchase a few drones and have them scan the area and collect information.

5. **Agriculture:** Drones a natural fit with the world of agriculture, where farmers can benefit from real time information about large tracts of land. Drones can help track almost everything including water use, crop health, heat signatures and soil analysis. Expensive aerial surveillances that could previously only be done occasionally with planes can now be completed weekly or even daily with drones that cost only hundreds of dollars. Agricultural uses for drones include: remote moisture sensing to identify which parts of a field are dry or need improvements, precision agriculture like mid-field weed identification, frost mitigation, variable-rate fertilization dispersal etc.

The mentioned areas do not include the final list, the industrial application of drone is larger concept and includes more spheres. But, actually the above-mentioned information goes to show how important drones are. From being used by the military, they quickly found a market for fun and recreational use. The coming the 4<sup>th</sup> industrial revolution will alter how people and companies interact, work and play. With the rise of the digital age, drones will change the way farmers grow crops just as it is going to revolutionize the way mining firms assess their projects. From construction, scientific research, commerce, entertainment, drones will play a significant role in near future. With cost going down, a drone has become a worthwhile investment in growing number of industrial sectors.

**Civil engineering:** Civil engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams and buildings. Civil engineering is traditionally broken into a number of sub-disciplines. It is the second-oldest engineering discipline after military engineering and it is defined to distinguish non-military engineering from military engineering. Civil engineering takes place in the public sector from municipal through to national governments and in the private sector from individual homeowners through to international companies.

The horizontal nature of civil engineering lends to some practical and creative uses of drones in the industry. From planning to final construction, nearly every stage of the engineering process can benefit with the help of drones. In fact, drones are now widely being used in the engineering and constructions fields. Many firms are using drones to evaluate the exterior conditions of their

client's facilities, such as the roof and other hard to get to locations. That can mean more accurate inspections with less worry over a worker falling from a ladder during the inspection. Drones are even being used during the construction and installation portion of projects. Drones provide better resolution when it comes to photos and video, while reducing the cost to a firm. That is a big advantage and savings over previous technologies such as satellite and other aerial resources.

Civil engineers are using drones to perform 2D and 3D mapping projects. This is achieved using laser scanning devices and can help engineers construct virtual representations of real-world projects – assisting engineers in the planning and development stages of their most difficult projects. Drones in civil engineering can be used for aerial mapping, LiDAR scanning, pipeline surveying, aerial photography, etc.

1. **Aerial mapping:** More and more companies are using drones for surveys and mapping. For instance, DroneDeploy users have mapped over 10 million acres, which generated an estimated \$150 million for the commercial drone industry. Here below are mentioned some *benefits* of using drones for surveying and mapping.
  - **Ease of Deployment.** Drones are capable of completing survey jobs in less than half the time of a traditional survey methods. Surveys that once took weeks to complete, can now be done in less than a few days. This allows for surveyors to complete more projects in less time.
  - **Reduced Risk.** Using UAS for data collection reduces the need for workers to enter potentially hazardous areas. The small, portable size of drones make them ideal for collecting data in a variety of different environments like roadways and steep terrain.
  - **Detailed Data.** Drones equipped with imaging software make it easy to turn images into a wide variety of georeferenced 2D maps and 3D models for surveying, city modeling, large-scale mapping, urban planning, cadaster and more.
2. **LiDAR scanning:** LiDAR is a laser-based remote sensing technology and stands for light detection and ranging. It is a technology widely used in the domain of geographical information system (GIS) for surveying and mapping different kind of natural resources and infrastructures. As a matter of fact the LiDAR technology is being used in numerous scientific fields, related to geomatics, which are relying on high accuracy definition of terrestrial three-dimensional points position. This includes to combine these data with an extremely precise and faithful calculation of the distances and angles between them. LiDAR scanning drones are well known and often chosen for their ability of producing high-resolution maps for a broad range of activities like remote sensing, atmospheric sensing, geomatics, geography, geomorphology, archaeology, forestry, contour mapping, laser altimetry, geographic informatics, etc.
3. **Pipeline surveying:** Building an oil and gas pipeline project is a major challenge for any organization to undertake. When it comes to building a successful pipeline, the costs and time requirements are high and the margin for error must be minimized. As a result, if organizations hope to complete a successful pipeline development project with no major

interruptions and minimal unforeseen costs, it is essential that they take advantage of the most advanced technologies available to them to collect as much data up front as possible. One example of a technology that can help organizations experience better results with their pipeline projects is the drones. The benefits of drones for the land surveying portion of a pipeline project are numerous.

The most important **benefits** of using drones for pipeline surveying are:

- **Completing large surveys with a high degree of accuracy:** One of the chief challenges of pipeline projects is the total amount of distance they must cover and nowhere is this challenge felt more than in the land surveying stage of the project. Of course, pipeline projects require a high degree of detail and accuracy, but organizations need a way to ensure that getting this accuracy does not slow down the project too much. Some drones can cover miles of linear coverage per day, meaning that they can fly the large distances required by pipeline projects much faster than traditional surveyors traversing the land. At the same time, drones can fly close to the ground while using high-resolution image capturing technology that offers up detail as fine as one centimeter per pixel. Drones truly offer the best of both worlds when it comes to covering long distances and providing high levels of accuracy. By bypassing difficult terrain altogether, drones allow a land surveyor to gather all of the information they might need without actually having to put people on the ground. Instead, surveyors can operate the drones from a position of complete safety. Additionally, the amount of data that is collected is exponentially more than that collected by traditional crews.
- **Turning around survey results quickly:** Another important goal for land surveyors should be to complete their work as quickly as possible so that the pipeline can begin construction. However, this can't take place if the results of the land survey require weeks or even months of processing time before they can be used. Working with a team of experienced drone operators is not just a great way to speed up the actual data collection process; such an operator can also begin processing and analyzing that data immediately after it is captured. As a result, land surveying results captured by drones are often processed and available for use within 24 -48 hours of when they were originally captured. This extremely fast turnaround enables organizations to start building their pipelines quicker, which in turn enables them to start experiencing returns quicker.
- **Sharing the data with key contractors and stakeholders:** Collecting massive amounts of data is pointless unless decision makers have a way to access the information easily and extract what they need. Key divisions/subcontractors that should receive access to drones data at the earliest possible stages include: surveyors (internal use), engineering, environmental, land / right of way, project managers and any other companies (such as construction) who are authorized to view and bid on the upcoming project. Sharing this data will ensure that everyone is on the same page and that bids are much more accurate since the most recent conditions along the route are available for analysis.

**4. Aerial photography:** Aerial photography is one of the best ways to monitor a construction site, a building, civil engineering projects, a work of art, etc. An aerial overview with drones will be a great help for the project managers in order to, among others:

- study the site before the operations start
- monitor and control the evolution of the activities and proceedings
- present an overview of a site
- check the quality of the work
- follow the deadlines in relation with the work progress
- monitor the compliance of the works with the specifications
- promote their know-how, skills and knowledge for future projects
- bring out and underscore the quality of the work.

High technology, precision, adaptability, endurance and robustness are some of the numerous Drone qualities explaining why these devices are so needed for improving working quality on the demanding sectors of architecture and civil engineering.

**Disaster Relief:** Disaster relief (or emergency management) refers to the process of responding to a terrible situation, providing humanitarian aid to persons and communities who have suffered from some form of disaster. It involves dealing with and avoiding risks and preparing, supporting and rebuilding society when natural or human-made disasters occur. Natural and man-made disasters destroy environments, often making conditions so difficult that relief workers are unable to access areas and provide assistance. Drones have the ability to take on roles where relief workers and manned vehicles fall short.

1. **Hazardous Chemical Spills:** Dangerous or nuclear chemicals can leak into the environment for various reasons. Some causes include factory or power plant malfunctions, spills during transportation or even terrorist attacks. In these and similar instances, measuring the damage and providing relief must be swift and effective. These events, known as CBRNE events (chemical, biological, radiological, nuclear or explosive) make for unsafe conditions, not only for the people exposed to the hazardous materials in nearby areas, but also for relief workers.
2. **The Need for Mapping:** Areas that are prone to large-scale disasters such as earthquakes and flooding benefit greatly from visual imaging and 3D mapping. Manned aircraft are often too expensive to use, satellite mapping does not meet high-resolution needs, and both take too much time during emergency situations. The use of drones to map disaster areas provides greater advantages in costs and in rapid response times when compared to traditional methods. Drones can be deployed quickly, generate high-resolution and 3D mapping, identify hotspot areas that have sustained the most damage and upload the data in real time to coordinate relief efforts.
3. **Assessing Structural Damage:** Relief workers often find it difficult and dangerous to assess structural damage from natural disasters. They often encounter buildings that are on the verge of collapsing, potential explosions due to chemical leaks and places that are hard to access such as tunnels and bridges. After an F-5 tornado in Wichita, Kansas, drones were used to identify infrastructure that was critically damaged. Equipped with “sniffers”

to detect high levels of methane, they were able to locate broken gas lines. Workers then shut down the lines and fixed the breaches before an explosion could occur.

4. **Delivering Emergency Infrastructures and Supplies:** Often after natural disasters or terrorist attacks, infrastructure supply lines are cut and disabled. When roads, bridges, communication cables and gas and water lines are compromised, the safety of residents in the area is also compromised. To mitigate suffering and further damage, rescue teams can utilize drones to support infrastructures, deliver supplies and establish communication. In areas that are nearly impossible to reach, drones can deliver supplies such as water and food to those in need, eliminating the risks of placing human-operated aircraft in harm's way. AWACS, or airborne warning and control systems, allow for temporary establishment of Wi-Fi and cellphone access to environments without power lines or functioning cell towers.
5. **Extinguishing Wildfires:** Drones can eliminate the risks that pilots face and can increase the effectiveness of battling fires. Unmanned aircraft are able to fly in low visibility and can drop fire retardants more accurately and safely. Bigger drones can transport people and supplies, while large numbers of smaller drones can be deployed to provide greater situational awareness. Drones that are outfitted with communication systems have the added benefit of being able to sustain contact between the command center and firefighters on the ground. For these reasons and beyond, drones are being used more often in emergency and disaster response situations. This forward-thinking unmanned technology has vast potential. It is already proving its ability to save lives and prevent damage in dire situations.

**Safety and Security:** Day by day drones are becoming increasingly more commonplace in the Globe, from aerial photography to assisting search and rescue operations, drones can be put to a variety of beneficial uses. However, the use of drones also carries concerns relating to both safety and security. The idea of having drones in the national airspace raises serious safety concerns for nearly the entire spectrum of society, which ranges from government facilities and aviation authorities to regular individuals. The safety concerns that have caused to limit the use of commercial drones, including only granting a few permissions on a case-by-case basis, are primarily related to the capabilities of a drone, the potential for accidents and the possibility of privacy rights becoming an issue. According to the "Washington Post," more than 400 U.S. military drones have fallen out of the sky since 2001. Drones are not just harmless toys – even some high-end consumer models reach speeds of around 80 km/h, which is very fast for a remote-controlled piece of ballistic metal and carbon fibre. While a car may be larger and travel faster, the big difference is that the drone pilot is not personally at physical risk in the case of a collision, and may therefore put the drone into situations that are extremely dangerous in search of that perfect YouTube footage – such as the flight path of an aircraft (<https://www.refund.me/drones-much-safety-risk/>).

Drones are already more widely used in the security industry. Whilst much attention is being given in the media to countering the threat posed by drones should they stray too close to sensitive sites like airports, whether by accident or design, on the other side of the coin drones have proven that they can have a positive impact. The performance of these systems, with the added dimension they

bring in terms of situational awareness via high definition cameras and even thermal imaging, and in-use economics compared to other aerial solutions like helicopters, means that investment in such assets by the emergency services as well as security professionals is really taking off. What about the **Security Requirements** they exist in order to protect the confidentiality and integrity of a drone's acquired and communicated information and to ensure its ability to adhere to its operational requirements. Securing the information of the system refers to protecting it from disclosure, disruption, modification, and destruction.

For a secure drone operation, let's identify the following security requirements:

- **Authorized access:** The drones must provide means to ensure that only authorized operators are granted access to its resources including both the ground control station and the aircraft.
- **Availability:** All the elements of the drones should be guaranteed to perform their required functions under defined spatial and temporal circumstances such that the system sustains its availability without disruption during its operational period. For instance, the drone must adopt measures such as anomaly-based intrusion detection systems to distinguish normal communications from those resulting from denial-of-service attacks.
- **Information confidentiality:** The drones should employ mechanisms to mitigate unauthorized disclosure of the telemetric and control information.
- **Information integrity:** The drones should be able to ensure that the telemetric information and the GPS and control signals are genuine and have not been intentionally or unintentionally altered. Authenticated encryption cryptographic primitives may be used to ensure both the integrity and confidentiality of such information.
- **System integrity:** The drones should be able to guarantee the authenticity of its software and hardware components. Techniques from trusted computing such as memory curtaining, sealed storage, and remote attestation can be used to ensure the authenticity of the system's firmware and sensitive data. The deployment of intrusion detection systems, antivirus software, firewalls, and strict policies regarding the use of external storage media can aid in the detection and prevention of malware.
- **Accountability of actions:** The drones should employ mechanisms that enforce non-repudiation to ensure that operators are held responsible for their actions. Digital signature algorithms may be used to both authenticate the operators and to bind them to an issued action. Moreover, logging procedures that are used to chronologically track the sequence of actions and changes in the system should be implemented.

#### **Some solutions of drone for safety and security:**

1. **Better visibility.** Drones help to minimise unwanted surprises, provide useful insights and help emergency personnel stay out of harm's way.
2. **Multifunctional design.** Drones adapt to the demands of the situation at hand faster and easier than ever before with the click and go payload system.
3. **Easy to deploy.** Drones deploy in a matter of seconds of arriving on scene, to respond faster and minimise the danger to those in need of assistance.
4. **Real-time awareness.** Equipped with infrared and VOC sensors, drones detect individuals and radiation that would otherwise go unseen.

## **Different functions of drones for safety and security**

### **1. Saving lives (drone-assisted rescues for coast guards).**

Faster response: Drones can be deployed in a matter of seconds and minimise the danger to those in need of rescuing.

Optimised visibility: Drones improve a coast guard's overall visibility of an expansive sea to locate vulnerable persons faster.

Thermal detection: Drones are equipped with thermal sensors to maximise the operator's ability to quickly spot individuals lost at sea.

### **2. Accident mapping (a safe, affordable and reliable method of documenting crashes).**

Faster documentation: Drones can help to document car accidents much faster, lowering the risk of further accidents happening to police and passersby.

Accurate evidenc: Drones easily document crash sites by collecting measurable and reliable data to determine the cause of the incident.

Less invasive: Drones easily deploy kilometers away from the scene to reach hard to access areas while reducing the level of disruption to traffic.

### **3. Surveillance (monitor subjects of interest without risk).**

30x zoom: Drones are equipped with 30x zoom cameras to effortlessly spot subjects of interest from a great distance.

Less sound pollution: Deploy drones to be more difficult to detect by suspects than manned helicopters.

Thermal IR vision: Drones track individuals that blend into their surroundings or are active at night by utilising infrared sensors.

Stream & record: Drones can simultaneously record both the visual and thermal video streams.

### **4. Helps to be aware of invisible threats (protect yourself from gas and radiation leaks).**

Gas monitors: Drones can monitor hazardous materials like toxic and combustible gases, VOCs and oxygen levels from a safe distance.

Radiation monitors: Drones can detect gamma radiation levels from afar with parts per billion precision.

