HISTROY

Unmanned aerial vehicles (UAVs) are aircraft with no on-board crew or passengers. They can be automated ‘drones’ or remotely piloted vehicles (RPVs). UAV’s can fly for long periods of time at a controlled level of speed and height and have a role in many aspects of aviation.

The first pilotless vehicles were developed in Britain and the USA during the First World War. Britain’s Aerial Target, a small radio-controlled aircraft, was first tested in March 1917 while the American aerial torpedo known as the Kettering Bug first flew in October 1918. Although both showed promise in flight tests, neither were used operationally during the war.

During the inter-war period the development and testing of unmanned aircraft continued. In 1935 the British produced a number of radio-controlled aircraft to be used as targets for training purposes. It's thought the term 'drone' started to be used at this time, inspired by the name of one of these models, the DH.82B Queen Bee. Radio-controlled drones were also manufactured in the United States and used for target practice and training.

Reconnaissance UAVs were first deployed on a large scale in the Vietnam War. Drones also began to be used in a range of new roles, such as acting as decoys in combat, launching missiles against fixed targets and dropping leaflets for psychological operations.

Following the Vietnam War other countries outside of Britain and the United States began to explore unmanned aerial technology. New models became more sophisticated, with improved endurance and the ability to maintain greater height. In recent years models have been developed that use technology such as solar power to tackle the problem of fuelling longer flights.

Drones now have many functions, ranging from monitoring climate change to carrying out search operations after natural disasters, photography, filming, and delivering goods. But their most well-known and controversial use is by the military for reconnaissance, surveillance and targeted attacks. Since the 9/11 terrorist attacks, the United States in particular has significantly increased its use of drones. They are mostly used for surveillance in areas and terrains where troops are unable to safely go. But they are also used as weapons and have been credited with killing suspected militants. Their use in current conflicts and over some countries has raised questions about the ethics of this kind of weaponry, especially when it results in civilian deaths, either due to inaccurate data or because of their proximity to a ‘target’.

**AERIAL TARGET**

The Aerial Target, a British radio-controlled aircraft from the First World War. Its remote control components, which were designed by Dr Archibald Low, are part of IWM’s collection (see AIR 567 to AIR 571). It became the first drone to fly under control when it was tested in March 1917. The pilot on this occasion was the future world speed record holder Henry Segrave

**The Queen Bee**

The Prime Minister, Mr.Winston Churchill, with Captain The Right Honourable David Margesson, Secretary of State for War, watching preparations being made in an unspecified UK location for the launch of a De Havilland Queen Bee seaplane L5984 from its ramp. The Queen Bee pilotless target drone was a radio-controlled version of the Tiger Moth trainer.

**Drone prototype**

A remote-controlled drone prototype based on a B-17 Flying Fortress airframe takes off from Hilo Naval Air Station in Hawaii 6 August 1946, to fly to Muroc Army Air Field, California, remotely controlled by United States Army Air Forces (USAAF) personnel nearby. This 2,600-mile journey involved two of these prototypes, taking almost 15 hours and setting a new endurance record for remote controlled aircraft.

**Drone trial**

The first Canberra U Mk 10 jet plane which was to be used as a pilotless drone aircraft in the Seaslug guided missile trials from HMS Girdle Ness, the Royal Navy’s guided weapons trial ship based at Malta, in 1961.

**The SDI surveillance drone system**

A drone of the SDI surveillance drone system, used by the Royal Artillery, is given a pre-launch check at Larkhill in Wiltshire, England, May 1962. This was the first of a family of new drones acquired by the Royal Artillery in the 1960s to extend observation over the battlefield and to locate targets for new long range weapons.

**RPV testing**

Two soldiers prepare to launch an RPV ( Remotely Piloted Vehicle ) drone from a Bedford three ton truck on exercise in Germany, probably in the early 1980s. The men, kneeling several yards away from the vehicle, control the drone through a remote keypad and joystick.

**Midge drone**

A technician serving with a Royal Artillery divisional locating battery checks the launch mechanism of a British Army Canadair RPV (Remotely Piloted Vehicle) Midge Surveillance Drone. The rocket powered Midge Drone was designed to carry out aerial photo reconnaissance on a pre-programmed flight. It was equipped with a single camera loaded with either black and white photographic film (daylight missions) or infra-red (night missions).

**Reconnaissance drone**

A pilotless drone aircraft designed for reconnaissance and artillery spotting used by British forces in the Gulf War, 1991

**Watchkeeper drone**

A British Watchkeeper UAV (Unmanned Aerial Vehicle) at Camp Bastion, the principal British base in Helmand Province, Afghanistan during Operation Herrick XVI (H16), August 2012. This UAV was operated by 32 Regiment, Royal Artillery for intelligence, surveillance, target acquisition and reconnaissance (ISTAR).