### **5. Helps to stay safe and alert (livestreaming capabilities ensure you are well informed).**

Real time analytic: Drones can help to stay protected from unexpected and unseen dangers with augmented livestream video. Whether it's thermal detection, or tracking a subject of interest.

### **6. Drones are built to perform in any environment (drones guarantee your mission's success in every environment).**

Are for all weather performance: The fuselage effectively shields the components inside against heavy rain and dust intrusion to ensure reliable operations.

Are capable of flying in wind speeds of 14 m/s and tested in both the harsh cold of the arctic and blistering heat of the desert to ensure it will perform in any environment.

All these mentioned points are important while using a drone. If we maintain our safety procedures, maintenance and best practices nobody is saying we will never have an incident, but we are definitely minimizing our risk and getting much better odds!



**In addition these main areas of application, drones are also used in engineering, construction and pre-construction work, aviation, maritime, marketing, real estate (both residential and commercial), insurance, utilities, mining, meteorology, education, and more. Today, many government agencies, private companies, and other institutions have their private drones.**

## **2.2. The drone role in national economy and market combination**

Drones are economic instruments used by businesses in the 21<sup>st</sup> century to promote the effectiveness and productivity of their business while reducing the cost of production. It is an innovative way by businesses to position themselves in the today's dynamic markets. The economic impacts of drones are powerful and cannot be ignored both in developed nations and in the third world countries. Drone technology therefore has both direct and indirect impact to business ventures and the nation at large.

The combination of greater flexibility, lower capital and lower operating costs could allow drones to give benefits to the economy in a whole by points of view of infrastructure management, farming, oil and gas exploration etc. The present-day unmanned vehicles have a more responsible approach to certain airspace operations from an environmental, ecological and human risk perspective, have longer operational duration and require less maintenance than earlier models and are more fuel-efficient. All these benefits show that proper utility of the drone technology could lead to great economic growth to individual sectors and the nation as a whole.

The integration of drones into the National Airspace System has been greatly increased in past few years. The growth of this phenomenon day by day increases the importance of drones both in economy and market. Here we have some benefits or positive sides of the integration of drones in national economy, from which should be mentioned, for example, that the integration of drones into the National Airspace System will create many manufacturing and non-manufacturing jobs in near future, the manufacturing jobs are forecasted to be high paying or the increasing role of drone integration is going to open new windows for economy growth.

The drone industry has been captured many markets and is already being used in a variety of applications, most of them we have referred previously:

1. Agriculture monitoring,
2. Disaster management,
3. Environmental monitoring,
4. Wildlife mapping,
5. Oil and gas exploration,
6. Thermal infrared power line surveys,
7. Aerial mapping,
8. Law enforcement,
9. Weather monitoring,
10. Television news coverage,
11. Sporting events,
12. Moviemaking,
13. Freight transport etc.

By combining all above mentioned applications in which the drone can be used, we can separate three types of drone market in total:

1. **Consumer market:** By saying consumer drones we mean an unmanned aerial vehicle designed for the mass market. In other words consumer drone also calls personal drone or hobby drone. Consumer drones are used in a wide variety of endeavors including:

- Search and rescue,
- Surveillance,
- Traffic monitoring,
- Weather monitoring,
- Geographical mapping,
- Agriculture and firefighting.

Besides the simple entertainment factor of remote-controlled vehicles, consumer drones have in the past most often been used for video photography, as these devices were able to achieve vantage points that were difficult or impossible to access otherwise. Potential applications for commercial drones include home security, child monitoring and the creation of virtual tours, among a great number of other possibilities. Programmable drones are expected to create a further market for specialized mobile apps.

2. **Commercial market:** Commercial drone use is any use of a drone which is connected to a business. This means that commercial drone use applies to any use of a drone from which we hope to profit. Commercial drone use can cover a wide variety of activities. In general, the term refers to any activity with a drone that provides:

- Profit through the sale of photos or videos,
- Provision of any kind of service, or
- Monitoring the progress of a business project.

Here bellow is mentioned a list of some specific activities that constitute the commercial use of drones:

- Wedding photography or videography,
- Land surveying,
- Utilities inspection,
- \*Deliveries,
- Pest control etc.

\* Here especially we would like to speak about the **deliveries** through drones, as this point has a big potential to bring enormous economic impact in near future. There are already some companies which use drone as a way to deliver food, medical help, different products etc. Drone delivery offers tremendous benefits in the form of cheaper, faster shipping. This could accelerate the growth of online retail sales as free and fast shipping are the most enticing factors drawing consumers to shop online more often. This branch is highly developing one and promises to have big impact to the economy of the world in a whole.

3. **Governmental market:** In this market are included drones which are used by governments for military or other purposes.

As we understood the economic benefits of drones to the country are enormous. Day by day the diversity of the drone types grows and opens new possibilities to the countries for growing and enlarging their national economies. The role of drones is becoming more and more important for any kind of applications in which the drone can be used as its first of all decreases the level of danger for human, which is the most important resource for every country!

## 2.3. The definition of Drone market strategies and the marketing strategy process

### What is Marketing?

Before the definition of Market Strategies let's understand what does the Marketing mean itself. By saying Marketing we understand a market activity directed to the satisfying of our customers' needs and wants, and to the gaining of more new customers. There are many definitions of Marketing; some of them are listed below:

- “**Marketing** is the human activity directed at satisfying human needs and wants through an exchange process.”
- “**Marketing** is a social and managerial process by which individuals and groups obtain what they want and need through creating, offering and exchanging products of value with others.”

*Philip Kotler*

- “**Marketing** is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, services to create exchanges that satisfy individual and organizational goals.”

*American Marketing Association*

- “**Marketing** is the management process for identifying, anticipating and satisfying customer requirements profitably.”

*The Chartered Institute of Marketing (CIM)*

**Marketing** is building your brand, convincing people that your brand (meaning your product/service/company) is the best and protecting the relationships you build with your customers. **Marketing** is a way to connect what products and services you have to offer with customers who want and need such products and services. It is multi-faceted, starting with researching your target market and how best to deliver the message to coming up with a plan to execute your promotion via various marketing media. The goal is to develop a strategy to create, price and distribute your products and services for an exchange that will satisfy both your and your customers' objectives. It is an ever evolving process – always evaluating that your message still meets the needs and wants of your market. **Marketing** is traditionally the means by which an organization communicates to, connects with, and engages its target audience to convey the value of and ultimately sell its products and services. However, since the emergence of digital media, in particular social media and technology innovations, it has increasingly become more about companies building deeper, more meaningful and lasting relationships with the people that

they want to buy their products and services. The ever-increasingly fragmented world of media complicates marketers' ability connect and, at the same, time presents incredible opportunity to forge new territory. The key word in this marketing definition is "process"; marketing involves researching, promoting, selling, and distributing your products or services.

### How to identify Marketing?

Marketing it is best identified using what are called the **4 P's** or a **mix of marketing: Product, Price, Promotion, and Place.**

- Starting with products, companies have many procedures they must undertake to ensure their **products** are ready for selling. The first stage is called the "ideation stage" where the idea for the product is conceived. Then, marketing departments usually test new product concepts with focus groups and surveys to ascertain interest levels among potential buyers. If the interest level is high, marketers may then sell products on a limited basis to track sales. If product sales are high, products are then rolled out on a national level. Before products go to the market, companies must decide what styles, sizes, flavors, and scents they should sell and the packaging designs they should use. Consumers have much input in these decisions.
- **Price** is also tested through focus groups and surveys. Companies must know the optimal price to sell their products to achieve maximum return. One way to determine price is to set it at a level comparable to competitors; that is if the company can recover all associated product expenses and still make a profit. If the company is introducing a new product that has never existed, they must determine how much the consumer is willing to pay for it. Customers will only pay so much for products. Price a product higher, and sales can drop off exponentially.
- **Promotion** pertains to brochures, ads, and information which companies use to generate interest in their products. For more complex concepts, like spas or computers, companies may promote their wares at trade shows. Promotions usually have two purposes: generate leads for sales reps or initiate actual purchases.
- **Place** in marketing nomenclature is the distribution. It is how and where products are sold. Consumer product companies, for example, sell to wholesalers who, in turn, sell to retailers. In the industrial market, the buying process is longer and involves more decision makers. Some companies also sell products or services on a local level, while others sell nationally and even internationally. All distribution decisions are part of the overall marketing process.

### What do we market?

- Goods,

- Services,
- Events,
- Experiences,
- Personalities,
- Places,
- Organizations,
- Properties,
- Information,
- Ideas and Concepts etc.

### **What is a Marketing Plan and which are the essential components of it?**

For growing a business everyone needs a marketing plan, which is a comprehensive document that outlines a business advertising and marketing efforts for the coming year. It describes business activities involved in accomplishing specific marketing objectives within a set time frame. A marketing plan has a formal structure, but can be used as a formal or informal document which makes it very flexible. It contains some historical data, future predictions, and methods or strategies to achieve the marketing objectives. Marketing plans start with the identification of customer needs through a market research and how the business can satisfy these needs while generating an acceptable level of return. This includes processes such as market situation analysis, action programs, budgets, sales forecasts, strategies and projected financial statements. A marketing plan can also be described as a technique that helps a business to decide on the best use of its resources to achieve corporate objectives. It can also contain a full analysis of the strengths and weaknesses of a company, its organization and its products.

Here are the essential components of a marketing plan that keeps the sales channel full:

1. **Market research:** Research is the backbone of the marketing plan. This is the process of gathering, analyzing and interpreting information about a market, about a product or service to be offered for sale in that market, and about the past, present and potential customers for the product or service; research into the characteristics, spending habits, location and needs of your business's target market, the industry as a whole, and the particular competitors you face .
2. **Target market:** This is a specific group of consumers at which a company aims its products and services. A well-designed target market description identifies your most likely buyers. In addition, you should discuss at least two or three levels of segmentation. This process of segmenting your customers can be done in many different ways, depending on how you want to slice up the pie.

3. **Positioning:** The process of positioning gives us the answer to the following question: “What is the perception of your brand in the marketplace?” The market positioning is an effort to influence consumer perception of a brand or product relative to the perception of competing brands or products. Its objective is to occupy a clear, unique, and advantageous position in the consumer's mind.
4. **Competitive analysis:** You need to know who your competitors are and how your products and services are different. What is the price point at which your competitors are selling, and what segment of the market are they aiming to reach? Knowing the ins and outs of your competitors will help you better position your business and stand out from the competition.
5. **Market strategy:** Your marketing strategy is your path to sales goals. Ask yourself “How will I find and attract my most likely buyers?” This is the core of what the strategy should explain. It should look at the entire marketplace and then break down specific tactics including such as events, direct mail, email, social media, content strategy, street teams, couponing, webinars, seminars, partnerships, and other activities that will help you gain access to customers.
6. **Budget:** Develop a month-by-month schedule of what you plan to spend on marketing. Also include a “red light” decision point. For each activity, establish a metric that tells you to stop if it’s not generating sufficient return on investment (ROI).
7. **Metrics:** Track your marketing success with Google Analytics for website conversions and a simple Excel sheet to compare your budget against the actual ROI. Test programs over the course of a 30- to 60-day period, and evaluate the results. Repeat any programs that are delivering sales or sign-ups to your email list, and get rid of anything that’s not.



### 3.The marketing strategy process

#### What is a Marketing Strategy?

A marketing strategy is a process or model to allow a company or organization to focus limited resources on the best opportunities to increase sales and thereby achieve a sustainable competitive advantage. The marketing strategy of a company contains the company's value proposition, key marketing messages, information on the target customer and other high level elements. A marketing strategy grows out of a company's value proposition. The value proposition summarizes the competitive advantage a company has in its market. The value proposition usually provides the key message for all marketing. Once the value proposition is briefly stated, the hard work is done! Mostly the marketing strategy is:

- systematic futuristic thinking by management,
- better co-ordination of company efforts
- development of better performance standards for control,
- sharpening of objectives and policies,
- better prepare for sudden new developments.

#### Which are the main steps of Marketing Strategy Process?

**Mission:** The first step in strategic marketing is to articulate the reason why the enterprise exists and how it can benefit target consumers over the long term. In particular, this mission statement is intended to anticipate the future and describe an ongoing role for the organization's product, service or expertise. For example, the mission of a **drone** might be to provide continuing innovation in global aerial system.

**Situation Analysis:** Organizations conduct a situation analysis, also known as a SWOT, to evaluate and prioritize their *strengths, weaknesses, opportunities and threats*. This second step in the strategic marketing process helps managers understand the resources they can build on and the challenges they face. Strengths and weaknesses are internal factors, under the firm's control. Opportunities and threats arise from the external environment, like a strong economy or new payroll tax.

**Objectives:** The third step in strategic marketing is to set marketing objectives. These are clear, measurable goals that give decisionmakers a basis for making choices and assessing progress. Objectives are typically expressed in terms of one or more quantitative targets like revenue, profit, sales or market share. Importantly, each objective must be achievable within a fixed period of time.

**Strategy and Evaluation:** The fourth step in strategic marketing is strategy development. This involves selecting a target market, a distinct group of consumers who are highly likely to buy the company's product. Planners must also choose implementation tactics, specifically, effective ways

to use the marketing mix tools of product, promotion, price and distribution to reach and influence prospective buyers. The fifth step, evaluation, means specifying how, when and by whom these tactics are to be monitored and assessed over time.

### **Why Marketing Strategy is necessary?**

A marketing strategy is always needed when we speak about some business activities. The marketing strategy of the company does not have to be complicated; it should be as simple as it possible, and as targeted as it possible at the same time. A simple marketing strategy includes both inbound and outbound marketing. **Inbound marketing** means helping customers find us, and **outbound marketing** strategy is about telling people about our company.

While we are trying to build our **drone marketing strategy** we have to pass through below mentioned steps:

- 1. Identify your target audience:** The key to successful marketing is to know your audience. This will dictate how we should communicate, where we should target our communications and what information we should make available. Identifying our target market means that we can tailor our website content, social media posts and even our brochures or presentations using information which will be relevant to our intended audience. Creating content relevant to our target customers will help grow our audience on social media, improve our SEO results (Search Engine Optimization) and convince potential customers that we can provide a valuable service specific to their needs. Knowing your audience is the best way to prove that you are an expert in your field to the people who matter.
- 2. Make a Good First Impression:** Your branding dictates how people mentally connect with your drone business. Whether it is your business card or website, you color scheme and logo count when trying to make a good first impression.
- 3. What problems we are solving for our customers?** It is very important to find out what problems our customers have and to find some ways about how we are capable to solve them. Our problem solving ways should be clearly visible for our customers, for example, when we do something entirely new for them, or when we are doing something faster and cheaper than it has been done until now. We need to make our values clear!
- 4. Meeting with our customers.** Sometimes it is very important to meet with our current and potential customers and ask them a lot of questions in order to understand what they expect from us and actually understand what we are able to provide them. Networking events, online forums, meet-ups, conferences can be some good ways to learn about new things about our customers. And in the process of having these conversations there is a chance that we can build rapport and gain new customers.
- 5. Talk to your customers in their own language:** Every industry has its own language. This can work against us - if we use our own, or it can work for us - if we talk like our customers. If our business's website is our main form of marketing, we need to use terms that are

meaningful to our customers on our homepage. For example, if we have identified that our customers are mostly real estate agents, we might choose a website header that says “Drone Real Estate Photography in Armenia” rather than “Armenian Drones.” The same concept applies if we meet our potential customers at networking events, trade shows or the local diner.