**Today’s drones**

An exterior view of pods at RAF Waddington in Lincolnshire from which MQ-9 Reaper unpiloted aircraft are operated.

**MQ-9 Reaper**

The interior of a pod at RAF Waddington from where the pilot (left) and sensor operator (right) fly an MQ-9 Reaper unpiloted aircraft on missions as part of Operation Shader. The Reaper is used for surveillance and reconnaissance, but is also armed for airstrikes.

Pakistan-born, US-based artist Mahwish Chishty held her first UK exhibition at IWM London. Chishty’s work combines silhouettes of military drones with decorative Pakistani folk art patterns to highlight the way in which the presence of foreign drones over Pakistan has become a feature of the physical, psychological and cultural environment of the country.

**FUNCTIONALITY**

**Working Principle of Drone and Flow Pattern**

The subject of Fluid dynamics plays a significant role in the design and development of aircraft and drones. This subject consists of the working principle of the aerodynamics of aircraft. A sufficient amount of upward force is required to lift the vehicle against gravity which is named Lift. A force created to move the vehicle or body in motion is called thrust. These forces can be studied using the kinematic laws of fluid flows. When air flows over an aerofoil and pressure, viscous and drag force act on the profiles.Force is directly proportional to the velocity of air at the inlet.The flow pattern around the cross-section of the aerofoil or propeller is shown below. High fluid pressure at the bottom and low pressure at the top of the propeller causes an upward force which is called a lift. This force is responsible for lifting the weight of an aero-plane or drone. The amount of lift force depends on the angle of inclination of the aerofoil or propeller.Based on the principle of conservation of energy in fluid flow (Bernoulli’s principle, the sum of all forms of energy in a fluid is constant along the streamline.When air flows over an aerofoil or wing, its velocity increases at the top portion. But the pressure of air decreases. In contrast, the air velocity decreases and pressure increase at the bottom side of the blade. The next pressure difference across the aerofoil results in an upward force which is called a lift.CFD modeling of flow over an aerofoil has been important in many vehicular and aerospace industries.

## ****Types of drones based on the number of Propellors****

A number of propellors are provided to drones. More propellors improve the stability of drones and load-carrying capacity but such drones need more battery power to drive more motors to get high power. A quadcopter is a more popular drone.

* + **Bicopter (2 propellers)**
  + **Triplecopter (3 propellors)**
  + **Quadcopter (4 propellers)**
  + **Hexacopter (6 propellers)**
  + **Octacopter (8 propellers)**

### ****Working  Principle of Quadcopter****

* A quadcopter has four propellors at four corners of the frame
* For each propeller, speed and direction of rotation are independently controlled for balance and movement of the drone
* In a traditional quadrotor, all four rotors are placed at an equal distance from each other
* To maintain the balance of the system, one pair of rotors rotates in a clockwise direction and the other pair rotates in an anti-clockwise direction
* To move up (hover), all rotors should run at high speed. By changing the speed of rotors, the drone can be moved forward, backward, and side-to-side

**Quadcopter Dynamics**

* The movement of drone are classified into four types based on the relation motion between four propellors: 1) throttle, 2) Pitch, 3) Roll, and 4) Yaw
* **Throttle/ Hover:** up and down movement of the drone is called throttle
  + If all four propellors run at normal speed, then the drone will move down
  + If all four propellors run at a higher speed, then the drone will move up. This is called the hovering of a drone
* **Pitch:**movement of a drone about a lateral axis (either forward or backward) is called pitching motion
  + If two rear propellors run at high speed, then the drone will move in a forwarding direction
  + If two front propellors run at high speed, then the drone will move in the backward direction
* **Roll**: movement of a drone about the longitudinal axis is called rolling motion
  + If two right propellors run at high speed, then the drone will move in the left direction
  + If two left propellors run at high speed, then the drone will move in the right direction
* **Yawn:** the rotation of the head of the drone about the vertical axis (either the left or right) is called Yawning motion
  + If two propellors of a right diagonal run at high speed, then the drone will rotate in an anti-clockwise direction
  + If two propellors of a left diagonal run at high speed, then the drone will rotate in a clockwise direction

**SKILLS REQUIRED FOR NEW ENTREPRENEURSHIP**

These days it seems just about anyone can get an FAA Section 333 Exemption that allows them to legally use small unmanned aircraft systems (sUAS) for commercial purposes in the U.S. As of October 20, 2015, almost 71% of all Section 333 grants have gone to firms claiming that their primary operation/mission is Film/Photo/Video (and most claim multiple uses). This includes companies that are using drones for movies, as well as for art and real estate, among other things. Inspection and Monitoring has seen the second highest issuance rate, at 31%, while Mapping and Surveying for land and commercial construction, rounds out the top three at 20%.

Looking further into the data, AUVSI reports that at least 84% and perhaps as many as 94.5%– of all approved companies are small businesses. While we don’t agree with their astronomical forecast (see our write-up here), we concur with this analysis.