The drone market today can be described as a melting pot of different technologies, where combinations of hardware and software components and service features are provided to the end user. In order to create sustainable success in this extremely fast moving market it is essential to maintain strategic partnerships. Our brand and reputation are the foundation of our business. But we have already understood that building a great brand and a good reputation is impossible if we do not know who our customers are, what they want, what our competition does to meet and exceed their expectations, and how to make prospects understand that our drone products and services are better than those offered by our competitors. Luckily, the development of a marketing strategy for our drone company will require us to focus on all these aspects and many other details critical to business success.

**If we have right drone marketing strategy, we can grow our influence - and, hopefully, sales!**



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*Educational for Drone (eDrone)*

*574090-EPP-1-2016-1-IT-EPPKA2-CBHE-JP*

# Educational for Drone (eDrone)

## Fundamental of aerodynamics, aircraft performance

Hrachya Karapetyan



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Name of presenter

meeting/event name  
date

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# Atmospheric Fundamentals

## Perfect gas law

$$p = \rho g R T$$

where:

p-pressure in N/m<sup>2</sup>

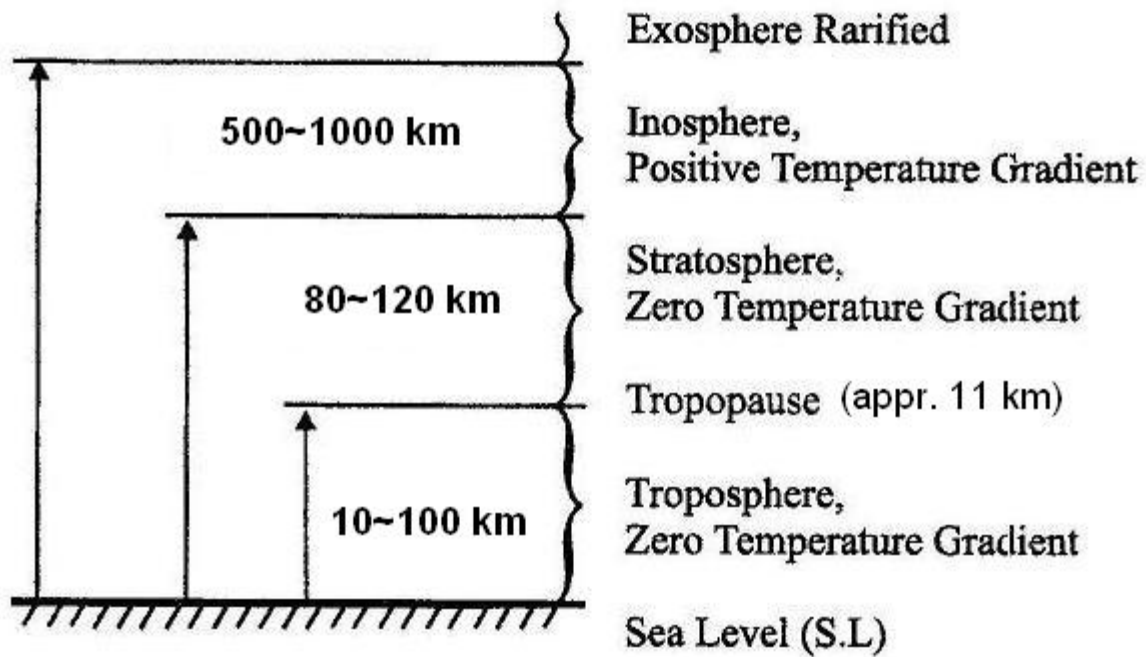
$\rho$ -density in Kg/m<sup>3</sup>

R-a gas constant, R=29,26m/ ° K

T-absolute temperature, ° K=° C +273,15°



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**Fig. 1 Regions of the Atmosphere**



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# The int-l standard atmosphere

The earth's atmosphere consists of 4 regions, as shown in Fig. 1. To provide a basis for comparing the performance of flying objects and to allow for calibrating of altimeters, it is desirable to have standard properties of the atmosphere representing so-called “average conditions”. Such standard properties of the atmosphere have been established by the Int-l Civil Aviation Organization (ICAO) and generally used by airplane manufacturers.



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# Standard sea level properties



According to the standard atmosphere, the standard sea-level properties of atmosphere are as follows:

$$g_0 = 9.81 \text{ m/sec}^2$$

$$P_0 = 1.013 \times 10^5 \text{ N/m}^2$$

$$T_0 = 288.2^\circ \text{K}$$

$$\rho_0 = 1.225 \text{ Kg/m}^3$$



# Temperature, pressure and density variation with altitude

$$\frac{T}{T_0} = \theta = 1 + \frac{a}{T_0} h = 1 - 6.785 \times 10^{-6} h$$

$$\frac{p}{p_0} = \delta = \theta^{5.2561}$$

$$\frac{\rho}{\rho_0} = \sigma = \theta^{4.2561}$$



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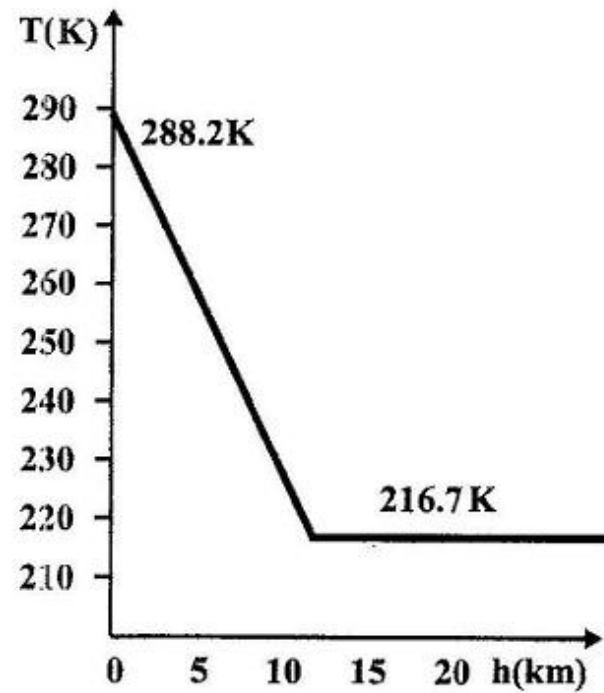


Fig. 2 Temperature Variation with Altitude



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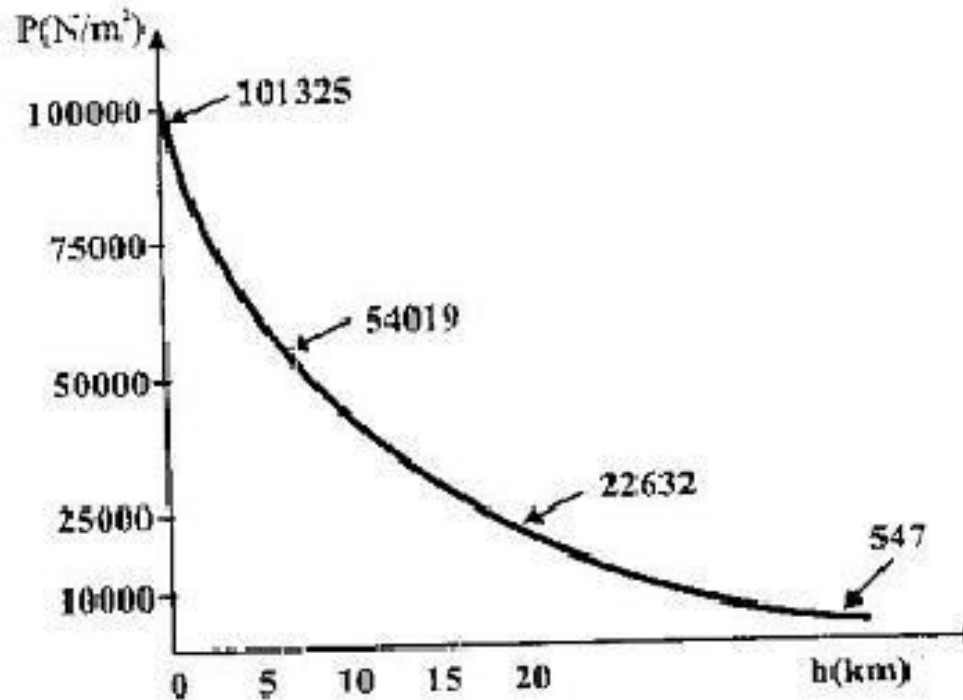


Fig. 3 Pressure Variation with Altitude



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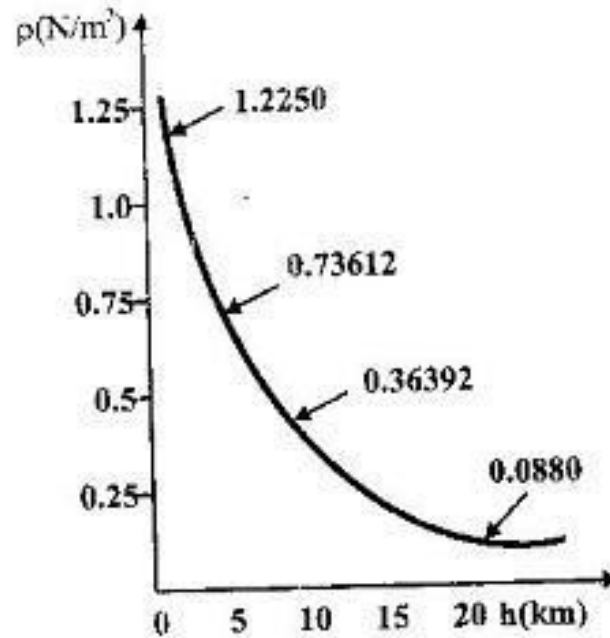


Fig. 4 Density Variation with Altitude



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Compressible continuity equation

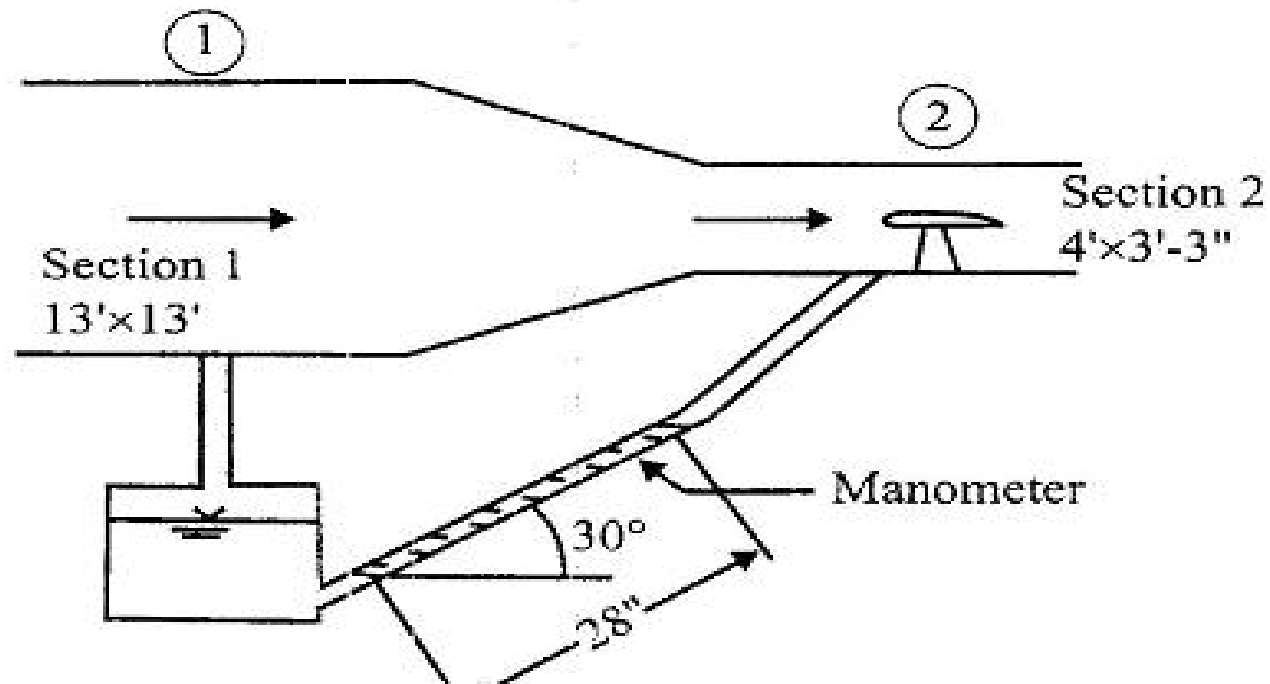
$$\rho AV = \text{constant}$$

Compressible Bernoulli equation

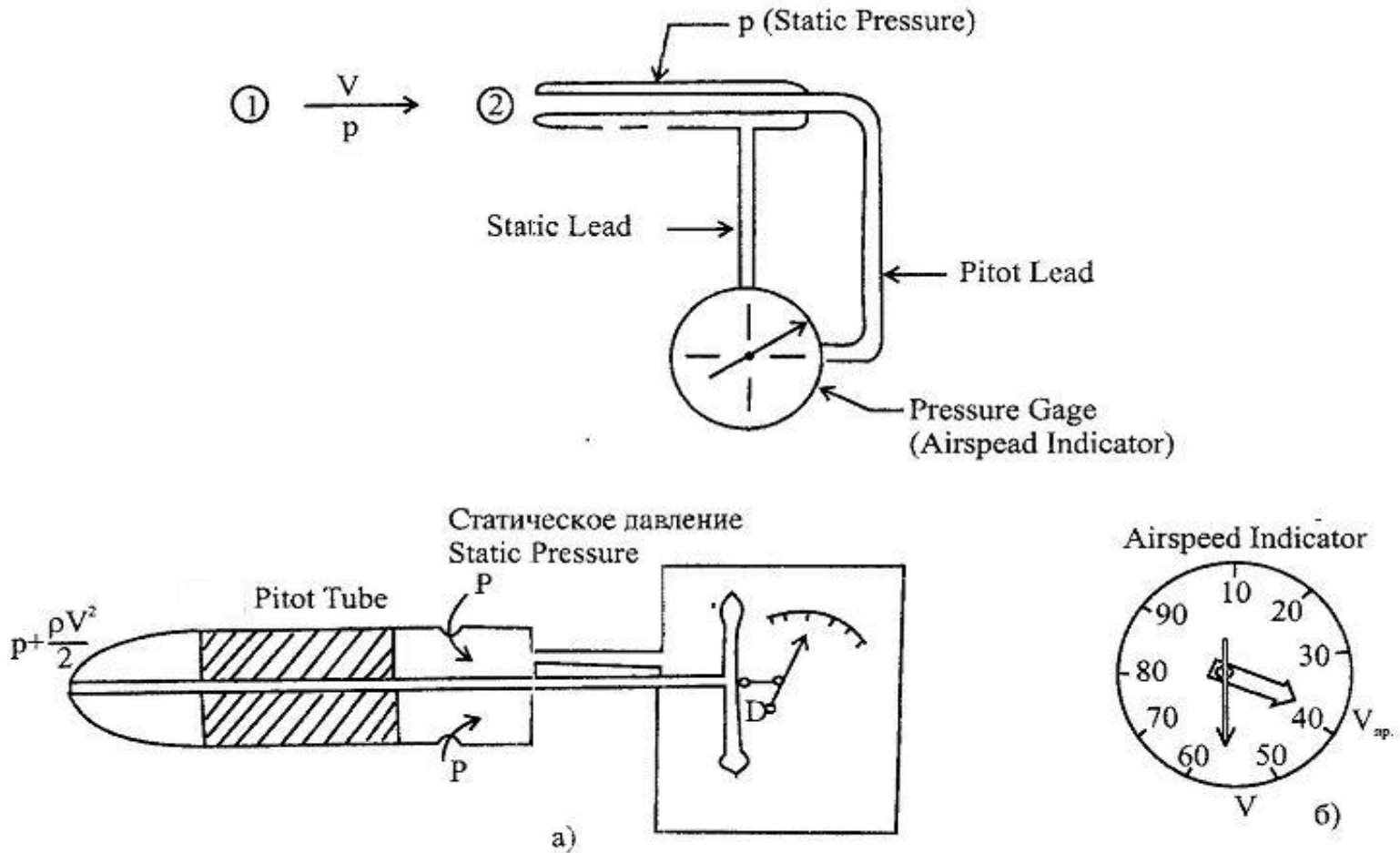
$$\frac{k}{k-1} \frac{p}{\rho} + \frac{1}{2} V^2 = \text{constant}$$

where:

k-ratio of specific heats, for air  $k=1,4$



**Fig. 5 A Wind Tunnel Set-up**



**Fig. 6 Pitot - Static Tube**



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The true airspeed ( $V_e$ ) at any altitude can be expressed in terms of  $V$  as follows:

$$V = \sqrt{\frac{2(p_t - p)}{\rho}} = V_e \sqrt{\frac{\rho_0}{\rho}} = \frac{V_e}{\sqrt{\sigma}}$$

where

$$V_e = \sqrt{\frac{2(p_t - p)}{\rho_0}}$$





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# Speed of sound and Mach number

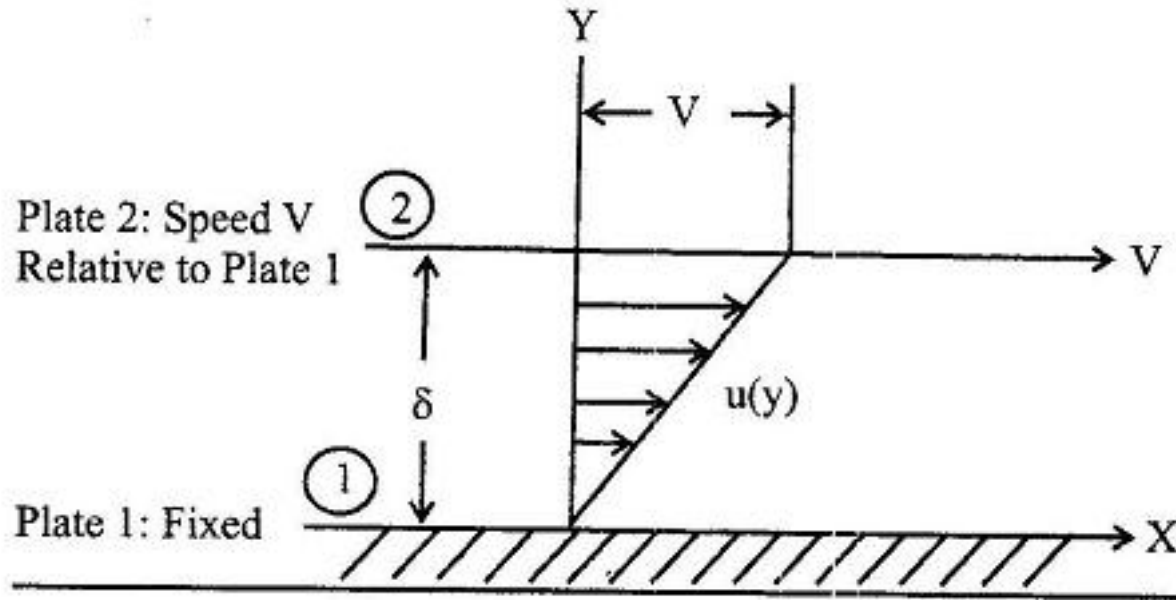


$$V_{\alpha} = \sqrt{\frac{kp}{\rho}} = \sqrt{kRT}$$

$$M = \frac{V}{V_{\alpha}}$$

The flight speed is called:

1. Subsonic, if  $M < 1$
2. Sonic, if  $M = 1$
3. Supersonic, if  $M > 1$
4. Transsonic, if  $0.8 < M < 1.2$



**Fig. 7 Velocity Distribution Between Two Plates**

# Viscous effects

In fig. 7 two plates, at distance  $\underline{\Omega}$  apart, are shown such that one is moving with velocity  $V$  to the right, while the other is held fixed. Due to viscosity those air particles in contact with the surfaces will acquire the velocities of the surfaces. Therefore, the velocity distribution will be as shown in fig. 7

The type of air flow in the boundary layer depends on the smoothness of the flow approaching the body, the shape of the body, the surface roughness, the pressure gradient and the Reynolds number ( $Re$ ) of the flow.

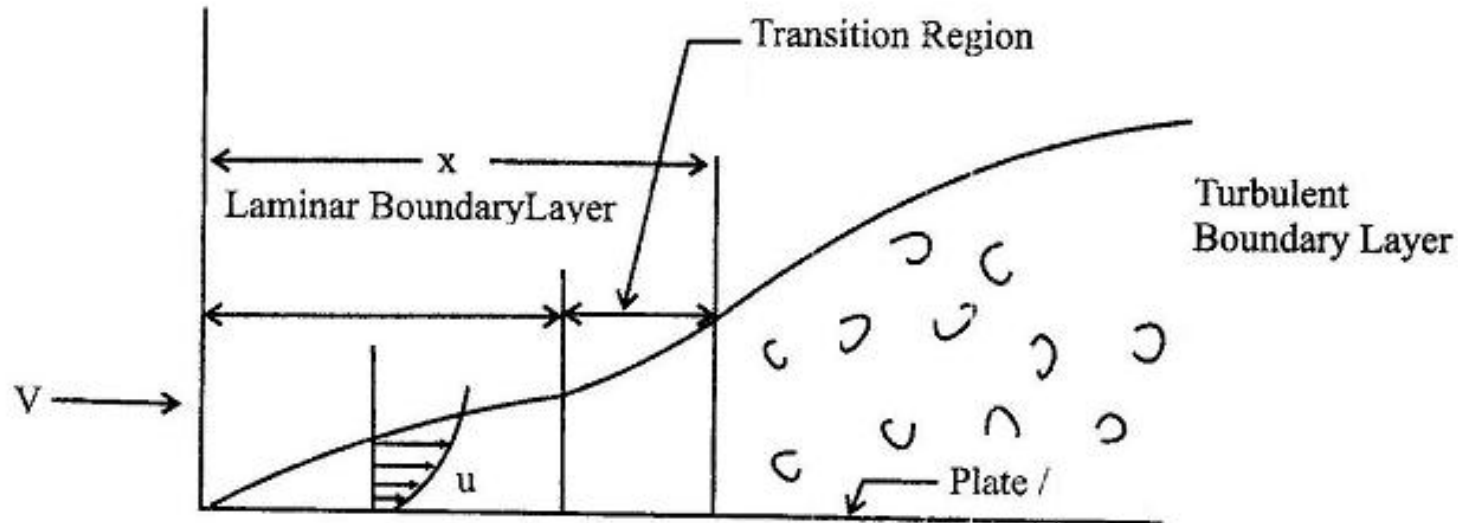
# Boundary layer

The Reynolds number is defined as:

$$Re = \frac{VL}{\nu}$$

Where  $\nu$  is kinematic viscosity

L is a characteristic length of the body in the flow direction and is equal to the chord length for an airfoil. At low Reynolds numbers the flow in the boundary layer is laminar (laminar boundary layer). Above certain transition Reynolds numbers the flow becomes turbulent (turbulent boundary layer)



**Fig. 8 Illustration of a Laminar and a Turbulent Boundary Layer**

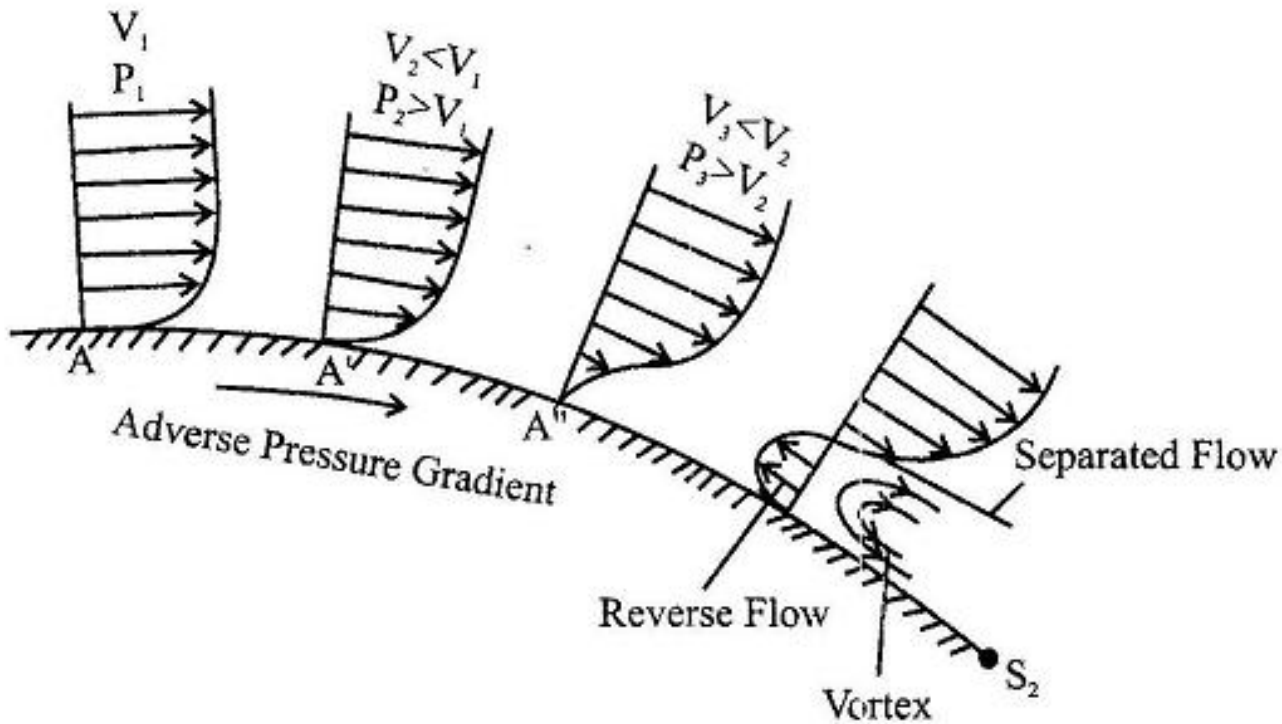
# Boundary layer

The thickness of the boundary layer is being calculated by the equation:

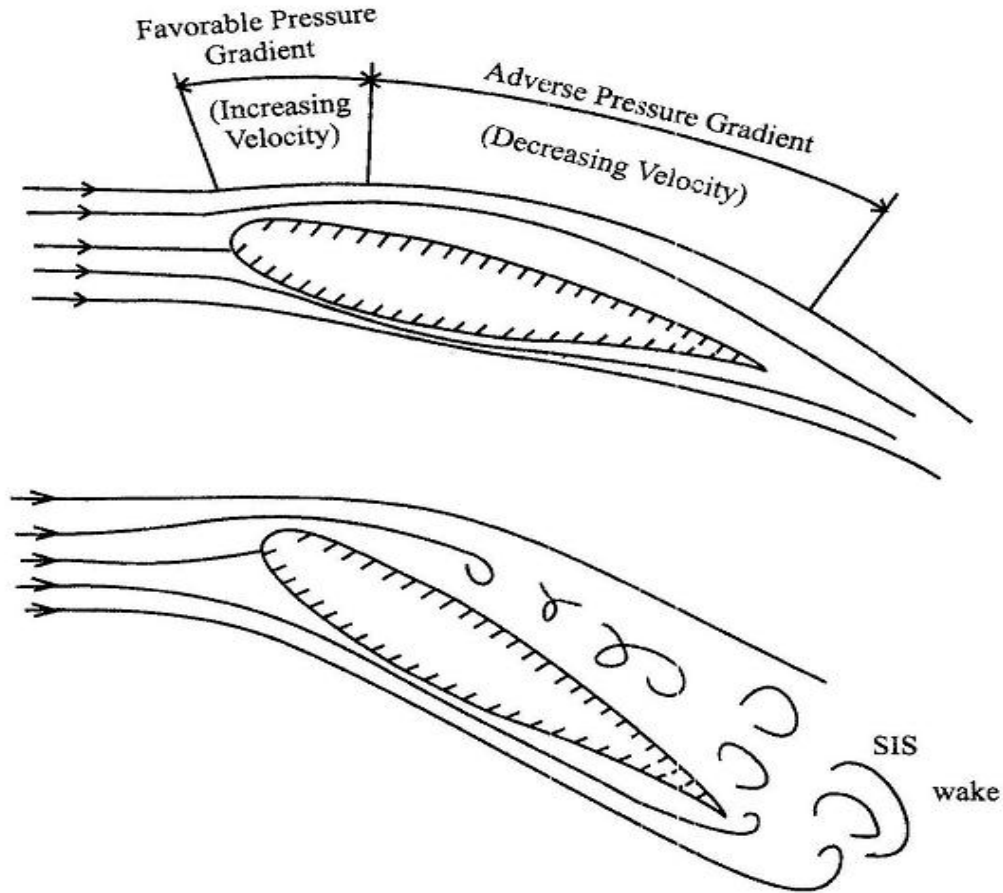
$$\delta = \frac{5,2x}{\sqrt{\mathbf{Re}}}$$

As shown in fig.8 the air velocity on the lower plate surface is 0 and increases rapidly away from the surface. When the flow is transitioned to turbulent flow, the boundary layer thickness will be increased and can be determined from:

$$\delta = \frac{0,37x}{(\mathbf{Re})^{1/5}}$$



**Fig. 9 Concept of Boundary-layer separation**



**Fig. 10 Example of Wake Induced by Boundary Layer Separation**



# Flow separation

As shown in fig.10, on the forward section of the airfoil, the air velocity increases downstream, so that the static pressure decreases in the same direction. Since the acceleration flow tends to assist the boundary layer to remain attached to the surface, the negative rate of change of pressure in the downstream direction is called a favourable pressure gradient. On the other hand over the rear section of the airfoil the opposite is true.

# Flow separation

When the air particles in the boundary layer do not have sufficient energy to reach the trailing edge, they will separate from the surface, creating a so called wake. This is illustrated in fig.9.