But here’s the catch. With the bar so low for starting a commercial drone service, what’s the guarantee these businesses will succeed? According to Bloomberg, eight out of 10 entrepreneurs who start businesses fail within the first 18 months. A whopping 80% crash and burn. So given the risk, it makes sense to assess which markets and use cases provide the best chance of success, the skills you’ll need, and the value-add services you should be offering those markets.

Here are five services we think you should consider offering as part of your commercial drone business.

1. Video
2. Mapping
3. Photogrammetry
4. LiDAR
5. Spectral imaging

**Skill 1 – Video**

Now some of you may be wondering why I included video on my list. We often see drone video footage on YouTube and think it’s cool. But the hard fact is commercial buyers of drone video services have a much higher standard. So you will, too, if you want to make money in the Film/Photo/Video market. By now you know shooting good drone video starts with selecting the right drone, the right camera, with the right lens, mounted on the right gimbal. It’s not a secret any drone enthusiast can go out and buy a DJI Phantom Vision 3 for about $1,200 and shoot 4K video. But just because you can fly it and press the ‘record’ button does not make you a professional aerial videographer. There is much more to it than that. For one, shooting good video requires you to be skilled in the basics of

* Shots (FOV, framing, perspective)
* Moves (pan, tilt, truck, dolly, etc.)
* Technique (zoom, action, follow, etc.)

For another, there is timeline editing. What are you going to do with all that footage? Hand it to the customer raw? You could, but it’s better to have it edited or least know how it’s done so you can offer assistance or more services. For that, you will need to be skilled at

* Storytelling / sequencing
* Cuts
* Transitions
* Graphics
* Lighting
* Color grading

These aren’t all the things you need to know but if you don’t know these I suggest you get some basic film-school training and offer a better service than the kid next door with a quadcopter and a GoPro.

**Skill 2 – Mapping**

In researching drones and aerial photography and mapping, you might find yourself coming across new terms. One of the basic ones you should know is “orthomosaic photo” or “orthophotos.” Orthophotos (aka ‘orthos’) are basically photos that have been stitched together to make a larger one and then corrected. The technique is not unique to drones. Orthomosaics have been created by aerial photographers in manned aircraft for years and used by lots of industries.

The point here is if you are not familiar with the techniques and software to create orthos, then I recommend you acquaint yourself with it because it is a valuable service for which customers in the Mapping / Surveying market will pay handsomely. There are even drone apps that automate the whole process like DroneDeploy and Pix4D.

**Skill 3 – Photogrammetry**

Photogrammetry is a technique which uses photography to measure the environment. This is achieved through overlapping imagery; where the same site can be seen from two perspectives, it is possible to calculate measurements. Again, this technique is not unique to drone imagery, but there is some good news here. Off-the-shelf software, like Agisoft PhotoScan and SimActive, is plentiful and fairly easy to learn.

The hard part is providing your customer with valuable measurement information. And the harder part is competing with firms that have been offering this service for years now using ground-based systems combined with aircraft. For this, you will need some specialized skills and will need to be certified so that you are recognized. One way to get certification is through the American Society for Photogrammetry and Remote Sensing (ASPRS).

An ASPRS Certified Photogrammetrist is a professional who uses photogrammetric technology to extract measurements and make maps and interpret data from images. The Photogrammetrist is responsible for all phases of mapping and other mensuration requirements, which include planning and supervising survey activities for control, specifying photography or other imagery requirements, managing projects for mapping or other mensuration requirements and interpretation. You can find more information on their programs here.

**Skill 4 – LiDAR**

LiDAR drones are fairly new as the units have become smaller and lightweight. But LiDAR is not new to surveyors and engineers. They’ve been using ground-based and airborne LiDAR scanning units for years.

The good news is LiDAR drones are great for scanning small areas like building sites and getting in hard-to-reach areas like under bridges. In this way they provide a significant cost advantage over aircraft or helicopters with LiDAR units and have the greatest margin potential as a service for the Inspection / Monitoring market.

You can get trained and become a Certified LiDAR Technologist (CLT) through ASPRS. A CLT is technician who performs routine LiDAR collection support and first-level data processing integrating established plans and procedures. Find information on that here.

**Skill 5 – Spectral Imaging**

I put this here last because, as I mention earlier, it’s not clear whether drones provide a significant cost savings to the buyer vs. the same service provided by manned aircraft for the Precision Agriculture market. There are ROI studies being done now, but most people who provide this service will tell you that farmers aren’t willing to pay much for this service. Why spend $4 to $5 per acre for you to fly a drone overhead and deliver a normalized difference vegetation index (NDVI) map unless there is a clear return on that investment? Some will – like growers of high-margin crops like fruits and nuts – but most won’t. Again, this is a competitive market that demands a lot of knowledge about precision agriculture and remote sensing techniques.