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# Airfoil geometry

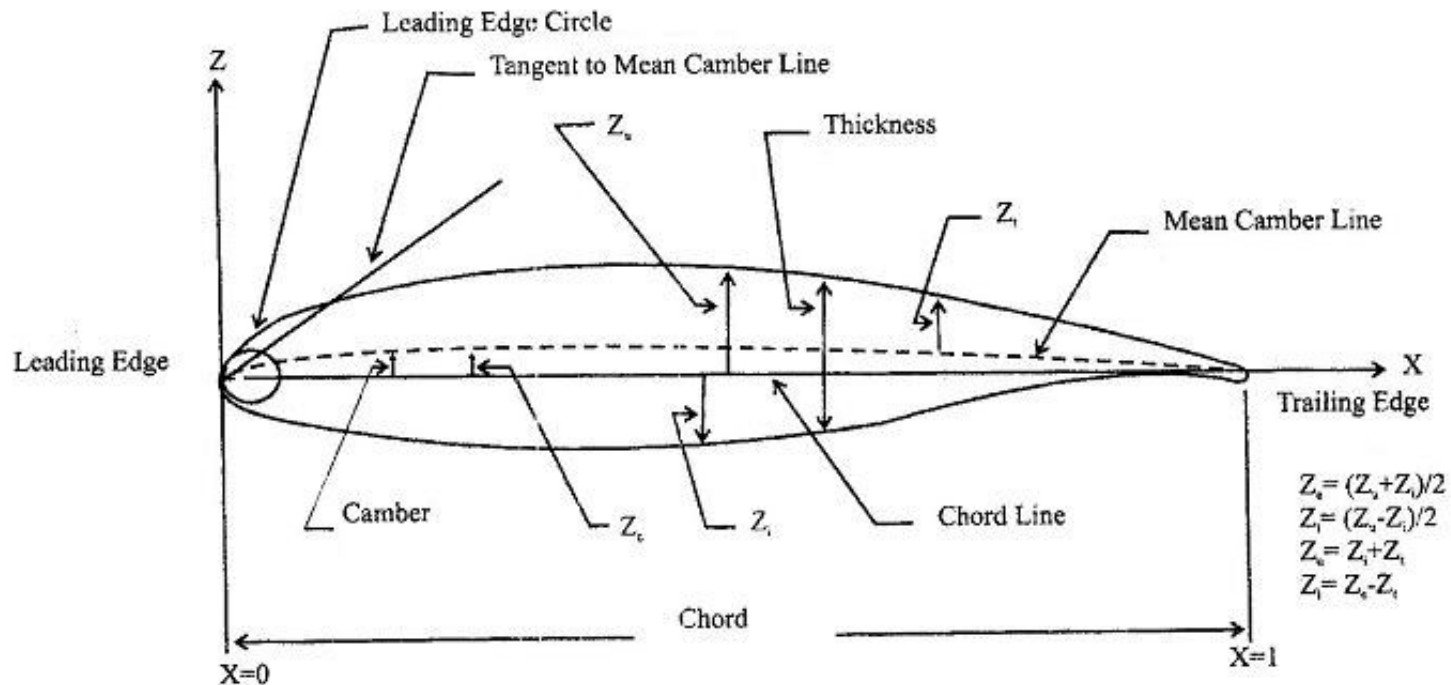


Fig. 11 Definition of Airfoil Geometry

# Section forces and moments

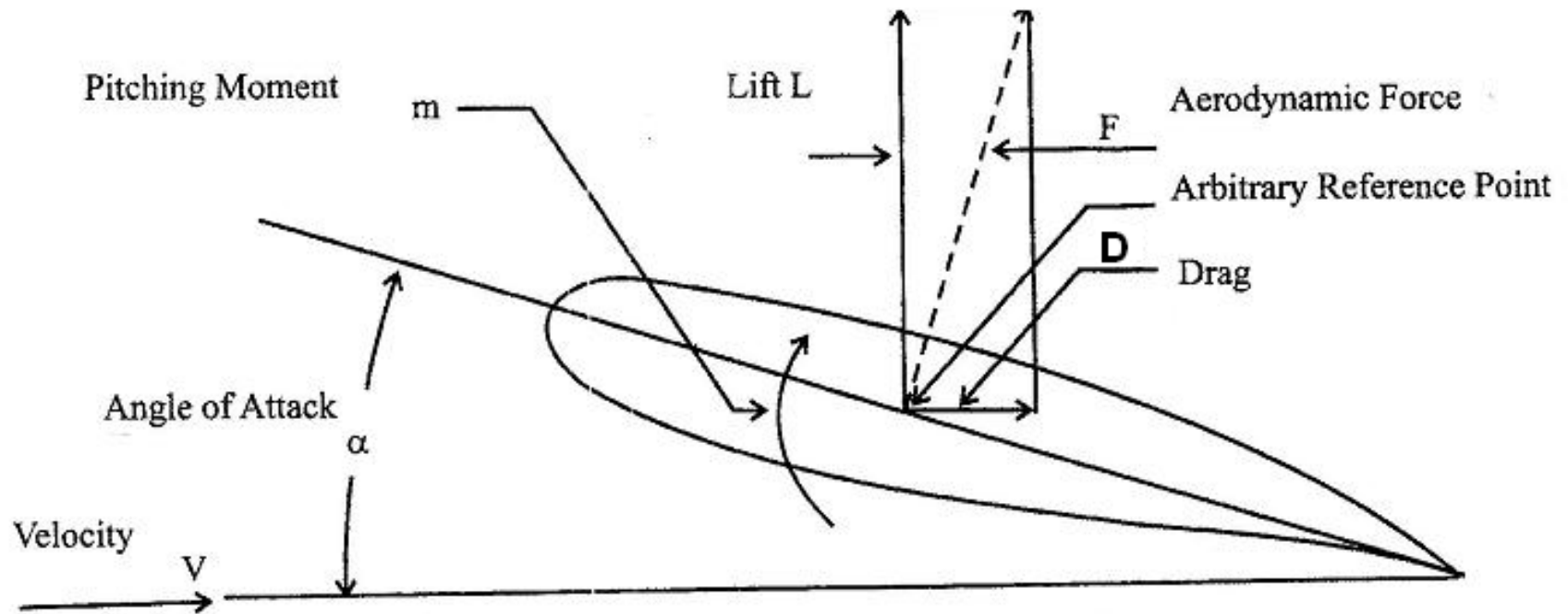


Fig. 12 Definition of Section Forces and Moments

# Lift and drag forces

Lift force (L) and drag force (D) are being computed as:

$$L = C_l \frac{\rho V^2}{2} A$$

$$D = C_d \frac{\rho V^2}{2} A$$

where  $C_l$  and  $C_d$  are lift and drag coefficients and are functions of  $\alpha$  (angle of attack),  $Re$  and  $M$ .

# Pitching moment

The pitching moment is computed as:

$$m = C_m \frac{\rho V^2}{2} A^2$$

where  $C_m$  is a moment coefficient and is regarded as positive if the moment is nose-up.

# Airfoil lift curve slopes

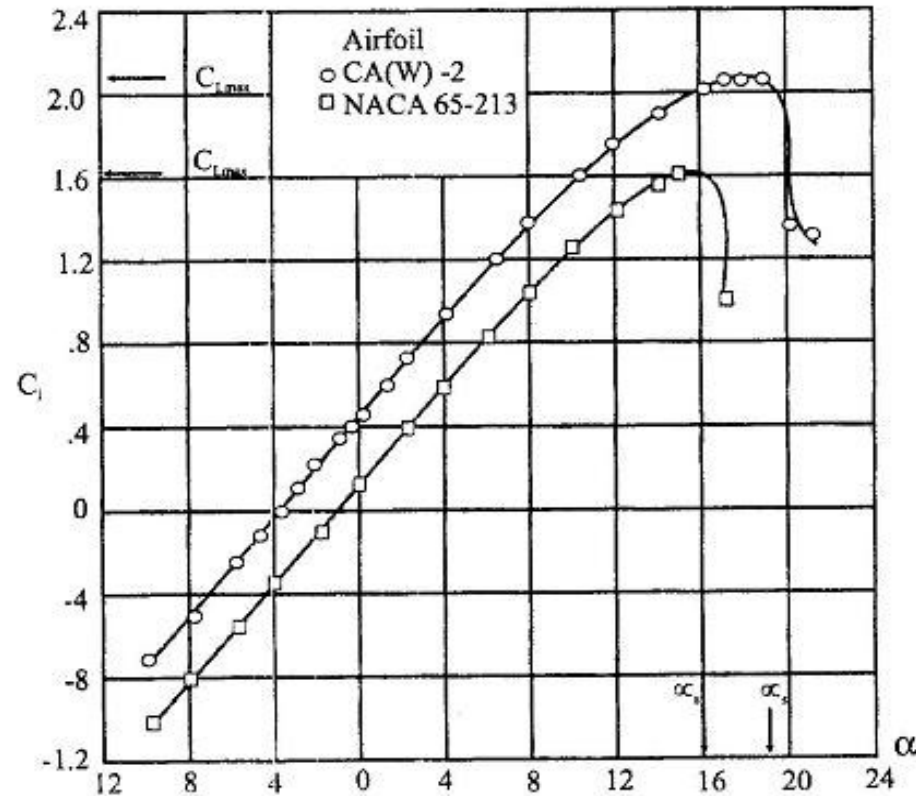


Fig. 13 Example of Airfoil Lift Curve Slopes



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# Airfoil drag polars

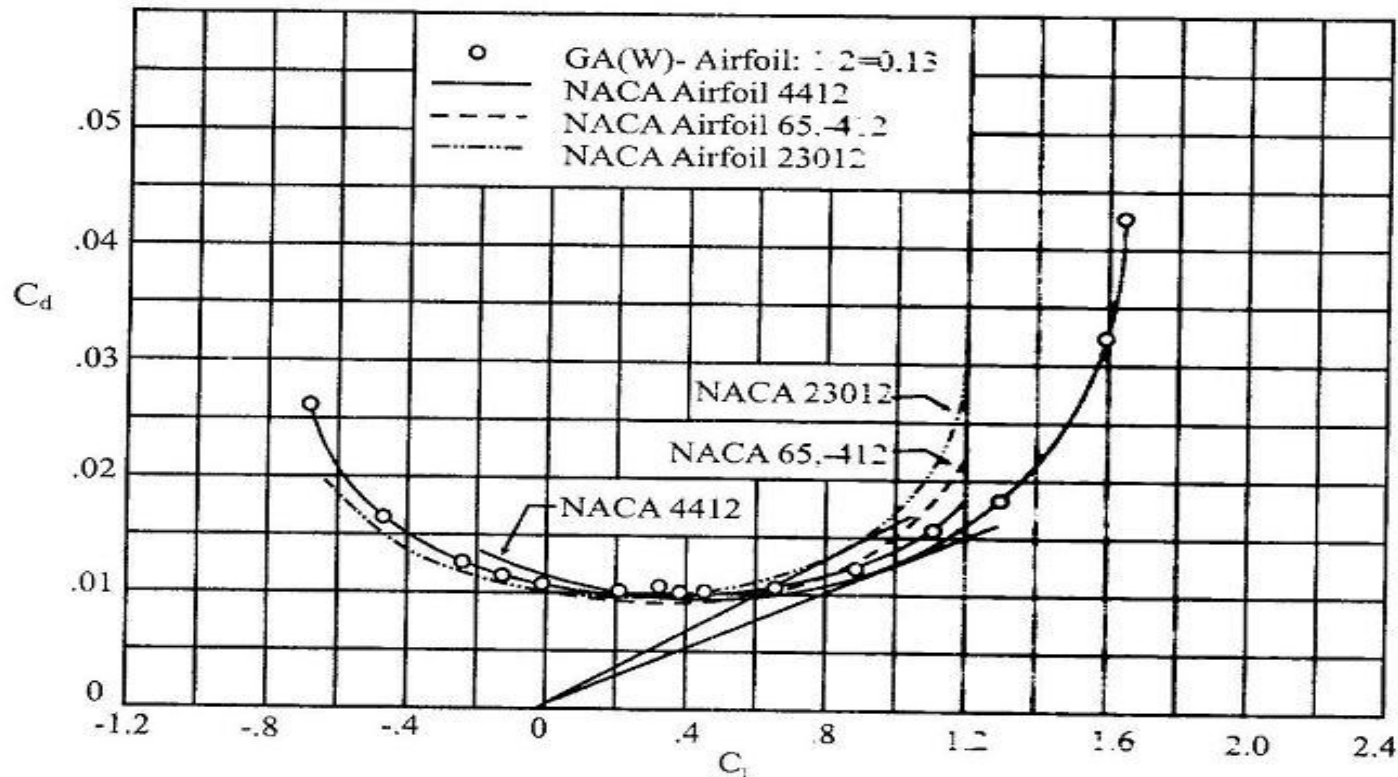


Fig. 14 Examples of Airfoil Drag Polars  $M=0.15$ ,  $Re=6.0 \times 10^6$





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# Pitching moment

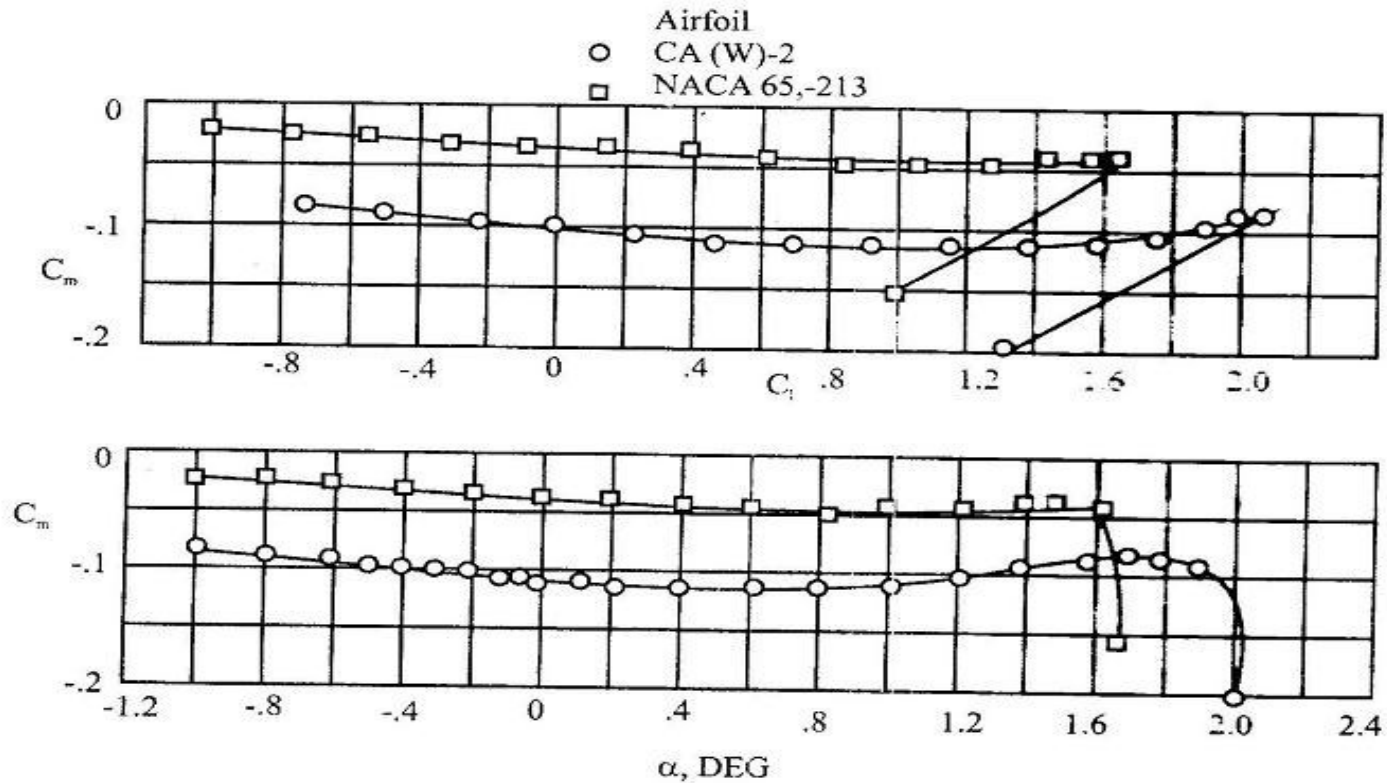


Fig. 15 Example of Pitching Moment



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# Airfoil pressure distribution

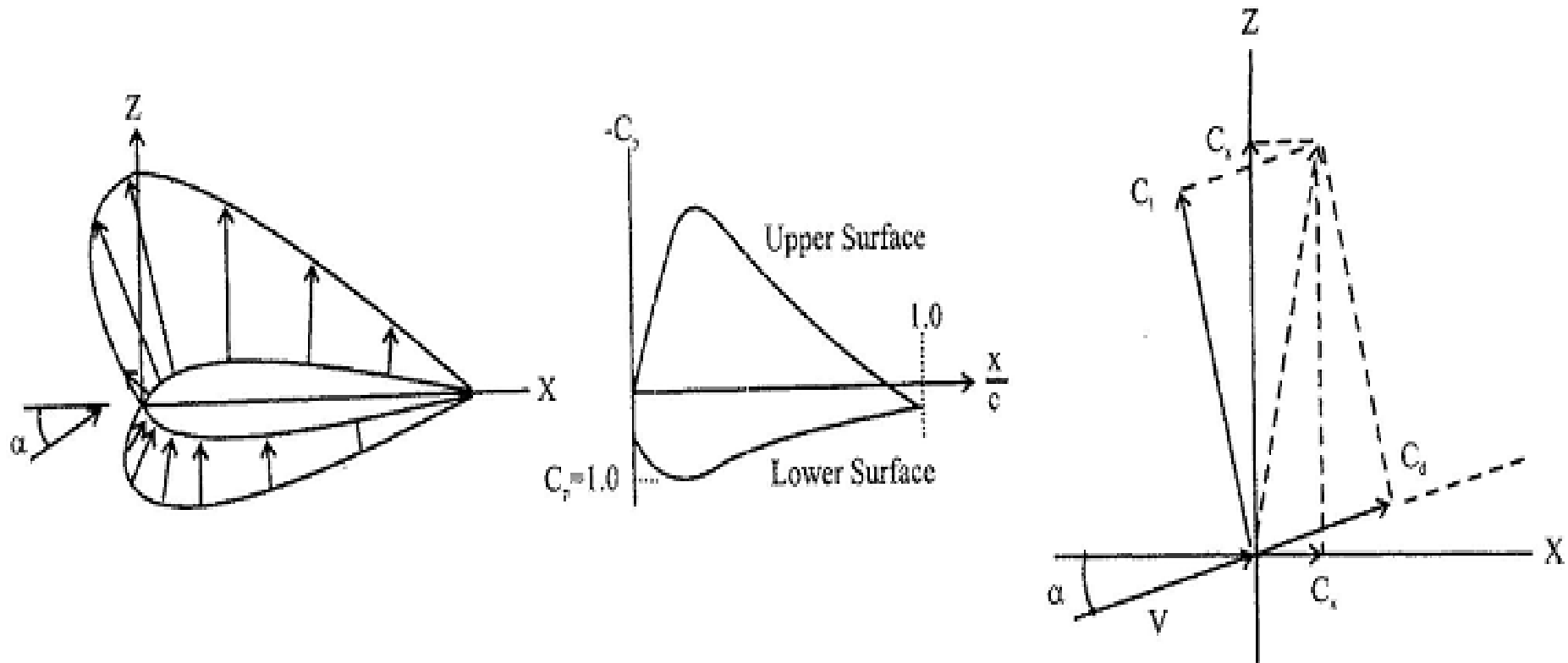


Fig. 16 Example of a low Speed Pressure Distribution



# Airfoil pressure distribution

Pressure distribution over an airfoil is important in load distribution calculations and control surface hinge-moment calculations. The pressure distribution is normally expressed in terms of the so-called pressure coefficient  $C_p$  which at low speeds is defined as

$$C_p = 1 - \left( \frac{V}{V_\infty} \right)^2$$

This equation shows that  $C_p=1$  at a stagnation point  $V=0$

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Faculty of Marketing and Business Organization

# **DRONES MARKET: CURRENT CIVIL AND COMMERCIAL APPLICATIONS**

## **LECTURE NOTES**

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2020

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# **International Drone Market and Involvement of Republic of Armenia**

Currently, high tech is considered to be one of the fastest developing directions not only in the world but in Armenia as well. It's more important for countries that don't have sufficient natural resources. So they need to develop the economy with the help of high tech. As you guess, Armenia is among them. So it's not accidental the RA government has adopted the technological development direction. By the way, there is the Ministry of High-Tech Industry.

In this sense, the drone industry is worth of our attention. They are also known as unmanned aerial vehicles. As the name suggests, the drones have a double use and meaning. If previously, they were used only for military purposes, now, they have mainly got civil and commercial use. Moreover, we have to point out they have a multi-meaning use and not only a double-meaning use. Particularly, we can separate a few directions of entertainment, hobby, professional, commercial, and military. The former two form the civil use sphere.

As Teal Group<sup>1</sup> points out the drones are going to become the most dynamic developing sector in the aero industry. Many venture companies are investing a lot in this sphere. Plus, in many

---

<sup>1</sup> <http://bit.ly/2w2rzIT>



countries, we can see myriads of legislative improvements that should regulate the niche and stimulate the civil use of drones. Unfortunately, there are no changes in the RA yet<sup>2</sup>. However, due to the increase of drone number, we can see some trends. Therefore, there is every reason to predict, in the nearest future, there will be considerable legislative changes in the aero field.

As the same source mentions, in the next decade, the production of civil drones will reach \$88.3 billion. As a comparison, in 2019, this indicator was \$4.9 billion (till the end of August, 2019). And in 2028, it's estimated to reach \$14.3 billion

Another report<sup>3</sup> shows that in 2018, the global drone production reached \$6.56 billion, and in 2027, it's predicted to reach \$21.62 billion.

Of course, these are approximate numbers, based on various predictions. They take into account various groups of factors. The specialists point out that it's impossible to predict all those factors and use them in analysis. This is mainly related to the fact the drone industry is interconnected with the development of several

---

<sup>2</sup> State of Art of Drones laws, Educational for Drone (eDrone), 2017, 145 pp.

<sup>3</sup> MarketWatch, Civil Drone Market Size will grow at 14.3% CAGR to exceed 21.62 billion USD by 2027, Sep. 6, 2019 (<https://on.mktw.net/2vIE4Zx>)

niches. They include cloud technologies, new-gen communication equipment, innovative batteries, aero-industry, etc.

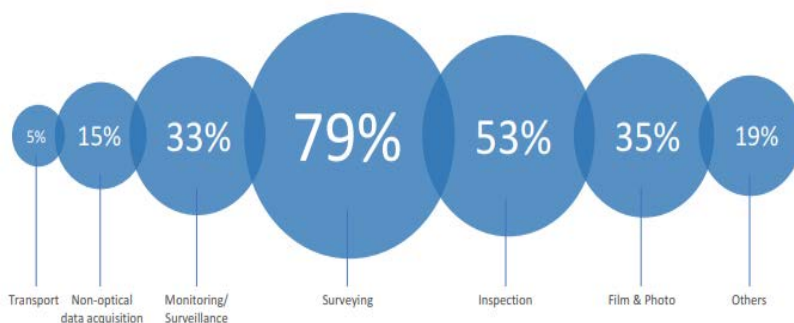
When it comes to the commercial drone production, it's tightly related to the hardware manufacturing, software development, and services. But the drone use spheres include agriculture, real estate, energy-production, etc. For the geographical separation, we use the following regions: North America, Europe, Asia, Middle East, Africa, and South Africa.

Of course, we are more interested in what is happening in Europe, because we should follow the strategy provided by European Aviation Safety Administration (EASA). Moreover, in this region, all countries take into consideration the sets of legislative changes offered by EASA.

# **European Drone Industry**

Drones with rotating wings take 65% of the European commercial drone market. Most of the drone makers design similar quadcopters. They can be used in various spheres and for various goals. However, the most popular niche is photography. The market share of drones used for this purpose is as much as 35%. But this causes a data privacy problem. That's why in many European countries, the drone use is strictly controlled.

The latest report of Droneii<sup>4</sup> shows which purposes the drones are used for:

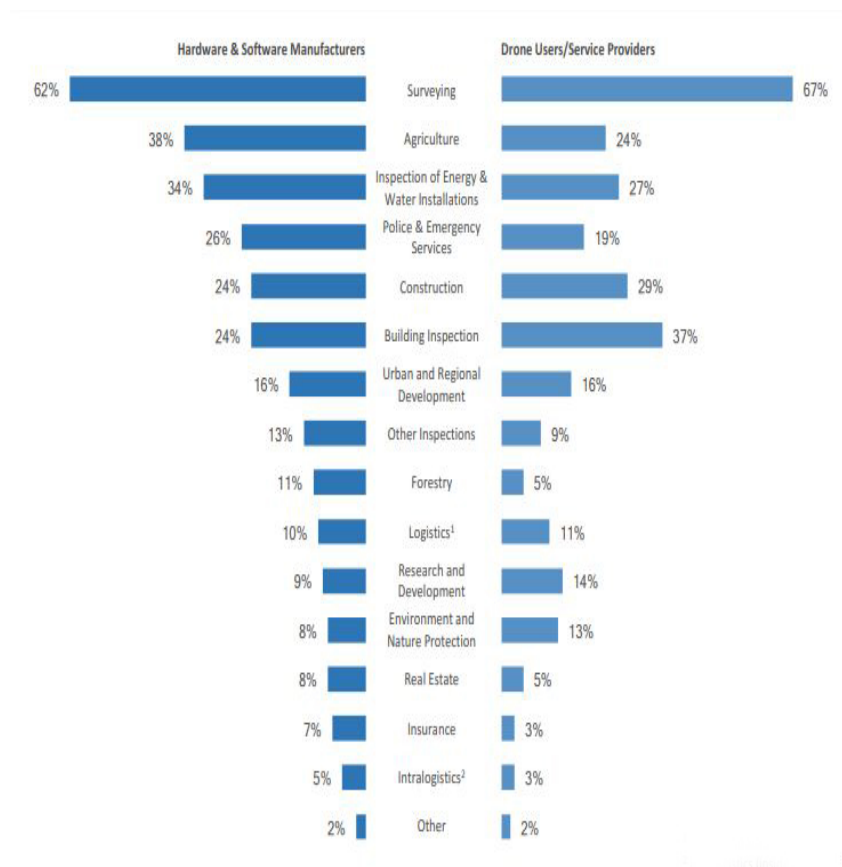


**Fig. 1. Use of drones by commercial users (in Europe)**

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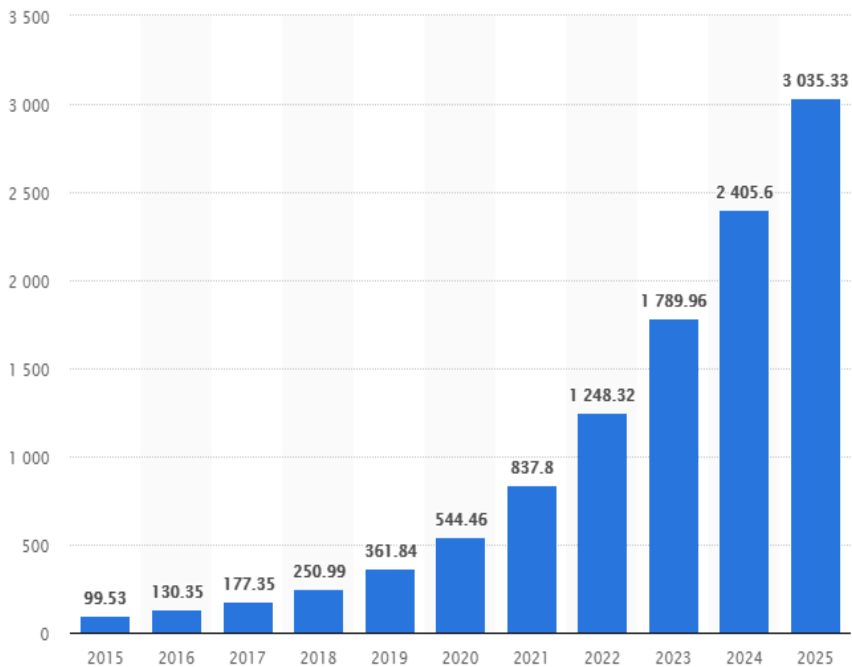
<sup>4</sup> The European Drone Industry, Drone Industry Insights | Whitepaper | June 2018 (<https://www.droneii.com/wp-content/uploads/2018/06/The-European-Drone-Industry-v1.1.pdf>)

This is going to change in the nearest future. Drones will be used in many other sphere due to the development of this industry and the emergence of new technologies.



***Fig. 2: Areas of application with the greatest growth in the next 12 months***

In its turn, this will bring income growth for those companies who are making drones or using them for commercial purposes. Some sources predict that growth will have the following picture<sup>5</sup>:

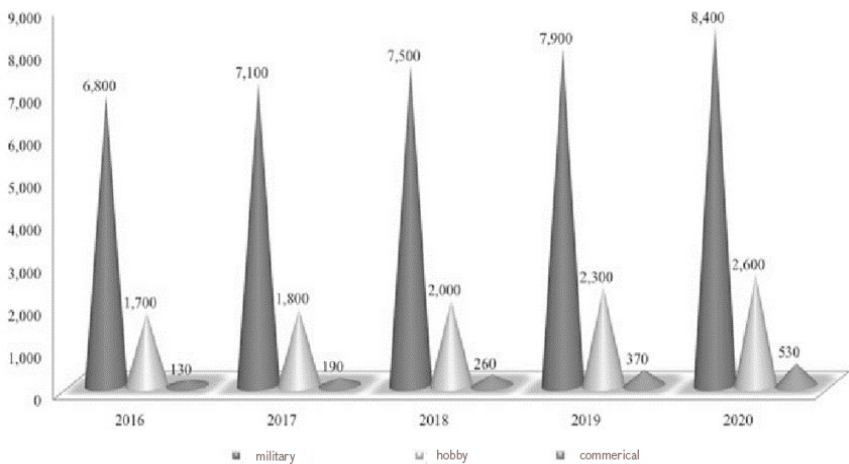


***Fig. 3: Projected commercial drone revenue in Europe from 2016 to 2025 (in million U.S. dollars)***

<sup>5</sup> <https://www.statista.com/statistics/607794/commercial-drone-market-revenue-in-europe-projection/>

However, there is a problem that refers not only to the European market but also touches the global drone industry. As drones have a multi-use meaning, it's quite difficult to regulate the niche in the way to meet expectations of all parties. Those difficulties are also related with the features of drones (size, weight, power, controlled distance, etc.). Therefore, when regulating this niche, the governments should take into account benefits of all parties` market, government, military use, research institutions, and society.

In the figure 4, we can see the predictions for the global drone use:



***Fig. 4: Prediction of drone use till 2020***

In this sense, it's quite important to understand what's happening in the RA and in this region. In Armenia as well as in neighbor countries, there are UAV productions. As you can guess, they have only military purpose. The Armenian drones are manufactured in the Republic of Artsakh. Besides this, there are myriads of foreign companies that are investing in the local firms. Particularly, there are Danish and Russian companies who are engaged in the drone production and make large investments.

However, because of the niche specifics, there is no statistical data. As for their civil use, as there are no laws restricting their application, institutes recording drones activities, authorization agencies, we can't get precise data.



# **DRONE USE**

## **Precision Agriculture Drones**

## ***What is Precision Agriculture?***

Precision agriculture is a farming management that observes, measures and responds to inter and intra-field variability in crops. Its main goal is to help farmers to optimize *crop science* by matching farming practices to crop needs, *environmental protection* by minimizing the farming footprint, *economics* by increasing the competitiveness through better practices and implementations. Precision agriculture measures different variables such as crop yield, terrain features, organic matter content, moisture levels, nitrogen levels, PH and other. It is considered to be a key component of new wave in modern agricultural revolutions and comes in the form of satellite imagery, weather prediction, fertilizer application, crop health indicators.

Precision agriculture is a new step for farmers as it also requires recording the farming activities, improving decision making process in agriculture, improving relationships with landlords and increasing the quality of agricultural products. The use of mentioned competitive activities created the understanding of prescriptive planting which is a type of farming system that requires data-driven planting in order to maximize yield (J. Bunge, 2014).

Precision agriculture is usually done in four sequential stages, as follows:

1. **Data collection:** Geolocating the necessary field helps the farmer to have information gathered from analysis of soils, crops and soil resistivity. Delineation of the field can be done either using an in-vehicle GPS receiver or on a basemap derived from aerial imagery.
2. **Variables:** Agricultural sphere covers number of variables that can be grouped into permanent indicators and point indicators. These include variables about climatic conditions, soils, cropping practices, weeds, disease, etc.
3. **Strategies:** Using soil maps, farmers have a possibility to implement two strategies which are predictive approach (based on crop cycle static indicator analysis) and control approach (information from static indicators is regularly updated during the crop cycle by sampling, remote sensing, etc.).
4. **Implementing practices:** The implementation of precision agriculture includes the use of technology on agricultural equipment such as sprayers, tractors and others.

## ***What is the role of drones in precision agriculture?***

During the last few years new technologies and techniques are continuously being employed to turn the data collected into usable information and low-tech industries such as agriculture have also become included into these changes. The new era in agricultural activities brought hand-written notes and analysis of farmers into robotic data collection and analysis through modern software, remote sensors and drones that are being created to improve yields and profitability in line with the sustainability. These improvements required investments totaling to \$4.6 billion (the major part in the software and technology) only in 2015 in order to bring traditional agriculture into digital agriculture (L. Burwood-Taylor, 2015).

Drones today are able to provide farmers with three types of detailed views.

1. The view of the crop from the air can make noticeable things that cannot be seen easily while using traditional methods.
2. Cameras can take multispectral images that help to create a view of crop to show the health level which is unable for a naked eye.

3. Drones survey crops every week, every day or even every hour, is able to create time-series animation, to take crop management into a higher level.

Drones will give agriculture to plan and make strategy on real-time data gathering and processing. There are six general ways that drones can be used in agriculture (M. Mazur, 2016):

1. **Soil and field analysis:** Drones can produce 3D maps for early soil analysis that can be very useful at the start of the crop. After the planting phase is done, soil analysis implemented by the drones delivers data for irrigation and nitrogen level.
2. **Planting:** Drones give an opportunity to shoot seeds and plant nutrients into the soil, providing the plant and the soil the nutrients needed for healthy life.
3. **Crop spraying:** Drone adjusts the altitude as geography varies base on the technological advances avoiding smashes. Having these characteristics drones are able to scan the ground and spray the right amount of liquid on the plants. As a result farmers have higher efficiency and lower consumption of chemicals and time.

4. **Crop monitoring:** Large fields make several obstacles for farmers as it with the size of the fields it becomes more and more difficult to monitor the crops. These obstacles become more dangerous with unpredictable weather conditions. Drones are able to help the farmers to fight also these problems giving them an opportunity to have time-series animations and unlimited photo-shoots for monitoring purposes.
5. **Irrigation:** Drones with appropriate sensors can give a chance to identify the parts of the fields that need water or other improvements. These sensors also help to calculate the vegetation index after the crop grows, showing the health and growth of the crop.
6. **Health assessment:** Agriculture always struggles to provide healthy products to the consumers so the assessment of health of agricultural products is of high importance level for all the farmers. Drones are able to scan the crops using specific lights. The outcome can be multispectral images that help to track changes in plants and indicate their health. A fast alarm can be sent to the farmer if some diseases are discovered, so farmers can monitor the sickness in a precise

way. This will help the farmer to overcome the diseases in the field.

### ***What are Pros and Cons of drones in precision agriculture?***

Drones encountered technical controversies in the past and it has its advantages and disadvantages in the farm use which will be introduced below.

#### **Pros**

- **Analysis:** Drones are good to be used for soil and field analysis that make available almost all the information about them.
- **Ease of use:** unlike traditional aircraft, the drones are easier and more understandable to use.
- **Mapping:** Drones make the survey of land and measurement of the area easier than farmers traditionally do. So once the drones are optimized, they can make images or spray fertilizers.
- **Prevents infestations:** Drones are able to show the farmers the currency of any animal or insect infestation which can

save and increase the health of the field by ultrasonic waves.

- **Moisture monitoring:** Farmlands are usually either drier or wetter than needed and drones can help the farmers to detect both types of phenomenon in the fields that can help to save the crops.
- **Reducing operational costs:** Mainly labour costs are reduced by use of drones. Drones can be seen as alternative manpower to the farmlands that assist the farmers in different aspects.
- **Increase yields:** Potentially finding yield limiting problems can help farmers increase production and efficiencies to higher yields.

## Cons

- **Flight time and range:** Most of drones have short flight times averaging in 40 minutes which can make limits for several things such as the acreage, the radius covered during on flight, etc.
- **Initial cost of purchase:** Drones constructed for agricultural use are costlier as they are equipped with the necessary equipment and software.



- **Laws:** The use of drones for agricultural purposes is considered as commercial use of drones so the farmers need to have a remote pilot certificate or hire an operator to drive the drone.
- **Connectivity:** Most of the farmlands worldwide have little online coverage if any which means that farmers using drones have to either invest in connectivity or buy a drone capable to store data locally in order to process it later.
- **Weather dependent:** If it is very windy or rainy outside it may not be possible to fly the drones.
- **Safety concerns:** Drones can create problems if not flown properly hitting people or vehicles.
- **Time commitment:** it takes more time than most expect from someone who has passed their drones systems test.

Drones have a growing role in agriculture assisting farmers to visualize their crops across their farmlands. Farmers usually have an increase in ROI after they start using drones. Drones help to save time and crops and to avoid losses from infestation and weather changes.

It is expected by different scholars and companies that precision agriculture will fundamentally change agribusiness

transforming almost everything in the value chain. Global Market Insights in its turn forecasts that the market size of drones specialized for agriculture will reach \$1 billion having around 200000 units by 2024. Farmers just need to realize that drones are the ticket to financial success and a better place to live.

# **Environmental Applications**

## *What is the Environmental Application of Drones?*

One of the greatest problems that the world is facing today is that of environmental pollution, increasing with every passing year and causing critical and irreparable harm to the Earth. One of Environmental pollution basic types is the air pollution, which is the most harmful form of pollution in our Environment. It is caused by the damaging smoke emitted by vehicles and factories. Evidence of increasing air pollution is seen in various breathing problems and diseases along with severe and irreparable harm to flora and fauna. Even the most natural phenomenon of migratory birds has been laden, with severe air pollution preventing them from reaching their seasonal metropolitan destinations of centuries. Today many companies from different parts of the world are trying to decrease this phenomenon by reducing their environmental footprint. The industry of drones is an inseparable part of this worldwide project and tries to find environmentally friendly solutions to the current issues. Drones help to not only decrease air pollution levels, which are harmful especially for people life, but also make the lifestyle of each of us easier and more comfortable.

At first sight it is a little bit difficult to imagine how important the drones can be in environmental protection processes,

as when we think of drones, most often we think them to be used for military purposes. Despite its common association with the military, drones are increasingly being used to sustain and improve the environment and already have a special mission: ***saving the Planet.***

The enrolment of drones in protecting and conserving the Environment helps to gather accurate and timely information in a non-harmful way. Drone technology suits a numerous environmental protection applications - offering quick, easy and cost-effective aerial imagery. In the scope of Environmental protection there are many reasons why professionals such as environmental engineers and scientific researchers are increasingly using drones. The area of drone use may start from glacial feature modelling and erosion monitoring to animal counting and species identification. The list of projects that drones are being used for is long and continues to grow. Here are some of them which should be discussed in the scope of Environmental Applications of Drones.

- **Sustaining sustainable energy:** One of the areas we are most likely to find drones at work these days are on solar farms. Solar farms can cover anything from one to one hundred acres and maintaining them manually can be both impractical and dangerous,

especially as engineers often want to inspect panels for defects when the sun is at its most powerful. As the solar electricity plants are larger, bigger and beyond the kind of scale that humans can handle the scientists have created *thermal imaging cameras* which provide an aerial overview to pin-point panels that might be damaged, covered in dust or obscured by invasive vegetation. Engineers then process this information and return to these specific locations to fix the panels at convenient times, making for more efficient maintenance. Drone inspections are keeping large-scale solar energy projects running around the world and mapping capabilities are assisting solar companies in the planning and building of solar farms.

- **A mission on emissions:** Protecting the Environment by mapping industrial emissions has its important role in drone industry. When we think of mapping it is often in relation to real estate or agriculture: developing an in-depth view of an area that can be used for planning and modelling. But one start-up in Finland called *Aeromon* (<http://www.aeromon.fi/>) is able to detect, measure and visualize more than 70 different industrial emissions and map air quality over large areas. With their solutions you can have automatic reporting of our emissions with a 360 degree view. In the past, these emissions might have gone undetected because

emissions sensors at ground level or higher altitudes would have missed them, but the flexibility of Drones means the data provided gives authorities more power when it comes to enforcing emissions legislation. With emission targets being set around the world in a bid to slow down global warming, it is easy to see how technology like this can help governments and authorities keep factories and fossil fuel companies in check. As says the *Aeromon* team ***“Emissions are complicated. They may be undetectable, but their damage is real.”***

- **Environmental conservation projects:** As well as being environmentally friendly in terms of performance, drones can help in the application of environmental research projects and wildlife preservation. Their agility and compact size mean they can be quickly deployed to monitor hard to reach areas with minimal impact. This makes them ideal for environmental observation projects from monitoring and mapping natural landscapes to tracking animal migration patterns. Small and light electric-powered drones, especially fixed-wing aircraft, make little noise and are often bird-shaped, meaning animals on the ground are rarely disturbed by these tools, if they notice them at all. Equipped with infrared cameras, drones are being trialled in hot and remote locations, to detect leaks in underground water pipes in the desert.

## ***What are Pros and Cons of drones in Environmental Application?***

### **Pros**

- **Environmentally friendly:** The big advantage of using a drone in the sphere of protecting Environment is that they are doing their missions causing minimal disturbance to the surrounding environment and wildlife. In comparison to other aerial vehicles the drones have the smallest motors which help to have as fewer emissions as possible. Most drones do not operate using fossil fuels meaning that they do not produce the high levels of CO<sub>2</sub> associated with planes and helicopters which makes them a more environmentally friendly alternative for aerial works.
- **Flexible:** Another valuable advantage of drones is that they have an ability to reach areas that were before too hard to access for conservationists and environmental researchers, while also generating minimal disturbance to the surrounding wildlife and environment, make drones a powerful tool that can give researchers the freedom to gather information like never before.



- **Safety:** One of the large benefits of using a drone over alternative methods is the added safety value they can provide. People who work in remote or more dangerous locations do not have to be put in harms way if they have to do aerial surveys over parts of the jungle, or, f.e., in the Arctic. Also we can mention that the launching a drone requires a minimal amount of workers which is also a good benefit for it.
- **Non-noisy:** One of the added bonuses is that the drones make minimal noise while they realize their missions. This means that the wildlife and surrounding nature can be monitored undisturbed, which is very important thing while we do some researches in in wildlife.
- **Small sizes:** Mostly the drones are lightweight, low-cost, require little in the way of infrastructure and, crucially, use little or no fuel, as we already know. All these mentioned factors are considered to be pros for drones.
- **Drones for environmental monitoring:** Photographers and videographers have started to use drones to produce stunning images of wildlife that would be very hard or expensive to obtain otherwise. Drones can be used to

perform environmental science as well. Often, scientists want to monitor one particular area for a period of time in order to track changes. For example, a buoy could listen for whales in a particular region. A robot could fly out to get that data, which then could be used to establish safe shipping lanes. A robot would be able to repeatedly see what's going on with a population or a microhabitat. Scientists probably don't have funding to send people out every day but they still could get really good readings.

- **Overall Conservation:** Drones can be used to track animals, particularly dangerous animals, without putting anyone at risk. They can also be used to watch for poachers and trespassers, increasing security in areas where there is simply too much ground to cover. Additionally, drones can be used to provide aid when natural disasters strike. Whether it is to comb an area after an earthquake or flood to look for survivors, or fighting fires by delivering payloads, drones are a powerful tool in the fight to keep wildlife, and wild areas, safe.

- **Brand new technology:** Drones are allowing people to ask questions and look at things that they may not have been able to look at before!

## Cons

When we try to speak about the negative impact of using a drone to the Environment, it is difficult to make a list and mention disadvantages, because the drone has a high level of conservative effect and almost completely has positive impact on our Planet.

In base of the above mentioned information we have already imagined the connection between the drones and the Environment, and found out that causing minimal disturbance to the surrounding environment and wildlife, the drones in the air can perform surveys, collect data and imagery, monitor wildlife and varying landscapes and even track or count animal populations. We have explored that drones – being a brand new technology hold a wide variety of advantages to those looking to aid in the protection and conservation of the environment and its wildlife. Drones most crucial advantages are that they are *timely, efficient and cost-effective* due to which now many conservationists and environmental researchers are aimed to enlarge the drones using spheres protecting our planet and making it to be more

conservative. The drones have all the potential to become more widely available across the whole spectrum of environmental monitoring in near future and they will!

# **Industrial Applications**

## ***What is the Industrial Application of Drones?***

In the beginning people were looking at drones as just another way to get pretty pictures or video, but now these people are starting to realize that these have an immense power for doing research from perspectives that we never thought we could get.

The innovation of an industrial drone is to monitor regions or terrains inside or outside a manufacturing plant which generally cannot be studied by human workers, either due to their dangerous setting or inaccessibility due to size or Environment. Factories, refineries, power grids, wastewater treatment, mines and other similar industrial sites are complex systems requiring inspection and maintenance for optimal operation and regulatory compliance. Onsite inspection by human workers can be time consuming and in explosive environments, next to impossible unless some complex computer systems are used. Industrial drones can operate under complex circumstances such as these and enter even the most challenging terrains and environments and carry out the operation it was designed for without so much as a scratch. From this it is clear that drones are the next generation in low-cost industrial sensors and mobile platforms in the interconnected web.

The growth of drone industrial application can be seen in its use in various industries, such as:

- **Energy and Utilities:** Part of making our electrical grid smart is getting access to real-time information on the status of power generation and transmission infrastructure. Utilities have already tested drones for inspecting transmission and distribution lines, looking for damage from storms and normal wear and tear. These tests have been run under temporary rules from the Federal Aviation Administration and utility companies are now ready to further demonstrate the value of drones. Imagine a utility that had a drone in every single line worker's truck. Workers could perform inspections without having to climb power poles or get close to dangerous wires. Drones can also inspect hundreds of miles of transmission lines in single flight - much faster than the traditional line worker having to climb several transmission poles.
- **Oil and Gas:** Drones are increasingly being used by the Oil and Gas industry for their monitoring and inspection operations. They are being used today to detect gas leaks, spot fugitive oil spills and even scout for whales. They can be used on any part of the platform where inspections

typically require rope access or scaffolding. Today drones are predominantly used in the midstream oil and gas sector. But they can also be applied to almost every aspect of the industry, including land surveying and mapping, well and pipeline inspections, and for security purposes. The key benefits are that they are much safer, faster and cheaper than conventional inspection techniques such as rope access and scaffolding. The use of drones means that oil platforms do not have to shut down for inspections. This is a huge cost benefit as shutdowns cost oil companies millions of dollars in lost revenue a day.

- **Mining:** Anyone involved in mining knows that worker safety is of paramount importance. By allowing surveyors to collect accurate spatial data from above, drone can vastly reduce risk by minimising the time these staff spend on site. Drone-based data collection can also increase productivity; surveying projects that once took days or weeks using traditional surveying techniques are now possible in just a few hours. Drones provide an efficient way to manage stockpiles and help with grading control, site exploration, and overall management. Drones can also help miners figure out more efficient ways to design haul roads, dumps,



and pits so they have less of an impact on the environment. Drones can improve safety in mining applications with real-time information on mining activities:

- Up-to-date surface surveys for optimized blast designs,
  - Rapid pre- and post-blast data,
  - Identification of misfire and wall damage.
- **Construction:** Here bellow are mentioned some reasons why construction firms want to use drones in their activities:
- Drones are less expensive than manned aircraft. They are easier to operate and collect more data in comparison to alternative aerial vehicles.
  - Drones can be used to survey the construction site and send information back. This usually takes a long time and requires use of various equipment and personnel. Drones are cheaper and they are more accurate in terms of data gathering.
  - Companies can use drones to provide client updates. If they are unable to personally inspect the site, companies can send some images and videos and show details of the construction progress.

- Drones are also ideal for monitoring the site. Rather than invest in loads of expensive manpower and equipment, a construction company can purchase a few drones and have them scan the area and collect information.
- **Agriculture:** Drones a natural fit with the world of agriculture, where farmers can benefit from real time information about large tracts of land. Drones can help track almost everything including water use, crop health, heat signatures and soil analysis. Expensive aerial surveillances that could previously only be done occasionally with planes can now be completed weekly or even daily with drones that cost only hundreds of dollars. Agricultural uses for drones include: remote moisture sensing to identify which parts of a field are dry or need improvements, precision agriculture like mid-field weed identification, frost mitigation, variable-rate fertilization dispersal etc.

The mentioned areas do not include the final list, the industrial application of drone is larger concept and includes more spheres. But, actually the above-mentioned information goes to show how important drones are. From being used by the military, they quickly found a market for fun and recreational use. The coming the 4<sup>th</sup>

industrial revolution will alter how people and companies interact, work and play. With the rise of the digital age, drones will change the way farmers grow crops just as it is going to revolutionize the way mining firms assess their projects. From construction, scientific research, commerce, entertainment, drones will play a significant role in near future. With cost going down, a drone has become a worthwhile investment in growing number of industrial sectors.

# **Civil engineering drones**

## ***What is civil engineering?***

Civil engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams and buildings<sup>6</sup>. Civil engineering is traditionally broken into a number of sub-disciplines<sup>7</sup>. It is the second-oldest engineering discipline after military engineering<sup>8</sup> and it is defined to distinguish non-military engineering from military engineering.

Civil engineering takes place in the public sector from municipal through to national governments and in the private sector from individual homeowners through to international companies.

## ***Using drones in civil engineering***

The horizontal nature of civil engineering lends to some practical and creative uses of drones in the industry. From planning to final construction, nearly every stage of the engineering process can benefit with the help of drones.

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<sup>6</sup> ["History and Heritage of Civil Engineering". ASCE. Archived from the original](#) on 16 February 2007. Retrieved 8 August 2007.

<sup>7</sup> ["What is Civil Engineering". Institution of Civil Engineers](#). Retrieved 15 May 2017.

<sup>8</sup> ["Civil engineering"](#). Encyclopædia Britannica. Retrieved 9 August 2007.

In fact, drones are now widely being used in the engineering and constructions fields. Many firms are using drones to evaluate the exterior conditions of their client's facilities, such as the roof and other hard to get to locations. That can mean more accurate inspections with less worry over a worker falling from a ladder during the inspection. Drones are even being used during the construction and installation portion of projects.

Drones provide better resolution when it comes to photos and video, while reducing the cost to a firm. That is a big advantage and savings over previous technologies such as satellite and other aerial resources.

Civil engineers are using drones to perform 2D and 3D mapping projects. This is achieved using laser scanning devices and can help engineers construct virtual representations of real-world projects – assisting engineers in the planning and development stages of their most difficult projects.

Drones in civil engineering can be used for aerial mapping, LiDAR scanning, pipeline surveying, aerial photography, etc.

**1. Aerial mapping:** More and more companies are using drones for surveys and mapping. For instance, [DroneDeploy](#)

users have mapped over 10 million acres, which generated an estimated \$150 million for the commercial drone industry. Here below are mentioned some *benefits* of using drones for surveying and mapping.

- **Ease of Deployment.** Drones are capable of completing survey jobs in less than half the time of traditional survey methods. Surveys that once took weeks to complete, can now be done in less than a few days. This allows for surveyors to complete more projects in less time.
- **Reduced Risk.** Using UAS for data collection reduces the need for workers to enter potentially hazardous areas. The small, portable size of drones make them ideal for collecting data in a variety of different environments like roadways and steep terrain.
- **Detailed Data.** Drones equipped with imaging software make it easy to turn images into a wide variety of georeferenced 2D maps and 3D models for surveying, city modeling, large-scale mapping, urban planning, cadaster and more.

**2. LiDAR scanning:** LiDAR is a laser-based remote sensing technology and stands for light detection and ranging. It is a

technology widely used in the domain of geographical information system (GIS) for surveying and mapping different kind of natural resources and infrastructures.

As a matter of fact the LiDAR technology is being used in numerous scientific fields, related to geomatics, which are relying on high accuracy definition of terrestrial three-dimensional points position. This includes combining these data with an extremely precise and faithful calculation of the distances and angles between them.

LiDAR scanning drones are well known and often chosen for their ability of producing high-resolution maps for a broad range of activities like remote sensing, atmospheric sensing, geomatics, geography, geomorphology, archaeology, forestry, contour mapping, laser altimetry, geographic informatics, etc.

**3. Pipeline surveying:** Building an oil and gas pipeline project is a major challenge for any organization to undertake. When it comes to building a successful pipeline, the costs and time requirements are high and the margin for error must be minimized. As a result, if organizations hope to complete a successful pipeline development project with no major interruptions and minimal unforeseen costs, it is essential that



they take advantage of the most advanced technologies available to them to collect as much data up front as possible.

One example of a technology that can help organizations experience better results with their pipeline projects is the drones. The benefits of drones for the land surveying portion of a pipeline project are numerous.

The most important **benefits** of using drones for pipeline surveying are:

- **Completing large surveys with a high degree of accuracy:** One of the chief challenges of pipeline projects is the total amount of distance they must cover and nowhere is this challenge felt more than in the land surveying stage of the project. Of course, pipeline projects require a high degree of detail and accuracy, but organizations need a way to ensure that getting this accuracy does not slow down the project too much. Some drones can cover miles of linear coverage per day, meaning that they can fly the large distances required by pipeline projects much faster than traditional surveyors traversing the land. At the same time, drones can fly close to the ground while using high-resolution image

capturing technology that offers up detail as fine as one centimeter per pixel. Drones truly offer the best of both worlds when it comes to covering long distances and providing high levels of accuracy. By bypassing difficult terrain altogether, drones allow a land surveyor to gather all of the information they might need without actually having to put people on the ground. Instead, surveyors can operate the drones from a position of complete safety. Additionally, the amount of data that is collected is exponentially more than that collected by traditional crews.

- **Turning around survey results quickly:** Another important goal for land surveyors should be to complete their work as quickly as possible so that the pipeline can begin construction. However, this can't take place if the results of the land survey require weeks or even months of processing time before they can be used. Working with a team of experienced drone operators is not just a great way to speed up the actual data collection process; such an operator can also begin processing and analyzing that data immediately after it is captured. As a result,

land surveying results captured by drones are often processed and available for use within 24 -48 hours of when they were originally captured. This extremely fast turnaround enables organizations to start building their pipelines quicker, which in turn enables them to start experiencing returns quicker.

- **Sharing the data with key contractors and stakeholders:** Collecting massive amounts of data is pointless unless decision makers have a way to access the information easily and extract what they need. Key divisions/subcontractors that should receive access to drones data at the earliest possible stages include: surveyors (internal use), engineering, environmental, land / right of way, project managers and any other companies (such as construction) who are authorized to view and bid on the upcoming project. Sharing this data will ensure that everyone is on the same page and that bids are much more accurate since the most recent conditions along the route are available for analysis.

**4. Aerial photography:** Aerial photography is one of the best ways to monitor a construction site, a building, civil engineering projects, a work of art, etc. An aerial overview with drones will be a great help for the project managers in order to, among others:

- study the site before the operations start
- monitor and control the evolution of the activities and proceedings
- present an overview of a site
- check the quality of the work
- follow the deadlines in relation with the work progress
- monitor the compliance of the works with the specifications
- promote their know-how, skills and knowledge for future projects
- bring out and underscore the quality of the work.

High technology, precision, adaptability, endurance and robustness are some of the numerous Drone qualities explaining why these devices are so needed for improving working quality on the demanding sectors of architecture and civil engineering.

# **Safety and Security**

Day by day drones are becoming increasingly more commonplace in the Globe, from aerial photography to assisting search and rescue operations, drones can be put to a variety of beneficial uses. However, the use of drones also carries concerns relating to both safety and security.

The idea of having drones in the national airspace raises serious safety concerns for nearly the entire spectrum of society, which ranges from government facilities and aviation authorities to regular individuals. The safety concerns that have caused to limit the use of commercial drones, including only granting a few permissions on a case-by-case basis, are primarily related to the capabilities of a drone, the potential for accidents and the possibility of privacy rights becoming an issue.

According to the “Washington Post,” more than 400 U.S. military drones have fallen out of the sky since 2001. Drones are not just harmless toys – even some high-end consumer models reach speeds of around 80 km/h, which is very fast for a remote-controlled piece of ballistic metal and carbon fibre. While a car may be larger and travel faster, the big difference is that the drone pilot is not personally at physical risk in the case of a collision, and may therefore put the drone into situations that are extremely

dangerous in search of that perfect YouTube footage – such as the flight path of an aircraft ( <https://www.refund.me/drones-much-safety-risk/>).

Drones are already more widely used in the security industry. Whilst much attention is being given in the media to countering the threat posed by drones should they stray too close to sensitive sites like airports, whether by accident or design, on the other side of the coin drones have proven that they can have a positive impact. The performance of these systems, with the added dimension they bring in terms of situational awareness via high definition cameras and even thermal imaging, and in-use economics compared to other aerial solutions like helicopters, means that investment in such assets by the emergency services as well as security professionals is really taking off.

What about the ***Security Requirements*** they exist in order to protect the confidentiality and integrity of a drone's acquired and communicated information and to ensure its ability to adhere to its operational requirements. Securing the information of the system refers to protecting it from disclosure, disruption, modification, and destruction.

For a secure drone operation, let's identify the following security requirements:

- **Authorized access:** The drones must provide means to ensure that only authorized operators are granted access to its resources including both the ground control station and the aircraft.
- **Availability:** All the elements of the drones should be guaranteed to perform their required functions under defined spatial and temporal circumstances such that the system sustains its availability without disruption during its operational period. For instance, the drone must adopt measures such as anomaly-based intrusion detection systems to distinguish normal communications from those resulting from denial-of-service attacks.
- **Information confidentiality:** The drones should employ mechanisms to mitigate unauthorized disclosure of the telemetric and control information.
- **Information integrity:** The drones should be able to ensure that the telemetric information and the GPS and control signals are genuine and have not been intentionally or unintentionally altered. Authenticated encryption



cryptographic primitives may be used to ensure both the integrity and confidentiality of such information.

- **System integrity:** The drones should be able to guarantee the authenticity of its software and hardware components. Techniques from trusted computing such as memory curtaining, sealed storage, and remote attestation can be used to ensure the authenticity of the system's firmware and sensitive data. The deployment of intrusion detection systems, antivirus software, firewalls, and strict policies regarding the use of external storage media can aid in the detection and prevention of malware.
- **Accountability of actions:** The drones should employ mechanisms that enforce non-repudiation to ensure that operators are held responsible for their actions. Digital signature algorithms may be used to both authenticate the operators and to bind them to an issued action. Moreover, logging procedures that are used to chronologically track the sequence of actions and changes in the system should be implemented.

### *Some solutions of drone for safety and security*

1. **Better visibility.** Drones help to minimise unwanted surprises, provide useful insights and help emergency personnel stay out of harm's way.
2. **Multifunctional design.** Drones adapt to the demands of the situation at hand faster and easier than ever before with the click and go payload system.
3. **Easy to deploy.** Drones deploy in a matter of seconds of arriving on scene, to respond faster and minimise the danger to those in need of assistance.
4. **Real-time awareness.** Equipped with infrared and VOC sensors, drones detect individuals and radiation that would otherwise go unseen.

### *Different functions of drones for safety and security*

#### ❖ **Saving lives (drone-assisted rescues for coast guards).**

- **Faster response:** Drones can be deployed in a matter of seconds and minimise the danger to those in need of rescuing.
- **Optimised visibility:** Drones improve a coast guard's overall visibility of an expansive sea to locate vulnerable persons faster.

- **Thermal detection:** Drones are equipped with thermal sensors to maximise the operator's ability to quickly spot individuals lost at sea.

❖ **Accident mapping (a safe, affordable and reliable method of documenting crashes).**

- **Faster documentation:** Drones can help to document car accidents much faster, lowering the risk of further accidents happening to police and passersby.
- **Accurate evidenc:** Drones easily document crash sites by collecting measurable and reliable data to determine the cause of the incident.
- **Less invasive:** Drones easily deploy kilometers away from the scene to reach hard to access areas while reducing the level of disruption to traffic.

❖ **Surveillance (monitor subjects of interest without risk).**

- **30x zoom:** Drones are equipped with 30x zoom cameras to effortlessly spot subjects of interest from a great distance.
- **Less sound pollution:** Deploy drones to be more difficult to detect by suspects than manned helicopters.

- **Thermal IR vision:** Drones track individuals that blend into their surroundings or are active at night by utilising infrared sensors.
- **Stream & record:** Drones can simultaneously record both the visual and thermal video streams.
- ❖ **Helps to be aware of invisible threats (protect yourself from gas and radiation leaks).**
  - **Gas monitors:** Drones can monitor hazardous materials like toxic and combustible gases, VOCs and oxygen levels from a safe distance.
  - **Radiation monitors:** Drones can detect gamma radiation levels from afar with parts per billion precision.
- ❖ **Helps to stay safe and alert (livestreaming capabilities ensure you are well informed).**
  - **Real time analytic:** Drones can help to stay protected from unexpected and unseen dangers with augmented livestream video. Whether it's thermal detection, or tracking a subject of interest.

❖ **Drones are built to perform in any environment (drones guarantee your mission's success in every environment).**

- **Are for all weather performance:** The fuselage effectively shields the components inside against heavy rain and dust intrusion to ensure reliable operations.
- **Are capable of flying in wind speeds** of 14 m/s and tested in both the harsh cold of the arctic and blistering heat of the desert to ensure it will perform in any environment.

All these mentioned points are important while using a drone. If we maintain our safety procedures, maintenance and best practices nobody is saying we will never have an incident, but we are definitely minimizing our risk and getting much better odds!